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SECTION OF ENGINEERING SCIENCES**

President: Dr. Asit K. Das

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I

PRESIDENTIAL ADDRESS

President: Dr. Asit Kumar Das

Presidential Address

Key contributions of Engineering Science in Sustainable Development of India

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Domain of Engineering Sciences

1. Domain of Engineering Sciences

“We cannot solve our problems with the same thinking we used when we created them.”- Albert Einstein

**“Scientists study the world as it is; engineers create the world that has never been.”
- Theodore von Kármán**

“Science is about knowing, engineering is about doing.” -Henry Petroski II

The Indian Engineering sector has witnessed a remarkable growth after independence. India ranks 8th in the world in terms of number of students graduating in science and engineering stream. Being closely associated with the manufacturing and infrastructure sectors, it has strategic importance to India's economy and security. Chemical engineers translate lab methods into commercial processes and work to improve them. Mechanical engineers design and develop machines and bring automation for reducing human physical efforts and to cope up with higher demand. Electrical engineers develop new devices which provide useful work from electric energy and electronic engineers develop devices which can function on very small flow of electrons mostly using semiconductors. Aerospace engineers develop rockets, missiles and satellites for exploration of our solar system and beyond. Civil engineers

are involved in development of infrastructure such as roads, bridges, buildings etc. for development of country. Biochemical engineers design and modify the genetic information of living organisms for either removal of inferior qualities or addition of superior qualities. Nature of work of an instrumentation engineer ranges from designing, developing, installing, managing equipment's that are used to monitor and control machinery. Industrial engineering deals with process development, optimization and monitoring of fundamental processes used in industry for transforming raw materials and precursors into useful commercial products for society. Metallurgy engineering deal with production of different metals and high strength products for various application. The curiosity of scientists and the restlessness of engineers drive together the zeal to develop a new and useful product or process from concept to commercialization.

2. Science & Engineering

“At its heart, engineering is about using science to find creative, practical solutions. It is a noble profession.” -Queen Elizabeth II

The definition of Science is: “The intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment.” And the definition for engineering: “The branch of science and technology concerned with the design, building, and use of engines, machines, and structures.”

Scientist and engineer aren't separate entities but belong to each other – without science, there wouldn't be engineering. Science is more abstract whereas engineering is more concrete in nature. Science and engineering are two faces of the same coin, one can't add value without other. Science explores the unknown whereas engineering exploits the knowledge acquired by science into something useful for mankind.

“Scientists ask what happens and why in the natural world, while engineers use the answers scientists find to create new inventions and ideas, not in the natural world. Both are equally important, as without scientists, engineers would not create, and without engineers the research scientists do would be wasted. They go hand in hand.”— Ashley

“The main difference lies in the main field of work. An engineer is more on the physical aspect of matter (or materials) while a scientist is more on the functionality & ‘concepts’ related to the matter (or material). However, both work on the same scientific concepts of matter or material in the field of science and technology.” — MT Maturan

“Both are students of science. One maps the way while the other shapes it so that it benefits the human race. Both are equally important.” —Akhilesh

Engineers invent the future in fits and starts. They dream, tinker, design, build, test—and learn from their failures. Engineering, an incredibly creative process both practical and visionary, makes use of both science and art. Engineers play with potentials and solve problems.

“Scientists are the ones who create the theories, engineers are the ones who implement them. They complement each other and often work together, the scientists telling the engineers what to make and the engineers telling the scientists the constraints that said thing to be made doesn’t meet. They are indeed different, but they work very close together.” —The Walker

It required unusual inquisitiveness to pursue the development of scientific curiosities, without such endeavours and the evolution of associated instrumentation, initially of purely scientific interest, most of the investigations that lead to the basic equations of electromagnetism would have been missed. We would have been deprived of electromagnetic machinery as well as knowledge of electromagnetic waves.

Even as science labs run amuck with funds and sophisticated gadgetry we must not forget that the most expensive and precious piece of equipment is still the human mind!. No one symbolized it better than Sir C. V. Raman – the only Indian scientist to have won the Nobel Prize for scientific work done in India. The equipment he used was very simple and of low cost.

3. Evolution of Engineering Science in the World

3.1. Electric Engineering

In 1752, Benjamin Franklin showed that lightning was electrical by flying a kite and explained how Leyden jars work. In 1800, Italian physicist Alessandro Volta invented the first battery. In 1827, German physicist Georg Ohm introduced the concept of electrical resistance and Michael Faraday developed laws of electrolysis in 1833.

Faith is like electricity you can't see but you can see the light.

French scientist Edmond Becquerel discovered the Photovoltaic Effect in 1839. Scottish inventor Alexander Graham Bell patented the telephone in 1876. Thomas Alva Edison introduced a long lasting filament for the incandescent lamp. In 1894, Indian physicist J C Bose introduced use of semiconductor junction to detect radio waves and extremely high frequency mm waves.

In 1895 Wilhelm Röntgen discovered X-rays. In 1904, English engineer John Ambrose Fleming invented diode and in 1906 triode was invented by Lee de Forest. Japanese engineer Kenjiro Takayanagi demonstrated CRT television with 40-line resolution which was the first working example of a fully electronic television receiver. In 1928 Indian scientists C. V. Raman and Kariamanickam Srinivasa Krishnan discovered Raman scattering which help in developing Raman laser. In 1951, first nuclear power plant was started in the US. Optical fiber invented by Indian physicist Narinder Singh Kapany in 1954.

Human are slave of electricity

3.2. Electronic Engineering

Old quantum theory was proposed by Planck in 1900 and in 1905 Einstein proposed the Theory of relativity. Particle accelerator was developed by Cockcroft and Walton in 1932. First Scanning electron microscope was developed by Knoll in 1935. First solar battery was developed in 1954 by Chapin, Fuller, and Pearson. First satellite Sputnik I was developed in 1957 in Soviet Union. Soviet scientist Kurchatov developed the first Nuclear Missile in

1957. First one-piece plain paper photocopier (Xerox 914) was developed by Xerox 1959. First microprocessor (4004, 60,000 oper/s) was developed by Intel in 1970. First modern ATM (IBM 2984) was developed by IBM in 1972. Metcalfe developed first Ethernet in 1973. John F. Mitchell and Dr. Martin Cooper of Motorola made the first mobile phone in 1973. First personal computer (Altair 8800) was developed by Roberts in 1975.

3.3. Biochemical Engineering

In the mid-1800s, Louis Pasteur was one of the first people to investigate the role of biological organisms when he researched fermentation. His work also contributed to the use of pasteurization, which is still used to this day. By the early 1900s, the use of microorganisms had expanded, and was used to make industrial products. It wasn't until 1928 when Alexander Fleming discovered penicillin that the field of biochemical engineering was established. Today, biochemical engineers can be found working in a variety of industries, from food to pharmaceuticals. Biochemical engineering has now been a serious discipline for over half a century. Developments in biotechnology, information technology, nanotechnology and sustainability has contributed for betterment of human race. The phrase, "biochemical engineering", first appeared in the late 1940s and early 1950s. Since the energy crisis caused by the oil embargo by the OPEC countries in 1974, there have been expanded efforts in research and development aimed at improved conversion efficiency of lignocellulosics as an alternative material resource.

"Genius is one percent inspiration and ninety-nine percent perspiration." Thomas Edison

3.4. Chemical Engineering

The origins of chemical engineering can be linked to the industrial revolution of the 18th and 19th century in Europe and the United States. For all intents and purposes the chemical engineering profession began in 1888. While, the term "chemical engineer" had been floating around technical circles throughout the 1880's, there was no formal education for such a person. The "chemical engineer" of those years was either a mechanical engineer who had

gained some knowledge of chemical process equipment, a chemical plant foreman with a lifetime of experience but little education, or an applied chemist with knowledge of large scale industrial chemical reactions. Davies has stressed previously the influence of 18th century chemistry, physics and mathematics on the development of chemical engineering. But, it was not until the first quarter of the 19th century, especially in England and Germany, that chemical processes in the form of what we now call “unit operations” became the basis of many industries.

The term “Industrial Chemistry” first appearing in Norton’s book to broadly describe industrial processes applied in the production of chemicals would become strongly associated with chemical engineering in the next fifty years. In 1901, Davis published a book titled with “Handbook of Chemical Engineering”. Davis was responsible for adopting the idea of “unit operations” although the term was coined by Arthur D. Little at M.I.T. much later, in 1915.

In the United States, M.I.T. is considered to be the first university to offer a four-year curriculum in chemical engineering in 1888. The establishment of the American Institute of Chemical Engineers (AIChE) in 1908 gave shape to the dreams of the “converted chemists” who were calling themselves “chemical engineers”. In 1936 Hougen and Watson published the book *Industrial Chemical Calculations*. Their textbooks had a profound effect upon students in the forties and fifties and thus upon many practicing engineers today. The first Ph.D. degrees in chemical engineering were awarded to C.H. Herty and J.L. Keats of MIT in 1924.

“Fear is a real killer. I try to trudge through the jungle with as little fear as possible.”

–William Shockley

3.5. Material Engineering

The beginning of materials engineering can perhaps be dated to the 8th century B.C, when the clay pot was first developed and used. Smelting of metals was developed ~5000 B.C, ushering in the Bronze Age which was then itself gradually displaced beginning a~1200 B.C., by the Iron Age. Hydraulic concrete came to us with the Romans, and this material still

provides the most ubiquitous artificial material in use today. Paper made of vegetable fiber was invented in China during about the 2nd century B.C., not to be introduced into the West until 1 000 years later. In 16th century a number of books were written that describe in great detail the high state of materials technology at that time e.g., Agricola's "de Re Metallica and Biringuccio's "de la Pyrotechnia".

In the first two decades of the 20th century, theoretical physicists began to understand the interior of the atom and to develop quantum mechanics, which gave a marvelous key to the differences between classes of solids. At the same time, the new X-ray diffraction techniques were being used to explore crystalline solids and real materials at last became a concern of the physicists. Materials were discovered to contain an inner hierarchy of many structural levels, with sufficient complexity to offer a foundation for explaining the complex properties of materials. Microstructure was revealed by optical microscopy, substructure by electron microscopy, crystal and molecular structure by X-ray diffraction, atomic structure by excitation spectroscopies, and nuclear structure by high-energy bombardment.

"The five essential entrepreneurial skills for success are concentration, discrimination, organization, innovation and communication." -Michael Faraday

4. Evolution of Engineering Science in India

Discovery of crude oil in Assam in 1867 was one of the major milestones in the history of engineering science in India. The first oil refinery was setup in Digboi Assam in 1901. In 1919 first sulfuric acid and phosphate fertilizer plant was setup in Ambarnath Maharashtra. Independence in 1947 gave another boost to several industries e.g., heavy machines, metallurgical, petroleum, chemicals, pharmaceuticals etc. The Government of India organized large scale engineering enterprises in to the public sector units in the area of oil refining, fertilizers, petrochemicals and downstream products. Indian Institute of Chemical Engineers was started on 18th May 1947 located at Dr H L Roy building, Jadavpur University, Kolkata, India. The Chemical Engineering department of Jadavpur University, established in 1921, is one of the oldest in this field across the world.

During World War II (1939–1945), foreign drug supplies decreased, and several Indian pharmaceutical companies opened, including Unichem, Chemo Pharmaceuticals, Zandu Pharmaceutical Works, Chemical Industrial and Pharmaceutical Laboratories (CIPLA), and East India Pharmaceutical Works.

Council of Scientific and Industrial Research (CSIR) was established by the Government of India on 26th September of 1942 as an autonomous body to develop and commercialize indigenous technologies. 40 research laboratories are doing interdisciplinary research under the aegis of CSIR.

The first Indian Institute of Technology was founded in May 1950 at the site of the Hijli Detention Camp in Kharagpur, West Bengal. The name “Indian Institute of Technology” was adopted before the formal inauguration of the institute on 18 August 1951 by Maulana Abul Kalam Azad. Now there are 23 IITs in various states.

Hindustan Machine Tools was incorporated in 1953 by the Government of India as a machine tool manufacturing company. The Indian government later established five public-sector companies. Two of them—Hindustan Antibiotics Ltd. (HAL) in 1954 and Indian Drugs and Pharmaceuticals Ltd. (IDPL) in 1961 — played particularly important roles. By the 1960s, India had also developed a sizeable alcohol-based chemical industry that used ethanol as feedstock.

ISRO was established on 15th August 1969 which gave new dimensions to Indian space science and engineering.

“I was originally supposed to become an engineer but the thought of having to expend my creative energy on things that make practical everyday life even more refined, with a loathsome capital gain as the goal, was unbearable to me.” - Albert Einstein

5. Emerging fields of Engineering Science and Interdisciplinary branches across World

5.1. Batteries (new generation batteries for electricity storage and use)

In today's world electricity is "the oxygen" of all modern gadgets. All gadgets like mobiles, laptops, cameras, fan, TV, Fridge, AC, washing machine, pacemaker, sensors, medical equipment etc. are dead without electricity. Can we imagine a life without electricity in modern world? Thus, today humans have become slave of electricity. Initially we used electricity in fixed locations like our homes and offices but in last decade due to portability of gadgets we need electricity on the go also.

Lithium Ion batteries (LIB)

Batteries provide storage of electricity in chemical form. Therefore, it provides life support to our gadgets while we are on the go. Lithium ion batteries are presently being perceived as the solution to energy requirement in portable and moving equipment because of their relatively high energy density to other batteries. But with depleting Li resources and demand of further high energy and power density, other options such as aluminium air batteries are also gaining momentum.

Lithium batteries initially started by making anode from Lithium metal. These were non-rechargeable primary batteries. They were very high in energy density but not very safe as Lithium metal is highly reactive to moisture. To improve the safety Lithium ion batteries were developed where the cathode was made from mixed oxide of lithium with several other metals such as Cobalt, Nickel, Manganese, Iron, Titanium etc. and anode is mostly made from material capable of intercalating the lithium ion such as graphite, silicon etc. The energy density of Lithium ion batteries varies from 150 to 250Wh/kg and cost is ~200 to 350\$/KWh.

Among different types of Lithium ion batteries, growth of Lithium Cobalt Oxide (LCO) and Lithium Manganese Oxide (LMO) is slowing down and growth of Lithium Iron Phosphate

(LFP), Lithium Nickel Manganese Cobalt (NMC) and Lithium Nickel Cobalt Aluminium (NCA) batteries is increasing.

Aluminum Air batteries: Promising challenger to LIB

Aluminium is the most abundant metal and the 3rd most abundant element in the earth's crust. In addition to its low cost, aluminium is one of the highest chemical energy-density storage materials. An aluminium-based redox couple, which involves 3 electron transfers during the electrochemical charge/discharge reactions, provides competitive storage capacity relative to the single-electron Li-ion battery. Aluminium air battery uses anode of Aluminium metal and cathode (several new materials are being developed such as VO₂ metastable monoclinic structure, V₂O₅ nanowire) immersed in aqueous electrolyte which takes oxygen from atmosphere to convert aluminium metal into aluminium hydroxide during power generation by the battery.

However, up till now aluminium/air batteries were considered unfeasible using aqueous electrolytes, due to the high corrosion of aluminium and hydrogen evolution in the electrolyte, which leads to a sharp reduction of the anodic efficiency. A typical commercial lithium ion battery loses ~5% of its charge after a month of storage whereas an aluminium air battery will lose ~80% of its charge over the same period, as the electrolyte reacts with the aluminium anode.

To overcome these issues researchers are designing the batteries as reserve systems with the electrolyte added just before use, or as mechanically rechargeable batteries with the aluminum anode replaced after each discharge. According to the MIT news release, "A key to the new system is a thin membrane placed between the battery electrodes. When the battery is in use, both sides of the membrane are filled with a liquid electrolyte. But when the battery is put on standby, oil is pumped into the side closest to the aluminium electrode, which protects the aluminium surface from the electrolyte on the other side of the membrane."

5.2. Rare Earth Free Permanent Magnets (Electric Vehicle motors)

Neodymium magnets ($\text{Nd}_2\text{Fe}_{14}\text{B}$) and samarium–cobalt magnets (SmCo_5) are some of the most widely used permanent magnets in high efficiency electric motors. Like lithium, these elements are also scarce and available mostly in China only. In USA, the Advanced Research Projects Agency-Energy (ARPA-E) has sponsored a Rare Earth Alternatives in Critical Technologies (REACT) program to develop alternative materials for permanent magnets. In 2011, ARPA-E awarded 31.6 million dollars to fund Rare-Earth Substitute projects.

5.3. Photovoltaic & Renewable electricity prospects and challenges

A solar panel with 20% efficiency and 1m^2 area will produce 200 W at Standard Test Conditions. Typical solar energy is about $1400\text{kWh}/\text{m}^2/\text{year}$ therefore a 1m^2 panel with 20% efficiency will produce $\sim 280\text{kWh}$ per year. Concentration photovoltaics technology uses lenses or curved mirrors to focus sunlight onto small, highly efficient, multi-junction (MJ) solar cells. Multi-junction solar cells where multiple p–n junctions made of different semiconductor materials produce electric current in response to different wavelengths of light. Combining concentrator and multijunction technology solar efficiency of 46% has been achieved. To further improve the efficiency of solar cells, work is focused on (i) developing material than have high transmittance as well as high electrical conductivity e.g., use of conducting nanowires, (ii) Lining the light-receiving surface of the solar cell with nano-sized Aluminium studs to increase photon absorption which can increase the efficiency by $\sim 20\%$ (iii) As 1°C increase in solar cell temperature reduces the efficiency by 0.45%, radiative cooling provision by coating of a IR emitting material e.g., transparent Silica crystals coating can help in reducing the temperature of solar cell. (iv) Passivation of rear surface of solar cell by coating with thin silica or aluminium oxide film topped with silicon nitride film can improve the efficiency by 1%.

5.4. Computers

Most semiconductor industry forecasters, including Gordon Moore, expect Moore's law will end by around 2025. Gordon Moore noted that transistors eventually would reach the limits of miniaturization at atomic levels. We have another 10 - 20 years before we reach a fundamental limit. By then they'll be able to make bigger chips and have transistor budgets in the billions.

In 2016 the International Technology Roadmap for Semiconductors produced its final roadmap. It no longer centred its research and development plan on Moore's law. Instead, it outlined what might be called the More than Moore strategy in which the needs of applications drive chip development, rather than a focus on semiconductor scaling. Application drivers range from smartphones to AI to data centres.

New AI based applications, machine learning, cloud computing and data analytics have already taken big focus in the industrial development and applications arena. Combination of AI and 3D printing provide a new platform to manufacture new products with much superior quality, not thought possible thus far.

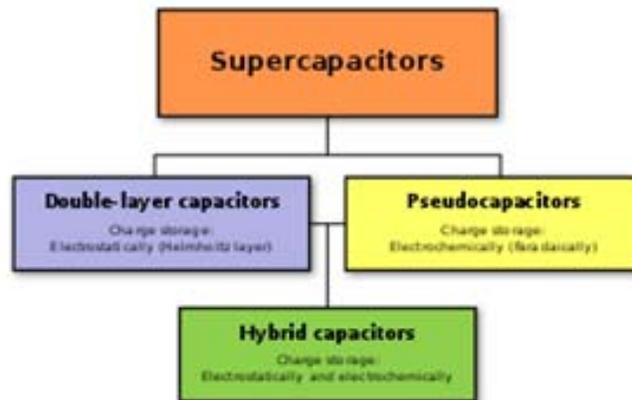
5.5. Mobiles (5G and beyond)

5G is the fifth generation cellular network technology. 5G will use millimetre waves (Extremely high frequency (ITU), Frequency range - 30 to 300 GHz, Wavelength range 1 cm to 1 mm) whereas existing technology uses microwaves (S band, Frequency range 2 to 4 GHz, Wavelength range 7.5 cm to 15 cm). Higher frequency electromagnetic waves can transmit higher amount of data, but they cannot travel long distance. Beyond mobile operator networks, 5G is also expected to be widely used for private networks with applications in industrial IoT, enterprise networking, and critical communications.

5.6. Super-capacitors (new ideas of electricity storage)

A supercapacitor (SC) is a high-capacity capacitor with a capacitance value much higher than other capacitors, but with lower voltage limits, that bridges the gap between electrolytic

capacitors and rechargeable batteries. It typically stores 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerates many more charge and discharge cycles than rechargeable batteries.



Graphene has a theoretical specific surface area of 2630 m²/g which can theoretically lead to a capacitance of 550 F/g. In addition, an advantage of graphene over activated carbon is its higher electrical conductivity. As of 2012 a new development used graphene sheets directly as electrodes without collectors for portable applications.

As of 2016 worldwide sales of supercapacitors is about US\$400 million. Supercapacitor costs in 2006 were US\$0.01 per farad or US\$2.85 per kilojoule, moving in 2008 below US\$0.01 per farad, and were expected to drop further in the medium term.

5.7. Un-conventional approaches of energy harvesting

World human population is expected to exceed 11 billion by 2100. With technological development the pressure on energy resources is bound to increase beyond sustainable limits. In addition to the emerging areas discussed above, the quest for unconventional energy harvesting has already begun. Following are some of the interesting examples of un-conventional energy harvesting techniques being pursued at Georgia Tech.

Thermo Electro-chemical Converter (TECC)

Electricity is generated from solar heat by thermally driving a sodium redox reaction on opposite sides of a solid electrolyte. This technology could be used for distributed energy applications.

Betavoltaics based on Strontium-90

Strontium-90 emits two high energy electrons during its decay process and its energy spectrum aligns well with design architecture already used in crystalline silicon solar cells. With continued improvements the beta voltaic devices could generate ~1 watt of power continuously for 30 years which has the potential of 40,000 times more energy dense than current lithium ion batteries.

Flexible thermoelectric generators (TEGs)

TEGs are solid-state devices that directly convert heat to electricity without moving parts. Waste heat can be converted to electricity by such devices.

Recycling Radio Waves

Researchers at Georgia Tech have developed an electromagnetic energy harvester that can collect enough ambient energy from the radio frequency (RF) spectrum to operate devices for the Internet of Things (IoT), smart skin and smart city sensors, and wearable electronics.

Vibrations to electricity

Scientists at Georgia Tech's are making advances with piezoelectric energy — converting mechanical strain from ambient vibrations into electricity. The nonlinear harvesters have secondary resonance which could enable frequency up-conversion in MEMS harvesters.

Friction to electricity

Triboelectricity enables production of an electrical charge from friction caused by two different materials coming into contact. Novel triboelectric nanogenerators (TENGs) combines the triboelectric effect and electrostatic induction. By harvesting random mechanical energy, these generators can continuously operate small electronic devices.

Optical Rectenna

Researchers have developed the first known optical rectenna - a technology that could be more efficient than today's solar cells and less expensive. Rectennas, which are part antenna and part rectifier, convert electromagnetic energy into direct electrical current.

Pulp Energy

Researchers are developing paper-based electronics, organic solar cells, OLEDs and organic field-effect transistors (OFETs), fabricated on cellulose-based substrates that can be recycled easily.

CO₂ and Water to Syn Gas

Researchers are using solar energy to reverse the combustion process and produce synthesis gas (mixtures of H₂, CO, and small amounts of CO₂), which can be converted into fuels such as kerosene and gasoline. Researchers are studying a two-step process using metal oxides that can split water and CO₂. The first step, which occurs between 1100-1800°C, thermally reduces or "pulls off" oxygen from the metal oxide material. Then at temperatures of 300-900°C, either water or CO₂ is introduced in the 2nd step.

Graphene based Super-capacitors

Super-capacitors are attractive sources for clean energy because they quickly charge and discharge and have long cycling lives. But they have low energy density (1/10 of lithium-ion batteries). Researchers are developing graphene-based supercapacitors that offer significantly increased energy density while maintaining high power and long operational life. Combining the metal compounds with 3-D porous graphene researchers have achieved capacitance of about 1,500 Faradays/g.

Monolithic Heat Pumps

Researchers have developed a novel textbook-sized cooling system that operates on waste heat rather than electricity. Researchers are working at the micro scale and creating a self-contained unit where no synthetic refrigerants are used, no compressor is needed, and it has modular design to generate anywhere from a few watts to tens of kilowatts of cooling or heating.

Next-gen Power Plants

Steam is being replaced with supercritical carbon dioxide (SCCO₂) as the working fluid to operate turbines and produce electricity. SCCO₂ has high density and compressibility which enables generators to extract more power from turbines.

“I don’t spend my time pontificating about high-concept things; I spend my time solving engineering and manufacturing problems.” - Elon Musk

6. What are key areas of focus for next 20 years in India for Engineering Science?

6.1. Energy

- Energy security for India
- Cost effective indigenous solar technology (Renewable electricity generation)
- Alternative low cost PV cells
- Cost effective indigenous rechargeable battery technology (Electricity storage and utilization)
- Alternative/complementary to battery technology super-capacitors (Electricity storage and utilization)
- Alternate methods of electricity harvesting (as discussed in point#4 above)
- Technology to maximize green fuel (ethanol, methanol, dimethyl carbonate) in IC engine
- Better hybrid technologies to maximize fuel efficiency
- CO₂ to fuels and chemicals
- AI and machine learning

6.2. Health care

- Technologies for efficient drug synthesis, evaluation and delivery
- Development of vaccines for cancer and other incurable disease
- Low cost sanitation hardware and building materials
- Using natural bio-reactors such as bacteria and algae to produce complex drugs
- Artificial low cost organs

- Low cost health monitoring kits
- AI and advance communication based better health care management in rural areas

6.3. Biotechnology

- Technologies to maximize food production with minimum water to alleviate world hunger
- Technologies for better food storage, processing and packaging
- Genetic engineering for developing crops with higher photosynthetic efficiency
- Technology to use bacterial, algae, Fungai as bio-reactor to produce chemicals, medicines, food and fuel using solar energy
- Synthetic biology for food applications replacing animal protein
- Electric power to Food for World hunger alleviation and water management

6.4. Water and waste water

- Low cost technologies for purification of waste water and sea water desalination
- Smaller, portable water purifiers for rural areas
- Energy efficient and reliable membrane purification techniques
- Water free processes and products for industrial and domestic applications

6.5. Materials

- Development of superior composites (light weight, corrosion resistant, tunable thermal, electric and electronic properties) as alternative to metals
- Development of new Nano-materials for solar, battery, super-capacitors
- Advance carbon based materials e.g. C-fiber, CNT, C-composite
- Low cost process for Si purification

6.6. Environmental

- Promoting Green Engineering Solutions in all aspects of industrial and domestic applications
- Developing climate change intervention thru engineering innovation

- Control of Air pollution, especially PM2.5 particulate emission
- Plastic conversion technologies to fuel and chemicals and recycling processes
- Solid Waste and MSW to energy – low cost reliable process development
- CO₂ capture and sequestration technology with capture cost of <10\$/Ton of CO₂
- Technologies for conversion of waste agro biomass into useful products circular economy
- New environmentally friendly chemical process to minimize toxic waste production

6.7. Infrastructure

- Developing world class infrastructure of transport of goods and people
- Low cost housing for economically deprived class of people
- Affordable communication and data based economy including rural areas
- Rethinking how Indian cities should look and work including efficient waste management infrastructure
- Developing rural economy for better de-urbanization
- Improving digital security and protection of personal data from cyber attacks
- Developing indigenous strategic defense capabilities
- Low cost satellite launching facilities and services

7. What courses need to be taught to prepare students in Engineering Science and what are new discipline required?

It is impossible to imagine a developed economy without a developed infrastructure to deliver modern engineering education. Engineering is a fundamental driver in many parts of any industrially developed economy. India is expected now to take its infrastructure and construction boom to the next level which saw similar trends in China few decades earlier. In addition to regular conventional courses specific to each engineering stream, new courses should be taught to budding scientist and engineers which are focused on nature. The world is going more digital, nano and bio technologies are taking deeper roots and fusion of interdisciplinary domains are giving rise to new ways of teaching engineering in modern era. For example, one needs to understand how nature can synthesize all types of complicated

chemicals in such mild conditions without generation any hazardous waste. The ingenuity of human mind is yet to be fully explored so courses on cellular neurophysiology and how computing occurs in living systems is also very relevant. How signals are transmitted in living systems and understanding biological evolution can help in developing complex models and computations. Engineers should also be taught how natural languages have evolved and how signals are processed in brain and how human intelligence works.

Modern engineers also need to learn how Artificial Intelligence, Machine Learning, Underactuated Robotics and Cognitive Robotics work. As data is the fuel of the future, courses on Big Data, Data Analytics and Data Science should also be included in the curriculum.

How the properties and behavior of material changes when the particle size is reduced to nanometer size, and how to fabricate such materials. How Microelectromechanical Systems (MEMS) work and how to make such systems. (Basic principles of nanotechnology)

For engineers of 21st century, Bordogna Joseph (Round, Flat, or Spiky: The World Turns on an Axis”, IEEE-USA Leadership Workshop. Washington: IEEE, 2006) suggested following key areas of focus:

- Sustainable development: avoiding environmental harm; energy / materials efficiency
- Life cycle / infrastructure creation and renewal
- Micro / nanotechnology / microelectromechanical systems
- Mega systems
- Smart systems
- Multimedia and computer-communications
- Living systems engineering
- Management of technological innovation
- Enterprise transformation

The other key competency is the knowledge and integration of multi-disciplinary areas as indicated by E. O. Wilson: “Most of the issues that vex humanity daily cannot be solved

without integrating knowledge from the natural sciences with that of the social sciences and humanities. Only fluency across the boundaries will provide a clear view of the world as it really is, not as seen through the lens of ideologies and religious dogmas or commanded by myopic response to immediate needs”.

Other than these areas engineers also need to learn courses on Engineering Innovation and Design, Patents, Copyrights, the Law of Intellectual Property, Ethics for Engineers, Entrepreneurship in Engineering, Engineering Leadership, Leading Creative Teams, Energy Technology and Policy: From Principles to Practice, Statistics for Research Projects etc. Environmental impact assessment should also be taught to engineers. For converting engineering to self-sufficient entrepreneurs, it is very important to induct financial management principles to all engineering streams right from under-graduate level.

The engineering courses should also include personal skill development like communication, teamwork, decision making, problem solving, initiative and leadership, perspective, lifelong learning, multidisciplinary perspective, negotiation, conflict resolution, goal setting, and understanding diversity and globalization.

“I have not failed but found 1000 ways to not make a light bulb.” - Thomas Edison

8. How to boost Sustainability in everything of Engineering Science?

The design of innovative educational framework for producing the next generation of engineers can boost the sustainability in Engineering Science. To ensure that every technology is sustainable it must be evaluated for holistic environmental impact assessment. Every new technology before implementation should be evaluated vis-à-vis the best available technology and ranked base on following criteria:

- What is the energy efficiency of this technology?
- How much waste it will generate and how to make it zero discharge process?
- How much CO₂ it will produce?
- Is it based Molecular Economy and other Green Process principles?
- How much water it will need and what will be the quality of effluent water?

- How much safe it is in terms of process conditions and materials?
- How much natural resources it will use?
- How easy and affordable it is to be adopted by the community (capital and operational expenditure)?
- What are lifecycle impact of the new process or product on environment?

If the new technology scores high in all above criteria vis-à-vis the best available technology then it should be promoted and given substantial incentive at all levels such as government, industry, academia and community.

9. Leapfrogging Rural Economy thru Engineering Science

Indian rural economy is dependent up on agriculture and animal husbandry. Research and innovations in the field of agriculture and animal husbandry will boost the rural economy. Development of crops which need less water to grow and produce less biomass will not only reduce water demand but will generate less bio waste. Better soil analysis techniques and knowledge of right fertilizer for their soil.

Nearly 600 million Indians do not have access to reliable electricity and about 700 million still use biomass as their energy source for cooking. Cheap solar electricity to villages will not only reduce the transmission losses due to long transmission lines but will also ensure regular electricity supply. Solar water heaters already very popular in rural areas similarly popularization of photovoltaic solar panels in villages will certainly boost the rural economy. Energy efficient solar cookers can save significant amount of fossil fuels and biomass on one hand and provide more nutritious food on the other.

In 2011, 92% of the Indian population officially had access to improved water sources (96% urban and 89% rural). According to UNICEF, 67% of Indian households do not treat their drinking water although it could be chemically or bacterially contaminated. The World Bank estimates that 21% of India's communicable diseases are linked to unsafe water. Simple and cheap water purification techniques like TATA Swach can provide clean water to rural population which can save them from several water borne diseases. A healthy farmer

can contribute much more to the rural economy than a sick farmer. Problems such as contamination of water with microbes, fluorides, iron, arsenic, pesticides and low per capita water availability are challenges that need to be addressed by providing new technological solutions.

Development of new AI and mobile based technologies for ensuring cheap and reliable communication in rural areas for example after launch of Reliance Jio the availability of voice communication and internet has remarkably improved. This will provide the rural population all the information needed to keep up with the urban population. Availability and affordability of energy efficient tools such as smaller and cheaper tractors, energy efficient water pumps, solar heaters to rural population.

10. Conclusions

The major responsibilities of scientists and engineers in today's world are to discover, invent and develop knowledge and techniques for a sustainable development. Technological development must not disturb nature as presently evident by deforestation, glacier melting, drought and floods, poor air quality, forest fires. Some of the areas where immediate technological solutions are required to reverse the damage already done by indiscriminate exploitation of natural resources while bringing more focus to rural development are:

- Reduction in depleting water table and water pollution: New methods of afforestation and sustained growth of forests especially agro-forestry
- Rural uplift by providing new technology for cheaper energy efficient houses, better sanitation and roads
- Reduction in existing atmospheric CO₂ concentration: Efficient CO₂ capture and sequestration techniques and CO₂ utilization technologies to fuel, chemical and materials
- Reduction in future CO₂ emission e.g., alternative to thermal power plants (solar and wind energy harvesting), alternative automobiles using fossil fuels (green electric vehicles), efficient mass transport, better virtual technologies to minimize travel requirement.

Section VI : Engineering Sciences

- Reduction in waste generation: Efficient techniques for waste recycle and development of new bio-degradable materials, waste to energy and materials, conversion to plastic waste to energy and chemicals etc.
- Developing new efficient ways of sustainable energy production
- Smart utilization of data, artificial intelligence and machine learning
- Developing low cost building materials and infrastructure for rural sector
- Sustainable development of urban transport and waste management
- New drug discovery and efficient health care infrastructure

It is hoped that India will make rapid advancement in its economy and infrastructure while improving its human development index by putting concerted effort in imparting and enhancing the engineering education, adapted to the current and future requirement of the country and the world at large.

JAI BHARAT

107TH INDIAN SCIENCE CONGRESS

January 03-07, 2020

BANGALORE

II

ABSTRACT OF PLATINUM JUBILEE LECTURE

Carbon dioxide capture and utilization: An intense area for research

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The increasing trend of carbon dioxide (CO₂) concentration in the atmosphere is the main cause for the enhancement in global warming which is known as the biggest environmental problem. The fossil-fuel power sector and energy-intensive industries are major producers of carbon dioxide emissions. In 2017, the global carbon emissions from fossil-derived fuel combustion were estimated to be 9855 million metric tons of carbon, or nearly 36 giga tonnes (Gt) of CO₂ [1]. Therefore, there is a need to control this increase in CO₂ concentration in order to prevent any further damage of our environment. Among the diverse available technologies namely absorption, membrane separation, cryogenic distillation and adsorption, absorption technique using alkanolamine and monoethanol amine is being used at large scale, but there are many drawbacks of this technology such as corrosion of equipment and high energy requirements. Adsorption technology is yet another promising and viable technique for capturing CO₂ due to its cost-effectiveness, high CO₂ uptake and low energy requirements of the selected porous adsorbents.

Different types of nanostructured carbon adsorbents have been prepared by nanocasting technique from melamine formaldehyde, urea formaldehyde (amino resins), epoxy resins, etc. and physical/chemical activation [2, 3]. In addition, alkaline adsorbents have been prepared by impregnation of K₂CO₃ on alumina support [4]. These adsorbents have been characterized for texture, morphology, functional groups, basicity, etc. Adsorption and regeneration performance (in fixed bed reactor system) have been evaluated for CO₂ capture. The dynamic CO₂ capture capacity depends on both the heteroatom functionalities and texture properties with CO₂ uptake 1-1.4 mmol g⁻¹ at 30 °C under 12.5% CO₂ flow were observed [3].

For electrocatalytic reduction of CO₂ to useful products, different nanostructured copper based electrocatalysts were synthesized by chemical reduction method, leading to ultrafine particles (50-70 nm) for PVP capped and 20-30 nm for citrate capped NPs with great stability. Maximum surface area obtained for citrate capped Cu NPs is 630 m² g⁻¹. Citrate stabilized Cu nanoparticle gives conductivity of 4.124 X 10⁴ S/cm. Anodic peak potential (E_{pa}) and cathodic peak potential (E_{pc}) observed, for a synthesized nanostructured Cu nanoparticle, is 190 mV and -200 mV vs. Ag/AgCl respectively, so, it is used as electrocatalyst. Chronoamperometry graph shows the long term performance of electrocatalyst in CO₂ saturated electrolyte [5].

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III

ABSTRACTS OF INVITED & SYMPOSIUM LECTURES

Cleaner & Sustainable Fuels and Related Technologies for Transport: Challenges and Opportunities

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Abstract

Globally the transport constitutes about 56% of global oil consumption and is heavily dependent on oil products (92%). Alternatives to oil products are natural gas, biofuels, and electricity. Natural gas use in transport constitute only 6.9% of total natural gas consumption which is growing and the two-third of the projected growth will be in road transport sector. Bio-fuels currently contribute around 3% of energy use in transport globally. Almost three-fourth of this is fuel ethanol and most of the remainder being Bio-diesel produced by esterification of fatty acids. Advanced Bio-fuel production constitutes less than 1% of total Bio-fuel volumes. The share of Electric cars in the global vehicle stock is only 0.1%.

In India we are faced with twin issues of energy security as well as environmental pollution in our cities. It is imperative that we seriously explore opportunities for the use of renewable and cleaner sources of energy besides using the conventional fuels in a more efficient manner.

The provision of cleaner and sustainable energy will be a great challenge which will require serious efforts for developing advanced motor fuels and technologies. In the short-term improving fuel quality through refining processes, increased use of natural gas, improved energy efficiency, hybrid vehicle technology besides production of conventional Bio-fuels will help. In the medium and long term further large scale development of renewables, advanced Bio-fuels and use of electric, hybrid and hydrogen fuel cell vehicles may provide cleaner and sustainable solutions.

In view of the high pollution in Indian cities, more stringent BS VI vehicle emission norms are being implemented from April 2020 for which refineries are implementing fuel quality projects. This will enable the auto industry to comply with the most stringent vehicle exhaust emission norms prevalent anywhere in the world by incorporating advanced engine & emission control technologies e.g. On Board Diagnostic (OBD) system, Selective Catalytic Reduction (SCR) for control of oxides of nitrogen & Diesel Particulate Filter (DPF).

In the next step, fuel efficiency norms will become mandatory and while oil companies may increase octane quality of fuel, the auto companies will make design changes to make vehicles more fuel efficient thus reducing carbon dioxide emissions. The more efficient hybrid technology, without the need of elaborate charging infrastructure, will help in reducing the costs and can expedite the transition from pure IC engine vehicles to Hybrid vehicles (IC engine + battery) which could be converted to hybrid hydrogen vehicles (fuel cell + battery) at a later date.

In case of CNG, which is being promoted as a clean fuel, while at present there are 1424 CNG Stations in few cities, it is proposed to give significant boost to cover 70% of country's population to have access to natural gas network in next few years. While CNG is being promoted for heavy duty truck applications it may have limitation of range to cover long distances, for which Liquefied Natural Gas (LNG) is being developed as an alternative. This require development of vehicles with LNG engine application, on-board storage besides the supply and distribution system for same.

A National Bio-fuel Policy has been providing financial and fiscal incentives to increase the supply of bio-fuels. The Policy categorises biofuels as "Basic Biofuels" viz. First Generation (1G) bioethanol & biodiesel and "Advanced Biofuels" - Second Generation (2G) ethanol, Municipal Solid Waste (MSW) to drop-in fuels, Third Generation (3G) biofuels, bio-CNG etc. The Policy expands the scope of raw material for ethanol production by allowing use of Sugarcane Juice, Sugar containing materials like Sugar Beet, Sweet Sorghum, Starch containing materials like Corn, Cassava and Damaged food grains like wheat, broken rice, Rotten Potatoes for ethanol production. In addition to ethanol, the Policy also encourages

setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, used cooking oil, short gestation crops etc.

While the Government is offering incentives for advanced Bio-fuels, developing the appropriate cost-effective technologies & processes etc. at a lower cost would be a challenge. Further for Bio-CNG, the new SATAT initiative of the Government and the purchase price guarantee could act as a great incentive for development of technologies, for methanation of waste and cleaning up of the gas to supply the same as Bio-CNG.

While the electric vehicles (EVs) are being promoted, the challenges for EVs are to create fast charging infrastructure and to develop new battery materials with less dependence on nickel and cobalt. We would need disruptive innovations for alternative battery materials which are available indigenously and are cost effective. Further, the CO₂ emissions will not reduce if we continue to produce electricity from coal. A study shows that even with 25% share of renewable energy in electricity generation mix, EVs do not seem to provide advantage of Carbon Emissions except to some extent in the case of small vehicles (two & three Wheelers).

The use of renewable solar and wind energy would require serious research and development work around the energy storage systems besides the batteries. One alternative which is available is to store energy in the form of hydrogen by splitting water but would require more efficient electrolyser systems. The production of hydrogen in a more efficient manner from conventional oil or gas reforming shall be needed besides the coal or bio-mass gasification route. Finally, the development of newer photo catalysis and photo bio technology routes for hydrogen production could eventually ensure that we use renewable hydrogen. The storage and utilization of hydrogen in fuel cells will need further optimization and development of the materials to be used in the same. The scientific innovation in all the above areas has large potential for disruptive innovations which could help in gradual switch over to the cleaner and sustainable fuels while providing the energy security to our country.

Role of Advanced Carbon Products in India's Development

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Abstract

Carbon is one of the most fascinating materials known to the mankind since ancient times. A common man recognizes carbon as coal for fuel, lamp black or carbon black for paints and tyre industries, electrodes for dry cells, carbon brushes for dynamos and motors and most common of all as lead for pencils. A little further, one comes across the use of carbon as electrodes for steel and aluminium industries, consumption of which runs into thousands of tons per annum.

All this we owe to the remarkable characteristics of this material such as low coefficient of thermal expansion, very low coefficient of friction, amphoteric in nature making it non-reactive even with strong chemicals, good thermal and electrical conductivities, capable of withstanding temperatures of the order of 3000 C in protective environments, and most importantly its ability to retain its strength at such high temperatures together with very high value of stiffness.

Such a unique combination of properties has globally generated a lot of interest in making use of this special material, by taming these extra ordinary properties, through fresh research and development for specific modern day applications.

With an eye to accomplish over all development of the country in all spheres, through indigenous development of technologies, following are the broad sectors, covering national security, robust industrial output together with the programs of social welfare.

a) Strategic b) Industrial and c) Societal

Under the Strategic sector, following programs have been taken up in the country.

- Intercontinental Ballistic Missile Program
- Space
- Nuclear Energy – Both Fission and Fusion
- Fighter Aircraft
- Advanced Light Helicopter.

Carbon in the form of C/C composites is one of the most critical components for any ICBM to be successful. Developing suitable C/C composites was a big challenge involving not only densification to densities of the order of 1.8-1.9 gms/cc, but also 3d/4d weaving of performs. This was a time when there was a complete embargo on India for all technologies or even equipment leading to successful development of C/C composites.

C/C composites with required densities, texture, ablative properties were successfully developed at NPL, New Delhi, tested at DRDO and are now being used in all versions of AGNI missile. It is important to mention that such high densities of C/C composites were achieved not by using HIP, which was denied to India at that point of time, but by inventing a novel technique known as “Intermediate Graphitization”. Interestingly, carbon fibres (Viscose Rayon based) needed for manufacturing nose tips etc, are also being manufactured in the country.

As far as the development of Light Combat Aircraft is concerned, there are two areas which are of utmost concern and these are “brake pads” and material for structure of the aircraft. It is a proud moment to mention that Carbon based brake pads have been developed and being used in TEJAS. Secondly, in order to reduce the weight of this fighter aircraft, carbon fibre based composites were developed and our TEJAS is made up of ~55% of composites.

For all types of LAUNCH VEHICLES, whether single stage or multi stage, out of total weight, 90% is needed for fuel, pay load about 1-2% and the structure ~9%. With no compromise on fuel and pay load, the only component that can be maneuvered for reducing

the overall weight is the “STRUCTURE”. This fact has been exploited in case of all recent launch vehicles e.g. “CHANDRAYAN I AND II”.

Both types of nuclear energy sectors i.e. fission as well as fusion depend critically on the availability of special types of carbon namely PURE GRAPHITE to be used as a moderator and high thermal conductivity graphite as first wall material for fusion reactor.

For our future “HIGH TEMPERATURE REACTOR” there is a critical need of “CARBON TUBES” for passage of molten metals. Such tubes have been developed at NPL and tested successfully at BARC recently.

Under the Industrial sector, Ultra High Power Electrodes are at the top. Technology for the UHP electrodes is only in the hands of USA, Japan and India, with a share of 25% of the world production. India, today, is 3rd largest producer of steel in the world-thanks to the availability of carbon in the form of UHP electrodes.

Success of Renewable Energy sector depends decisively on the availability of Carbon in specific forms. In the case of Fuel Cell, two most critical components i.e. bipolar plate and the catalyst carrier are made of specific carbon forms which have been made available. India is fifth largest wind power generator with installed capacity of ~20,000MW and is poised to produce ~60,000MW by 2020. It is translated to requirement of ~8,000 metric tons of CFRP annually. GRP can also be used, but using CFRP gives weight saving of ~35% together with cost reduction of ~15% for making Blades.

Another very important area is Lithium Ion Battery (LIB). Energy Density of LIB would be decided by the type and chemistry of the two electrodes. Graphite as Anode offers an energy density of 372mAh/gm which is one of the highest and is a preferred material for Anode in LIB. Apart from use of LIB in Automobiles, it's another big application/use is in Mobile Phones. As of today, India manufactures 150M cell phones per year and this number will go to 600M by the year 2025 translating into ~5GWh demand for LIB cells and accordingly 4,000 MT of special grade of Graphite will be required annually. Automobile

sector is a huge user of high power LIBs and once adopted, the Graphite demand will run into thousands of tons. This technology is in the making and latest position will be presented.

The above few examples show how Advanced Carbon Products, in their various manifestations, have helped India in its security needs. Will be elaborated during the presentation.

India, today, is on the world map of a handful of countries possessing specialized Carbon based technologies, without which over all development in various sectors would not have been possible.

Biogas production, upgradation, power generation and utilisation for energy self-reliance in rural areas

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Abstract

Bio-methanation is the most suitable technology for organic wastes treatment and generation of energy and biofertilizer which can become a major tool for Swachh Bharat Mission. The larger portion of waste comes from domestic, municipal, animals, agriculture and forestry. In recent years enhanced energy security and climate change mitigation have been the major drivers for the transformation of such biomass waste into energy, to reduce dependency on fossil fuels along with the reduced burden for waste management. Biogas production from various kinds of organic wastes collected during the mission could be an important key to provide solution for “Swachh Bharat Abhiyan”.

Biogas especially in Indian context has been playing an important role in transformation of various wastes to a low carbon economy. The total potential of biogas from all sources has

been estimated to be 48,382 Million m³/y. Biogas typically consists of methane (50-70%), carbon dioxide (30-45%), traces of water vapor and hydrogen sulfide (H₂S). Thus, raw biogas needs to be upgraded to natural gas quality in order to use in vehicles that are designed to use natural gas, which means carbon dioxide (CO₂), hydrogen sulphide (H₂S), ammonia, particles and water (and sometimes other trace compounds) have to be removed so that the product gas has a methane content of more than 90% by volume. This upgraded gas is generally referred to as Biomethane. This upgraded gas or Biomethane is bottled at pressure of 200 bar, referred as Compressed Biogas (CBG). A new biomethane standard BIS: 16087 (2013) has been developed by Bureau of Indian Standards for its utilization in vehicles and others.

The water scrubbing based biogas upgradation and compression/ bottling system is enhancing the utility of biogas application by upgrading it to natural gas quality for application in vehicles and cooking developed and patented by IIT Delhi. At IIT Delhi a passenger car testing on CBG is going on, this vehicle has already covered 75,000 km run on upgraded biogas. Thus biogas has a potential in India towards achieving energy self-reliance using locally available organic wastes, which may also helping in reducing greenhouse gases emission and supplying good quality bio-fertilizer.

Biogas can be utilised for cooking, power generation and vehicular application. For vehicular application, biogas needs to be upgraded to make it CNG equivalent which is known as Compressed Biogas (CBG) adopted by Ministry of Petroleum and Natural Gas (MoPNG) as SATAT program (Sustainable Alternative Towards Affordable Transportation.). Therefore Biogas seems to be a fit option for all energy requirements in rural areas. It will help in sanitation, energy self-sufficiency and promotion of organic agriculture in villages. There are many models envisaged for promotion and commercialisation of biogas in India, which will be presented in the congress.

Application of Nuclear Spin off for Promotion of Entrepreneurship and Self-reliance for Rural Area through AKRUTI Program

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Abstract

AKRUTI stands for Advanced Knowledge and RUrAl Technology Implementation. It is a Department of Atomic Energy (DAE) societal initiative for technology deployment and entrepreneurship promotion in rural areas. It aims to empower villages with technologies and provide an eco-friendly work plan for sustainable techno-economic growth of rural sector.

In order to encourage locals from rural areas and also urban entrepreneurs to start AKRUTI activity in rural sector a Technology Package named 'AKRUTI Tech Pack' is offered at an affordable price. For details log on to website: <http://www.barc.gov.in/akruti-tp/index.html>. To create sustained workforce for AKRUTI Programme, a concept of Rural Human & Resource Development Facility (RHRDF) has been developed with knowledge and technology support from BARC/DAE. Shri Vithal Education & Research Institute (SVERI), Pandharpur, Maharashtra has set up RHRDF. RHRDF acts as a DAE Out Reach Centre and has gained wide experience in training, deployment, demonstration and dissemination of BARC-DAE technologies in rural areas. It has high-speed internet connectivity through National Knowledge Network (NKN) and provides easy access for information and other internet dependent activities. Experts from BARC conduct online training sessions for college students and village entrepreneurs through Video Conferencing using this connectivity. NKN connectivity has also been extended to Five schools in villages. AKRUTI has proven to be a fine example of blending Education, Research, Technology and Development into a common eco-system for socioeconomic development in the rural sector. This has led to a concept

called Cillage. City like opportunities in villages and best of villages i.e. pristine and eco-friendly environment for development of rural population through innovation and technologies. Cillage becomes centre of innovation to solve the problems of the region and disseminate the developed technologies in the region through AKRUTI nodes. It is a BARC –DAE Concept.

Details will be covered in the presentation with case studies.

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Eye in the sky for sustainable development of India

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Abstract

Indian Space Research Organization (ISRO), Department of Space is the nodal agency for the Space Research activity. Main responsibility is to provide data on Earth Observation and communication. Indian Remote Sensing Satellite constellation has taken giant strides in ensuring many areas of application. Some of the most prominent ones are Agricultural Crops Inventory, Water Resources Information System, Ground Water Prospects, Forest Working Plans, Biodiversity and Coral Mapping, Potential Fishing Zones, Ocean State Forecasts, Rural Development, Urban Development, Inventory & Monitoring of Glacial Lakes / Water Bodies, Location based Services using NavIC constellation, Disaster Management Support Programme (Cyclone and Floods Mapping & Monitoring, Landslide Mapping & Monitoring, Agricultural Drought, Forest Fire, Earthquakes, Extreme Weather Monitoring and experimental Forecasts and so on), mobile communication etc

Polar Satellite Launch vehicle being used to keep the satellite in Polar orbit . IRS (Indian remote sensing) series of satellites, that has enabled unique applications of space based imaging are, Cartosat-1 & 2, Resourcesat-1 & 2, Oceansat-1 & 2, Risat-1, Megha-Tropiques, SARAL, Scatsat, INSAT series, and host of other satellites.

This paper highlights the space based data provided to the user agency to sustain the development of earth observation and communication area.

Keywords: satellite, ISRO, Earth observation, communication, Launch vehicle, remote sensing, INSAT, Ocean Sat

Developing and commercializing new process technologies in global market: Challenges and Opportunities

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Abstract

Refining Industry continuously faces challenges that require technology solutions. Because of the large scale and complex operations associated with projects in our industry, the time line for development and commercialization is typically long, especially for first-of-a-kind technologies. This requires the developer to look out and anticipate needs of the industry and track trends ahead of 5 to 7 years in the future. A disciplined approach is critical to selecting the right idea that yields the highest return, and is ready for commercialization when the market needs it. This paper will address the typical stage-gate approach that is used in developing and commercializing new process technologies, the strategies utilized to mitigate risk and the elements that are critical to a successful development. The typical stage-gate approach is outlined below.

Preliminary investigation: It is also known as the discovery or concept exploration phase. This is very preliminary technical, market and competitive & strategic assessment based literature and patent search. There is no laboratory nor process development yet and the main focus is on idea generation or area identification for potential research and development.

Concept definition: Preliminary business case – technical and economic assessment based on the literature information and data. Identifying the market needs, gap areas and potential new business opportunities beyond the current innovations.

Proof of concept or detailed investigation: R&D funding is obtained and a laboratory is set up during this phase. Experiments are conducted to quantify the performance, identify the key process variables (known and assumed inputs/ outputs), key strengths and weaknesses of the process conceived. Also assess the need for protecting the intellectual property rights (including preparing patent application).

Proof of application development and verification: Key components of process/ technology are tested and combined to determine how the system functions as a whole. Identify the critical success factors such as scalability that includes qualifying the process variables by replicating a commercial type system at a pilot plant level and hardware specific experimentation. In addition, accurate prediction of commercial performance from pilot and semi-commercial or demonstration plant data is a critical goal of any scale up study. Therefore, kinetic and hydrodynamic models are developed at this stage. These efforts are essential for process and hardware scale up due to the following:

- ✓ Prediction of process performance and unit operations
- ✓ Hardware/hydrodynamic modeling using customized models
- ✓ Validation of models using pilot plant and cold flow or commercial development experimental units or any relevant facility that represents commercial scale hardware.

Process demonstration: This step is considered based on the specific needs or the nature of a process (especially if it is a brand new reactor or product/concept). Performance validation of integrated process and hardware system, applying process & hardware modeling

tools for data validation so that they can be utilized for design and scale up, carry out technical and economic assessment with more accurate data, revisiting competitive analysis, development of a business case for a commercial scale unit and identify potential first adopter of the process/technology.

Final design/ commercialization: Integrating the information generated from all the steps above especially process demonstration phase to design and scale up to the commercial unit. Providing basic design, engineering, safety, environmental impact, capital & operating costs, utility info, risk mitigation strategies/ design flexibility, product yields and properties and their integration with commercial production facilities and requirements.

Can the pitfalls be avoided? What are the pitfalls that should be avoided? Whenever things are done for the first time on an industrial scale, surprises are expected.

It is clear from the above discussion that there are some challenges and opportunities during the course of every process technology development and commercialization effort. The stage-gate approach helps minimize the risks and facilitates mitigation in a gradual manner.

To summarize, this paper will discuss more details of the stage-gate approach and risk mitigation aspects for successful development, design and commercialization.

Sustainable Technologies for Development of Rural India

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Abstract

Technology can help improve the quality of life especially for the poor and disadvantaged by permitting more and better services, transforming economic activity and reducing inequalities

based on factors like geography and history. The appropriate technology may be something elemental or it may be a state-of-the-art satellite based system. What we need are solutions that are affordable, sustainable and acceptable to the people who are using them. The matter of building high technology or low technology is immaterial as long as it is the right technology. Questions often raised are how to encourage development of technologies and technology based solutions appropriate for the rural sector, how do we support rural employment and bring equitable growth through the application of technology.

India, still after 72 years of Independence, need special focus on distress of human lives and loss of properties due to drought and flood every year. Technological development including proper distribution of water for irrigation in India helps improve food security, reduce dependence on monsoons, improve agricultural productivity and create rural job opportunities. The ultimate sustainable irrigation potential of India has been estimated to be 139.5 million hectares (mha), comprising 58.5 mha from major and medium river-fed irrigation canal schemes, 15 mha from minor irrigation canal schemes, and 66 mha from groundwater well fed irrigation. Technological innovation in the irrigation projects, inter-linking of rivers, dredging and river tracking and rain water harvesting can contribute a lot on rural development.

Access to energy services is a key component of alleviating poverty and an indispensable element of sustainable human development. Over 45% of the country's population is currently denied energy access. In India, nearly 70% of India's population lives in villages and agriculture is the main support for their livelihood. It is, therefore, ironical that India's rural population shares a much larger burden of poverty as well as energy poverty. Lack of access to energy (energy poverty) and its impact on human welfare, including health of women and children, education and income, continues to be a significant cause of poverty in India. Expanding energy access to poor households in rural and remote areas is a complex development challenge to planners and development practitioners. The rapid expansion of clean and sustainable energy would prove to offer a win-win situation for ensuring the rural energy security, mitigating the impact of rising fossil-fuel cost on the economy and avert the negative implications of depleting natural resources and ensure the rural energy security. Therefore, there is considerable scope for the use of renewable energy in bridging this gap by providing affordable and clean energy to the poor to meet their lighting, cooking, and thermal needs. Otherwise the availability of electricity in rural India will still be a distant dream. Renewable

resource can be obtained from solar energy, wind power, bio-mass, hydropower, geothermal and wave & tidal power. Typical bio-mass fuels for power plant in rural India are Rice husk, Juliflora, Cotton stalk, Wood chips, Bagasse, Ground nut shell, Coconut shell, Coconut stalk, Chilly stalk, Paddy straw, Saw dust, Jute stalk etc. The bio-mass based power plants are region specific pertaining to rural areas and are installed nearby the location where bio-mass is available in sufficient quantity.

Adequate and safe water is important for human health and well being, economic production and sustainable development. Although drinking water is a basic human right, many people do not have access to safe and adequate drinking water or proper sanitation facilities. Various physical disorders and chronic illness such as pigmentation, keratosis, anaemia, respiratory diseases, hepatameology etc. have been identified due to exposure of arsenic contamination of water. Accordingly, various water supply schemes have been executed at Government level for supply of arsenic free water to the affected areas of various parts of the country and specifically in rural areas. Some of the schemes are surface water based, where river water is treated and supplied in the area. In other schemes, underground water is tapped, treated for arsenic removal and supplied in the area, where surface water source is far away from target supply area.

Information and Communication Technology (ICT) can contribute a lot in socio- economic development in rural area. ICT can play a big role on the improvement of education, agricultural process, health care facility, disaster management, tourism (if exist) etc.; thus contributing towards economic growth. ICT application needs to be used to bring transparency and accountability in various economic and social programme of government. ICT shall be used in such a way that it can give more opportunities for employment in rural areas which will lead to improvement of quality of life of rural people.

India's manufacturing sector, including large scale and small scale, contributes only 17% to the country's total GDP, as against 30% or more for advanced industrial economies. It is likely that India will have around 900 million working population by 2020, of which around 600 million will be accounted by the country's youth, which is a strong force for the progress and development of any nation. Reduction of manpower requirement in the agricultural sector due to multiple reasons, including greater farm mechanization, has led to creation of

surplus workforce in the rural area that cannot be directly absorbed by the fast growing service industry, mainly due to the significantly different requirements of skill sets by the service sector and limitation of service industry to absorb such large surplus workforce. On the other hand, a strong and vibrant small scale manufacturing sector would be in the greater interest of rural India that can create greater employment through retraining, and thus would ensure the long term growth and sustenance of the country's economy.

Inclusive growth is extremely important in India today. At the most basic level, economic growth results from work force growth and productivity growth of workers. With 80% of the work force stuck in low-productivity activities in informal employment, it is not surprising that the Indian economy is performing far below its true potential. For the Indian economy to reach the growth potentials, ways and means must be found to train the work force towards skill development and more than from informal to formal employment. Ultimately, the economy can reach its full potential only when the hundreds of millions of Indian workers can have access to newer technology and can escape the trap of low productivity.

The Technical Efficiency of Handloom Clusters in India

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Abstract

The handloom sector is known for its heritage and the tradition of excellent craftsmanship. It provides livelihood to millions of weavers and craftsperson. This sector contributes country's GDP, manufactured output employment and exports. For inclusive growth and sustainable development most of the Handlooms has adopted the Cluster Development Approach. The objective is to Study the Technical Efficiency (è), Peer Weights (ëi), Input Slacks (S-) and Output Slacks (S+) of 20 Handloom Clusters (Decision Making Units -DMUs) in India.

The methodology adopted is collection of data from Ministry of Textiles, Government of India and analysing with Data Envelopment Analysis of Input Oriented Banker Charnes Cooper (BCC) Model by taking Number of Weavers, Yarn Worth (In Rs Lakhs) and Amount Utilized (Rs. In lakhs) as inputs and Sales, as output. A DMU is efficient if $\theta = 1$, $S^- = 0$ and $S^+ = 0$. 6 Handloom Cluster has got $\theta = 1$ and $S = 0$ (Score =1 and Rank =1) and for other 14 Handloom clusters $\theta < 1$ and $S > 0$ (Score < 1 and Rank = 7 to 20). The non-zero θ_i 's represents the weights for efficient clusters is peers to 14 Handloom Clusters and got rank 7 to 20. The $S > 0$ obtained for 14 MSME clusters (rank 7 to 20) reveals the excess Number of Weavers (S^-), Yarn Worth (S^-) and Amount Utilized (S^-) and shortage in Sales (S^+). However the Variable Returns to Scale (VRS) are increasing for 15 clusters, constant for 5 more clusters and decreasing 0 Clusters. To conclude, for inclusive growth and sustainable development, the inefficient Handloom clusters should increase their Sales. Moreover the Handloom Clusters should strengthen infrastructure interrelationships, technology interrelationships, procurement interrelationships, production interrelationships and marketing interrelationships and should make use of the benefits announced by Government of India under MSE-CDP or MIIUS. The soft and hard intervention on Cluster Development Programme of Government of India will help Handloom Clusters in India to increase their productivity and efficiency.

Keywords: Technical Efficiency-Cluster- Handloom- India.

Location Specific Technologies for Agriculture and Rural Development - in response to aspirations of New India

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Abstract

India is predominantly a rural country, nearly 60% of the population and 70% of workforce live in rural areas contributing to 46% of the national income. Despite the rise of urbanisation more than half of India’s population is projected to be rural by 2050. Thus, growth and development of rural economy and population are a key to overall growth and inclusive development of the nation. Such rural development could be achieved by improving rural livelihoods and quality of life through new technology intervention. Agriculture still continues to be at core of rural livelihood, while employing more than 50 per cent of the total workforce in India it contributes around 17-18 percent to the country’s GDP (India Economic Survey 2018). Though, India has achieved self-sufficiency in food production, however, technology fatigue is being manifested in Indian Agriculture in the form of yield plateaus, rise in costs of cultivation, non-remunerative market returns, alarming food loss and food waste.

In alignment with the second Sustainable Development Goals (SDGs) to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture, Government of India is targeting to double the agricultural productivity and the income of farmers by 2022. At the core of this approach is shifting focus from production to post-production, subsistence farming to commercial farming systems. The approach is focussed on increasing the efficiency of the agricultural production system and strengthening the non-farm sector through technology intervention for increasing the farmers’ income.

Indian agriculture and rural development are also suffering due to lack of interest from next generation in traditional farming. Considering the small landholdings size, Indian agricultural productivity needs to be boosted through Precision Agricultural technology consisting of drones, sensors, robots, aerial images, and GPS technology. Agriculture no longer depends on applying water, fertilizers, and pesticides across entire fields. Instead, farmers use the required quantities based on location specific requirement. Drone technology along with remote sensing and sensor technologies can help throughout the crop cycle by precise Soil and field analysis, Planting, fertilizer and pesticide spraying, Crop health monitoring and Irrigation. GPS technology brings spatial accuracy in the above operations. While robotic small farm machinery like happy seeder, crop harvester etc, bring operational and energy efficiency in small farms. Internet of Things (IoT) and Artificial Intelligence are reducing the uncertainty of Indian Agriculture by making available the right & relevant information available to farmers in real time analysing and correlating big data about weather, types of seeds, soil quality, probability of diseases, historical data, marketplace trends, and prices for more informed decisions. Artificial Intelligence (AI) helps make better sense of the inherent fuzzy data and rapidly put out answers from extremely complex inputs. Further, the logic improves with learning and these factors make AI suited as an agricultural technology. The new revolution is precision agriculture driven by nanotechnology, where nanoparticles are delivered to plants and advanced biosensors for precision farming. Nano-encapsulated conventional fertilizers, pesticides, and herbicides release nutrients and agrochemicals in a slow and sustained manner, resulting in precise dosage to the plants.

Improving agricultural system efficiency will improve the farmers' income, however, to significantly improve the same, Doubling Farmers' Income (DFI) depends on strengthening the non-farm sectors through technology intervention. Beyond food and nutritional security, Agriculture should also be mandated to generate resources as raw materials to feed and support industrial enterprises – chemicals, construction, energy, fibre, food, medicinal, etc. Post-harvest processing should be strengthened through array of technologies like low cost solar dryer to high through put additive manufacturing (3D printing), where printers using

hydrocolloids (substances that form gels with water) could be used to replace the base ingredients of foods with renewables like algae, duckweed, and grass. 3D printing technology

also can be used to improve the production efficiency of traditional handicrafts and potters. In order to improve the rural livelihood system semi-mechanized ferro-cement based panels for housing; Micro Solar Dome for lighting; hand washing devices using bamboo and development of Bio-Solar ATM prototype have been developed.

The invited lecture will enumerate the technological advancement and application for Doubling Farmers' Income through improving agricultural production efficiency and non-farm sectors for sustainable rural development.

Cryogenic and allied research activities for rural sector as well as for replacement of CFCs –An Overview

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Abstract

Cryogenics is the science of ultra-low temperature below -150°C (123K) covering low temperature production, maintenance, measurement, control and its utilization for scientific investigation at low temperature. It is interdisciplinary in nature and it has pervaded in all branches of science and engineering. Cryogenics is becoming increasingly important in fuel & energy, space science, material science, agriculture and food engineering, cryo biology & cryosurgery, superconducting wire for power transmission and MRI for diagnostic purpose and in cryogenic rocket engine. Though UNESCO in its status report-1996 stressed the spread of cryogenic education and research in India for development of indigenous cryogenic technologies, India still lags far behind China and other advanced countries in cryogenic technologies.

An attempt is made to present a glimpse of the various Governments sponsored Research projects carried out by the author as Principal Investigator in cryogenics and allied field in relevance to rural sector .The following area of works are briefed in the paper.

i) Cryogenic Container:

The liquid Nitrogen Container is used for ultra low temperature preservation of Bull semen for artificial insemination of cattle, storage of blood and other biological samples for medical research applications. These Containers can not only maintain Sub-zero temperature as low as -196 degree C but can also be used in Animal husbandry, Research Laboratories, Industry etc. The Centre has developed small cryogenic Dewar from stainless steel for carrying liquid nitrogen in villages.

ii) Preparation of Cryogenic Grade activated Carbon-its physical characterization and application to mixed gas separation-DST Govt. Of India Project

The activated carbon production methodology has been made simpler so the rural people can manufacture it from waste coconut shell in small scales industries. Moreover, the gas separation technology based on activated carbon could easily be extended for enrichment of calorific value of Bio-gas.

iii) Feasibility studies on Development of Refrigeration Cycle based on activaed Carbon Carbon dioxide pair- DST Govt. of India Project

This project has its importance in replacing harmful CFCs (chlorofluoro carbon compound) from all conventional refrigeration system. Prototype developed could be up scaled and optimized for application rural sector in generating chilled water etc. This unique feature of this system is that it is based on two waste products namely, activated carbon developed from coconut shell and carbon dioxide gas as waste gas.

By applying this mechanism, a gas-active carbon system working in a Pressure Swing Adsorption (PSA) cycle could be chosen as an alternative technique for producing Cold after running a few adsorption-desorption cycles. A prototype was developed which successfully produced chilled water by eco-friendly mechanism

iv) Development of a System for prevention of post-Harvest spoilage of sesame seeds-DST-Govt. of W.B. Project

The Farmers are facing crop damage and substantial post harvest losses of Sesame (Till) seeds, as its harvesting time is April to Middle of June, which is the time for monsoon rain causes a great damage to the ripe fruits (pods) as they are stacked in the seed growing fields itself.

A unique solution has been found out by CRCT. The innovative method known as cryogas enrichment method of ripening sesame which takes two days against 14 days time. The method seems to be promising and cost effective and eco-friendly.

v) Production of liquid fuel from Jatropha Seeds, its characterization and viability studies as an eco-friendly fossil fuel substitute for rural sector- DST Govt. of W.B.

It aimed to explore the suitability of Jatropha Carcass seed oil (bio-fuel) as raw material in substituting fully or partially the two important Petroleum products like Kerosene and Diesel either as such or after suitable treatment/modification to get the desired properties. . The work intended to promote the direct use of Crude Jatropha oil as rural fuel and for rural illumination.

vi). Indigenous Development of liquid nitrogen plant of 7 – litres /hr capacity for various cryogenic application-DST–Govt. of India Project

Liquid nitrogen is user friendly and it has got wide application amongst the all cryogenic liquid. It is needed for any research & development work at low temperature and also required in Small-scale industrial application such as in material processing, food processing, biological preservation and plenty of liquid nitrogen is required to preserve bull semen in all Artificial insemination program of all veterinary departments. Most of the small liquid nitrogen plants are imported from abroad involving huge foreign exchange. So indigenous development of such plants is a national priority.

The Centre has successfully developed a small scale reverse Stirling Cycle based air/Nitrogen Liquefier of 7-litre/hr capacity for various Cryogenic application.

In conclusion, it is to be mentioned that India is a agriculture based country and presently about 40% of agricultural produce are wasted due to lack of proper storage facilities and non-availability of appropriate cold chain mechanism. As India started setting up liquefied natural gas (LNG) terminals in a big way there lies tremendous scope of developing Agri-Food Cold supply chain based on eco-friendly refrigeration recovery during LNG regasification. It is expected, cryogenics will play a crucial role in India in Ware house/cold storage and transportation towards minimizing post-harvest losses of agricultural produce.

Advancing technologies in R&D pipeline from Fuel, Food to Biomaterials

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Abstract

Innovations in biology, especially synthetic biology has made it easier to leverage living micro-organisms to produce products useful for human life and civilization. We at Reliance Industries Limited (RIL) have developed cutting edge tools and technologies for synthetic biology to utilize the fullest potential of this opportunity. Advances in synthetic biology and gene editing technology, bioinformatics and availability of different high-throughput technologies can enable significant increase in productivity of microorganism including algae to produce several value added products. Some of these developments at RIL will be discussed during the presentation.

Sustainable Rural Development of Engineering Science & Technology Education: “Challenges & Remedies Ensuring Quality”

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Abstract

Earlier to privatization, there were only few Government Engineering Colleges, which were 6/8 in Maharashtra and initially 10/15 all over India. Then slowly the growth of these colleges started in few rural places like Sangli, Karad, Ahmednagar & so on.

As the Institute Number was growing a need was felt for Controlling Quality of these institutes by a centralized body and then AICTE came into existence in 1987. By this time few Institutes like M.I.T., V.I.T., D.Y.P., C.O.E. and opportunity was available, multi-fold facilities for becoming Engineers came up in big cities. However, the flow of students in these renowned institutions attracted many politicians to encash their political influences, to get Government acquired land and start Engineering & Management Institutes on ancestor’s and relatives name, as a source of income by way of filling quota and management seats by huge donations, though not permitted. This was because of vacant seats as parents were preferring Institutes near to their native places and hence were changing colleges before the cut off dates creating more vacancies. This is how many of the renowned politicians have 70 to 100 Institutes in renowned cities like Pune, Mumbai, Nagpur, Nasik, and comparatively not even 20% in rural areas like Ahmednagar, Kolhapur, Solapur, Chiplun, Ratnagiri, Seed, Latur, Kankawali and so on. In urban areas, many Educationalists have established their institutes to impart so called medical, Engineering & Management Education for their next generations as source of income.

This paper talks the challenges and opportunities in the engineering education in India.

Participatory Poverty Reduction and Local Level Water Resources Management for Sustainable Rural Development: A Comparative Study on Rural Tanks and their Need for Modernisation in Tamilnadu and Karnataka States in India

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Abstract

Rural tanks have been the community assets gifted from the nature and they are the smallest water bodies in the rural areas of semi-arid tropical parts of south India. Rural tanks characterise ‘traditional’, collective irrigation in South India, since they are centuries-old infrastructures and very widespread. Most of them were built before the 18th century and their development in northern Tamil Nadu is mainly due to two dynasties that reigned from the 6th to 13th century. There is a very large number of the tanks, amounting to 159,000 and 39,000 in South India and Tamil Nadu, respectively for servicing about 65,000 and 3,10,000 villages. There have been geological characteristics that facilitate groundwater recharge. However, rural tanks are not only used for irrigation. They have multiple functions – economic, ecological and social – especially since their ecosystems provide many resources (water, fish, trees, grass, silt, etc) that benefit different sectors of society other than farmers. The present paper is intended to analyse the indigenous technologies adopted in various parts of rural tanks and ponds, with a view of an analysis of technology traditions adopted in the tank for management of local level water. Rural Tanks have different types of technological aspects in tank bunds, tank sluices, foreshore area, surplus weirs and water distribution system. The present paper is intended to analyse the importance of tanks, with a view of participatory poverty reduction. In order to field based research, few of the tanks from each two select districts from Tamilnadu and Karnataka have been selected for analysis. Based on the present

analysis, it is concluded that tanks are the central for poverty reduction through participation of people, which determine the sustainable rural development.

Keywords: Participatory Poverty Reduction- Sustainable Rural Development- Rural Tanks- Water Management Traditions- Tank Bunds- Sluices- Surplus Weirs

Biofuels Impact on the Water and Food Securities

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Abstract

Prior to Industrial Revolution - wood, charcoal and edible oils were the only main sources of energy for household uses like cooking, heating, and lighting. Of course, solar energy was used for drying clothes and for the processing of food grains to store and use it in future. The first Edison hydroelectric power plant, the Vulcan Street Plant, began operating September 30, 1882, in Appleton, Wisconsin, with an output of about 12.5 kilowatts. By 1886 there were 45 hydroelectric power plants in the U.S. and Canada. So, hydropower became a very important source of energy only after 1850 the year of the commencement of the Industrial Revolution. Subsequently, fossil fuels such as coal, oil and natural gases have become the world's dominant sources of energy.

At the later part of the 20th century, solar, wind, tidal, thermal, geothermal and nuclear energy have been used. However, the energy security was not able to be achieved even

after using these sources of energy not only in the developing and underdeveloped countries but also in the developed countries. So, now biofuel is being produced in many countries to attain sustainability in their energy demand.

Biofuels are being produced from woods, food grain residues like hay, husk, and other bio wastes, bagasse, cow dung etc. If we produce biofuels from these sources, they have no impact on water and food securities of the people. But producing biofuels from food grains which are being used for human and animal consumption, they have their impact on water and food securities of people even today. Biofuel production to bridge the energy demand is likely to affect the water and food securities of the people according to United Nation.

Presently about 1,120 cubic kilometres of fresh water is used for biotech crops. During 2030 about 3,540 cubic kilometres of water is likely to be used for the projected biotech crops area of 600 million hectares of land during 2030 according to the International Energy Agency (IEA). The water presently used and during 2030 for biotech crops is likely to provide water for about 22,736 million people and 71,834 million people respectively per annum, supplying domestic water at the World Health Organization's (WHO) standard. The food grains produced by this water now and during 2030 are likely to supply food for about 1,405 million and 4,438 million people respectively during these periods. While there are water and food scarcities now in many countries and it is also likely to increase many folds in future, it is not advisable to use huge quantities of water for biotech crops and convert the grains into biofuel.

Therefore, this paper aims at to throw light on the impact of biofuels such as ethanol, biodiesel and biogas on water and food securities of the people.

Keywords : Green energy - Biofuels – Ethanol – Biodiesel - Biogas - Energy security – Water and food scarcity – Bridging energy demand - Water and food security

Community Based Waste Water Treatment System in Rural Area

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Abstract

Wastewater treatment is the process of converting wastewater water that is no longer needed or is no longer suitable for use into bilge water that can be discharged back into the environment. Wastewater is full of contaminants including bacteria, chemicals and other toxins. Its treatment aims at reducing the contaminants to acceptable levels to make the water safe for discharge back into the environment. There are two wastewater treatment plants namely chemical or physical treatment plant, and biological wastewater treatment plant. Biological waste treatment plants use biological matter and bacteria to break down waste matter. Physical waste treatment plants use chemical reactions as well as physical processes to treat wastewater. Biological treatment systems are ideal for treating wastewater from households and business premises. The issue of water availability and wastewater management is a common scenario all over the world. Delay in summer and soaring temperatures have massively reduced the existing stock of water resources in the past few decades. Drying up of small surface water sources like pond, lakes, etc., decline in groundwater table, deterioration of water quality, and poor wastewater management are some of the current problems encountered in both urban and rural areas in India. West Bengal, particularly Murshidabad, Nadia, North 24 Parganas districts, etc., are highly affected by arsenic rather than other mineral's presence. Apposite management strategies and safety planning play a crucial part to combat these problems to some extent. This study highlights the quantification of wastewater generated from households, and finally a sustainable eco-friendly technological solution is to be developed at project site.

Keywords: Phytoremediation; Phytoextraction; Grey Water Management; Constructed Wetlands.

Energy Efficiency – Challenges in Agriculture Sector

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Abstract

Traditionally Agriculture Sector occupies a pivotal position in Indian Economy. Agriculture is the most important Private Business in India which Accounts for almost 15% of total GDP and provide income and employment opportunity to half of its population.

Energy is an important component in Agriculture and Agro Food Sector which not only runs the Equipment's but also Irrigates the crop, Sustain the Livestock, Transport and Process the Food. There is an indirect consumption of Energy for manufacture of inputs such as Fertilizer and Pesticides. Presently Agriculture consumes around 7% of total Petroleum Product Consumption and 18% of total Electricity Consumption of the Country.

India is having 18% of World Population, 2.4% of World Surface Area and 0.4% of World Petro Reserve. With Continuous Growth of Population more Agricultural Production is essential to meet the growing Demand of Food. As result of this Crop Production and Agro Processing emerges as a major Consumer of Commercial Energy. The requirement of Energy per hectare by Indian Farmers is 1.5 times of World Average. For Sustainability it is essential to increase Agricultural Yield per unit area without affecting Environment.

Therefore improving the Energy Efficiency of the Agro Food Chain is a Key Priority for India and a core element to our "Green Growth Strategies".

This paper deals with various Energy Efficient Opportunities for Sustainable Agriculture and Environment.

Keywords: Energy, Energy Efficiency, Green Growth, Environment, Efficient Practices

Valorizing Biomass-Fermentation Products, Acetone and Butanol

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Abstract

Acetone availability from phenol processes and biomass fermentation is well known. (1). It's over-supply offers an opportunity for value addition into it. Products such as isopropyl alcohol, IPA (2) methyl isobutyl ketone (MIBK) (3); and diisobutyl ketone (DIBK); etc. form via acetone hydrogenation. (4) Acetone also can be alkylated with biomass derived butanol. (5) Earlier (6) increased rate of hydrogenation was attributed to improved hydrogen surface diffusivity on carbon nanotubes (CNT) as a support. CNT also provides higher metal dispersion and little metal-support interactions. (7) Synergistic effect of Cu on Pd in hydrogenation reaction has been reported. (8) Melo et al. (9) used zeolite ZSM-5 for acetone transformation into MIBK. Thus, combining these works, we planned to study performance of Pd/MWCNT (multi-walled carbon nanotubes), Pd/MWCNT+HZSM-5, and Cu-Pd/MWCNT+HZSM-5 and correlated it with their relative metal and acid functions.

A Laboratory Study on the Influence of Saltwater Intrusion on Sand relevant to Coastal Environment

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Abstract

Aquifers of coastal regions degrade by saltwater intrusion, which is major hazard to coastal communities, where main source of water is fresh groundwater. Saltwater intrusion is mainly influenced by the rising sea-level and impact of human activities. With high extraction-rate, the problem is complicated, requiring efficient solution. This paper presents laboratory investigation on engineering properties of sand influenced by saltwater intrusion. Experiments on specific gravity, relative density and hydraulic conductivity were done on normal sand of particle size 75-425 μm , submerged in different concentration of saltwater for different periods. The results reveal that saltwater intrusion alters engineering properties of sand.

Keywords: coastal aquifer; saltwater intrusion; hydraulic conductivity; sand

Information session on Fulbright-Nehru, Fulbright-Kalam and other Fulbright fellowship opportunities

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Abstract

The 15 minute presentation will provide an overview on Fulbright-Nehru, Fulbright-Kalam and other Fulbright Fellowship, jointly funded by the Governments of India and the United States through the United States-India Educational Foundation (USIEF), the Fulbright Commission in India. The Fulbright Fellowships provide fully-funded opportunities for Indian academics, students and professionals to visit the United States for study, research or to teach, and provides opportunities for American citizens to visit India for similar professional development purposes. The presentation will discuss the various grant categories, disciplines offered, eligibility criteria and requirements of the fellowships (Website: www.usief.org.in).

Destination: Clean Fuel

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Abstract

While travelling by road to airport, one frequently comes across the hoardings of 'Ujjwala Yojana' regarding the LPG gas. The Chullha (firewood stove) used in rural

areas for cooking uses firewood which not only causes deforestation but in-house gas pollution of Carbon Monoxide and Dioxide has been a well-known issue now. The problem arises when a farmer buys a LPG cylinder though he has 2 to 4 cattle which can be used for clean fuel. But the purchase of a gas cylinder instead of Biogas will disturb the economy of a village in the long run. If we consider a village has 250 households and each household has enough cattle, the expenditure on LPG will be Rs. 21,00,000 annually in a single village, if a cylinder is used each month that costs Rs. 700. If we construct a Biogas plant, this money can be saved. Government gives Rs 10,000 per Biogas plant (capacity 2 m³). A Biogas plant costs around Rs 22,000. Although the calculations above are correct, the social reality in which we live are very different. The scheme for the LPG is- becoming popular, but it is not able to replace the rural Chullha even if we use the LPG cylinder in a conservative fashion.

Bhagirath has constructed more than 8,000 Biogas plant in last 15 years. We have a success rate of 98%. We have been constructing a thousand biogas a year for several years now. NABARD, UNDP and CSR from BPCL, IRCON, and Rotary have been instrumental contributors to speed up the process. District Co-operative Bank sanctions a loan of Rs 20,000 for a Biogas plant. There is a paradigm shift in Biogas movement from subsidy based to a loan based project. The shift from cooking on the Chullhas to biogas and from there to Pressure cookers has minimized the time for cooking by half. What took 4 hours can now be done in a couple of minutes. This change is due to the education and awareness regarding sustainable energy. More and more farmers are now taking cattle more seriously because the cow dung and urine is the feed for biogas. One time investment of Rs 22,000 with payback period of 3 years is like a boon to a poor farmer. The village, Nivaje in Kudal Tehsil of Maharashtra has 130 Biogas plant along with milk collection centres. Their turnover on the produced milk is Rs 20 lakh per annum, while per year the 130 biogas plant produce biogas that costs around Rs 10 Lakh. They have a well-equipped bank of agricultural equipment and machinery for carrying out activities of group farming. The farmers have digitalized the school in village by crowd funding and social contributions.

Vados, a village in Sindhudurg, now known as the village of eggs has been producing 2 lakh s eggs per month by Joint Venture with Venky's and a loan of Rs 3 lakh per farmer form

District Co-operative Bank. This village has become the egg basket for the district. The poultry waste is reused for biogas plant, which produces gas of a much better quality. The NPK essential for organic farming is now produced in the village only. Thus biogas plant acts as a catalyst in sustainable development. It initiates a thinking process as farmers start thinking about the use of surplus resources. A natural resource needs to be converted into a source of economy by using science and technology in an appropriate fashion. Bhagirath used Bamboo strips instead of 6 mm steel for Biogas plant construction. This project is supported by NABARD under RIF (Rural Innovative Fund).

India has 2% of fertile land, 18% of cattle population and 9% of Human population of the world. If we construct Biogas on a mission mode then energy security of the country can be achieved. If not, these things fossil fuels will only fuel the issue of Global warming. We at Bhagirath believe in the concept of global village. WEHAB denotes Water, Energy, Habitation, Agriculture and Bio-technology. We are doing a small pilot experiment with help of Society, Bank and Government. It is a replicable model. A whistle of pressure cooker acts as a biological reminder for women to participate in Gramsabha and SHG meetings. It will launch a battle for freedom from tragic conditions and a monumental shift to economic, social and political empowerment. We believe that Biogas plant can act as a nucleus for all such changes. Calorific value of Biogas may be low in comparison with LPG but there is not yet a suitable parameter to major social transformation in a mathematical form. Social transformation can be perceived when there is an enhancement of sensitivity and sensibilities on the whole in the society.

Mr. Sagar Suki, a resident of Amberi, a village in the Sindhudurg district had taken a loan of Rs 1 lakh and he now has assets worth Rs 3 to 4 lakh. He achieved this within a short span of 3 to 4 years. Currently he owns a biogas plant, an irrigation well, around 50 buffaloes and 3 goats. It's a classic example of economic cycle. Everything he has is bought by selling milk worth Rs. 15,000 and other products every month. The women in self help groups are now rearing more than 10,000 Kaveri birds (chickens) for eggs. Each hen produces 180 eggs per year. Small interventions caused by biogas plant often cast huge impacts in multiple ways.

We need to add words like Rethinking and Redefining to our life styles along with Reduce, Recycle, and Reuse. The rich and the poor are not different in this aspect as they are putting the resources to extravagant use. Their resources only differ. While the poor cut down the present and would-be forests for their present use; the rich use petrol, diesel to rob earth of its fossilised forests, a limited resource. Bhagirath's aim is to connect both of them. Mahatma Gandhi rightly said, "For a sustainable development of a society, one should only use resources available within 5 kilometres of his or her own radius." So a farmer who has sufficient cattle purchases LPG instead of constructing Biogas plant defeats the purpose of sustainability. It is not a question of only clean fuel for the present but for generations to come. If such a blue flame revolution takes place, it will not only free villages from the smoke but it will also empower the Indian rural economy on a whole. A man who dreamt of making India a superpower, Dr. Abdul Kalam rightly put it, "A dream is not what you see in sleep but a thing which does not let you sleep". And true to his words, Bhagirath has been working tirelessly for last 20 years to make the dream of an empowered economy and smoke free village, a reality. To initiate the change across India we need more like minded organisations like Bhagirath. In a society, tissue culture is not really possible but we must replicate such models and Bhagirath is ready to give the formula for social and cultural change.

GoI's Ujjwala Yojana: A boon for Rural Families & Development

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Abstract

Fuels serve as a major part of our energy requirement. They are the concentrated store of energy, which is related as heat when fuels are burnt. Fuels are combustible substances of organic origin or artificially obtained substances, which are used for producing heat and energy. Wood, coal, petrol, diesel, Naphtha, Kerosene, LPG, Natural Gas, and biogas are some of the examples of fuels. Fuels play an important role in our everyday life because they

are used in homes, transport and industry for providing energy. Fuels like wood, coal, kerosene, domestic gas, cow dung etc. are used in our homes for cooking.

Prior to launching of Ujjwala Yojana, India was home to more than 24 Crore households out of which about 10 Crore households were deprived of LPG as cooking fuel and have to rely on firewood, coal, dung cakes etc. as primary source of cooking. The smoke from burning such fuels causes alarming household pollution and adversely affects the health of Women & children causing several respiratory diseases/ disorders. As per a WHO report, smoke inhaled by women from unclean fuel is equivalent to burning 400 cigarettes in an hour. In addition, women and children have to go through the drudgery of collecting firewood.

Air pollution is not only a major health risk, it also has damaging impacts on the environment and agricultural crop yields. These impacts have significant economic consequences. While existing policies have made progress in reducing air pollution, further action is needed to bring air quality to safe levels.

Pradhan Mantri Ujjwala Yojana (PMUY) aims to safeguard the health of women & children by providing them with a clean cooking fuel – LPG, so that they don't have to compromise their health in smoky kitchens or wander in unsafe areas collecting firewood.

Pradhan Mantri Ujjwala Yojana was launched by Hon'ble Prime Minister Shri Narendra Modi on May 1st, 2016 in Ballia, Uttar Pradesh with an initial target of five crore LPG connections which was later revised upward to eight crore connections. Under this scheme, LPG connections provided to BPL families with a support of Rs.1600 per connection with an initial fund allocation of Rs.8000 Crore towards the implementation of the scheme. Ensuring women's empowerment, especially in rural India, the connections is issued in the name of adult women of the households. Further, an option is provided to provide a loan at zero interest to bear the cost of cooking stove and first refill, which has to be paid by the beneficiary.

Some of the significant achievements of the scheme are:

- More than 7 Crore LPG connections have been distributed over a span of 34 months. This comes down to around nearly 69 thousand connections are being released per day.

- LPG coverage has increased from 56.2% (as of 1.4.2015) to 94.3% (as of 1.4.2019) out of over 28 Crore Households.
- 82 per cent PMUY beneficiaries are going for refilling their cylinder and average refilling is about 6.5 cylinders per beneficiary in a year.
- About 42 per cent of the total beneficiaries belong to SCs and STs.
- World Health Organisation (WHO) has acknowledged the PMUY as one of the decisive interventions by the Indian Government to address the indoor air pollution which accounts for nearly 10 lakh (1 million) deaths every year across India.

Initially the beneficiaries under the scheme were identified through Socio Economic Caste Census Data. However, all the poor of the country are now eligible to get PMUY connection.

Further to give a fillip to the scheme, 6800 new distributorships were given to strengthen rural supply chain.

PMUY resulted in an additional employment of around 1 Lakh and provide business opportunity of at least Rs. 10,000 Cr. to the Indian Industry. Launch of this scheme also provided a great boost to the 'Make in India' campaign as all the manufacturers of cylinders, gas stoves, regulators and gas hose are domestic.

Keywords: Pradhan Mantri Ujjwala Yojana (PMUY)

Sustainable Catalytic Conversion of Agri-Biomass, High Ash Coal and Waste Plastic to Useful Products

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Abstract

Coal is the primary fossil fuel for India which is abundantly and widely distributed (319 BT + 45 BT lignite) across the country and provides ~53 % of primary energy needs & 70% of electricity for India. On the other hand, India produces about 600 million tons of agri-residue per year (from ~330 million hectares land) and ~30% is burning in the paddy itself which causes severe air pollution especially in winter season. Moreover, India is significantly generating plastic waste (~7 MMTPA) which causes several environmental problems such as drains choking, floods, land infertile, impact on animal /marine life and emits pollutant gases when burnt garbage. India's net energy/oil import is ~45% of total primary energy / ~83% of oil demand, further India's energy demand expected to be nearly double by 2030. This scenario has led researchers to explore and provide an effective solution for utilization of high ash Indian coal and other alternate non-conventional sources e.g. agri-residue, waste plastic, MSW etc. The most interesting fact is that H^o114 GWh energy equivalent agri-residue is not utilized in an effective manner and ~28 million barrels of crude oil equivalent waste plastic is not utilizing in an effective manner. Though there is a potential energy content in Indian coal (0.8 GWh /1 MMTPA), but it has not been exploited fully because of its high ash content.

Although, gasification is known to be the best carbon conversion technology with enough proven operations, the commercial installations were not been widely exploited due to the technology sensitivity towards the quality of feedstock and high capital and operational

expenditures. In order to obtain high carbon conversion, entrained flow gasifiers operate at high severity conditions (T: 1300 to 1500°C & P:20 to 50 bars) by using pure oxygen which necessitates additional CapEx and OpEx for air separation units. The Entrained flow gasifiers are most suitable for high quality/low ash feedstocks such as anthracite, petcoke, bituminous coals etc. Overall, the process frequently encounters with several reliability issues (such as refractory/ metallurgy erosion and slag handling issues etc.) ends up with a lower 'on-stream' factor i.e. <60 days. On the other hand, fluidized bed gasifier operates with relatively high reactive / moderate ash content feed stocks at a temperature between the ash softening and melting point temperatures. The operating regime (such as T) and feed quality (such as ash content) leads to several issues such as low carbon conversion, agglomeration, caking, hotspots, uncontrolled oxy-combustion and low calorific value of the product gas due to N₂ dilution etc. Fluidized bed gasifiers are inefficient to handle the high ash Indian coal and high oxygen content agro-residue as ash content and tar formation can accelerate the agglomeration of ash particles, and the larger sticky particles fall to the bottom of the bed which reduces the gas permeability and tend to block the reactor and hence ends up with de-fluidization. Further, the reactor feed lines and their removal pose a considerable problem. It is well reported that catalytic gasification process has the capability to get complete carbon conversion at low temperature thus by avoiding extreme operating conditions and operational issues etc. However, in conventional catalytic gasification, catalyst is impregnated on coal/ coke which ends up with major challenging tasks such as catalyst loss, recovery and regeneration which requires an elaborate and expensive processing steps. Overall, there is no suitable commercial gasifier developed so far which can handle the low-quality feed stock such as high-ash Indian coal or agri-residue without any operational difficulties.

At the same time, there are several reactor configurations are reported for waste plastic pyrolysis process (such as fluidized bed, rotary kiln reactors, fixed bed reactors etc.) for obtaining liquid product. Most of the processes are encountered with several unresolved challenges such as agglomeration, sticky char/tar formation on the inner surface of the reactor, leakages between moving and stationary parts, de-fluidization etc. are yet to be resolved. Moreover, quality of the liquid product is also inferior i.e. very low RON / cetane value, less stable and highly acidic in nature. Further, this liquid product has to be upgraded severely for blending with the commercial fuels. Hence, there is a need of efficient, commercially viable

continuous process for catalytic conversion of waste plastic in to high quality liquid product which is also expected to address all the operational issues.

Reliance R&D has developed a low temperature catalytic gasification technology for the conversion of carbonaceous feedstock in to high quality syngas. This unique process consists of dual fluid bed configuration wherein primary portion (~80%) of solid carbonaceous feedstock gasified with steam in-presence of proprietary catalyst at significantly low temperatures (<720 oC) in the gasifier and remaining portion (~20%) get combusted with air in the combustor while the catalyst gets circulated between these two vessels. This process has certain advantages such as (i) it produces a high calorific value syngas (free from nitrogen dilution) moreover it uses air thus eliminates the expensive air separation unit (doesn't use the pure oxygen); (ii) Catalytic gasifier produces H₂ rich syngas i.e. catalyst is capable to accelerate the water gas shift reaction thus molar ratio of H₂ / CO >3 vs. 0.62 which eliminates the cost for CO shift unit (iii) Complete carbon conversion occurs <720 oC (iv) The uniqueness i.e. low operating conditions and external solid catalyst can address all the issues of conventional catalytic gasifiers such as catalyst loss, regeneration, agglomeration, sintering, refractory corrosion, molten slag, tar generation, and dilution effect of N₂ on the product gas etc.

This process has been demonstrated in pilot scale reactor with different feedstock such as high-ash Indian coal, bituminous coal, brown coal, agro-residue and biomass under various operating conditions and filed four number of patents on process and catalyst worldwide through PCT route. Particularly one process patent has been granted in various countries like USA, Australian, Russian, Taiwanese, Europe, India, Indonesia and others are at different stages of granting. The result confirms that this in-house developed process is capable to handle variety of feedstock such as low-quality high ash Indian coal, agro-residue effectively and convert them in to high quality syngas at significantly lower temperatures (<720 oC) without any operational difficulties. This catalyst has possessed excellent properties such as hydrothermal stability, attritions resistance (<5%), high surface area/pore volume, better active metal dispersion and superior gasification activity. The proprietary catalyst remains within the gasifier without losing its activity while feed is continuously consumed. This is the primary advantage and uniqueness of the process. The proposed process has the excellent operational

features like commercial FCC process (on stream factor ~5 yrs.), and it is expected to minimize the all operational issues of commercial gasifier's such as catalyst recovery and regeneration issues, loss of catalyst along with flue gas etc. The additional advantage of this process is compatibility with air, i.e. use of pure oxygen is eliminated and the composition of the syngas (i.e. molar ratio of $H_2/CO > 3$) which leads to the elimination of OPEX and OPEX for the ASU's and CO shift reactors. This would save minimum 1/3 of the total project cost.

In addition to the catalytic gasification, RIL R&D has also developed a simple and innovative process for the conversion of waste plastic feed by using an improved catalytic rotary kiln reactor system, wherein as received waste plastic undergoes pyrolysis in the range of 350 to 650 degC in presence of a RIL propriety catalyst which is yielding ~80% of high quality of liquid products (Gasoline >50-70%, LCO 20-30, CSO: 5-15 wt. %) and 5-10 wt. % of gas and 5 to 10 wt. % of char as a by-products. Product gas can be used as heating medium to provide the heat for kiln reactor burring externally. This process is capable to overcome all the operational issues reported in conventional thermal processes such as agglomeration, lumps / tar formation, coke layer formation along with the inner walls of the reactor even at lower temperatures (min. 50 oC) and capable to produces higher liquid yields continuously without any other operational issues. Depends up on the heat demand and market value of the product gas, char can be burned in a separate vessel thus hot flue gas is passes through the outer surface of the kiln reactor for its heating and hence catalyst is regenerated. RIL completed the pilot scale studies and tested variety of feeds including different type of waste plastic feedstocks and planning to carry out further scale up studies. Overall, RIL's in-house developed process is most reliable and commercially viable route for the conversion of waste plastic in to high quality liquid fuel without any operation difficulties which can provide an EBIDTA of ~\$100/ T of feed.

RCAT-HTL: Sustainable Technology for Biomass Conversion to Liquid Fuel

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Abstract

Climate change is real, and its adverse impacts are visible worldwide. Use of fossil fuels to meet the ever-increasing energy demand has already increased the carbon dioxide to very high level in the atmosphere, leading to the global warming. Decarbonisation is the necessity. At the same time, energy demand will continue to rise in the developing economies and under-developed economies with large and increasing population. India is heavily dependent at this stage on the imported fossil fuel. With fast urbanisation and higher standard of living, waste generation is also increasing at much higher rate, leading to environmental pollution. Therefore, it is the need of the hour to have environmentally sustainable, and economically competitive technologies to combat the climate change and meeting the energy demand.

Renewable energy is recognised as one of the effective mitigation measures to curtail the CO₂ emission into the atmosphere. Solar and wind as sources of renewable energy have made significant advances. However, there are limitations in using solar and wind energy as source of energy in transportation sector. Aviation industry and long-haul transport by sea or road will continue to depend on liquid fuels. In this context, sustainable renewable liquid fuels from biomass and organic waste play very critical role. Sustainable liquid fuels are those renewable liquid fuels which can be produced from sustainable feed stock without burden on natural resources and can be processed and used in the existing infrastructure including the engines designed for fossil derived fuel. Reliance Catalytic Hydrothermal Liquefaction (RCAT-HTL), is one such new technology which produces drop-in energy-dense renewable liquid fuel from biomass and any organic waste, which can be processed in the existing infrastructure, producing the final product which meets all the sustainability criteria.

RCAT-HTL, a catalytic thermochemical process developed by Reliance Industries Ltd. (RIL), converts biomass, bio-waste, agricultural waste, plastic waste and any organic waste into energy-rich drop-in green liquid fuel, and recovers fertilizer-rich water from wet waste. This environmentally sustainable process overcomes the limitations of the existing technologies and offers a green solution to the global problem of waste disposal. RIL's RCAT-HTL is more feed-flexible – it can handle both dry as well as wet bio-waste, organic waste, mixed waste by co-processing or independently. The kinetics of the reactions can be tuned in such a way that the desired product mix can be obtained to suit the market demand and economics. RCAT-HTL adds value to low revenue streams such as agricultural crop residues benefiting rural economy and generating employment. RCAT-HTL is a promising technology for addressing Climate- Water- Energy nexus.

In the presentation, we will share and discuss our experience gained during the journey starting from conceptualisation to reaching the stage of technology level ready for commercialization.

Unnat Bharat Abhiyan program of MHRD GoI for catalysing S&T interventions and development of villages through Higher Educational Institutes of India.

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Abstract

Strengthening the link between higher education institutes and rural India, IITD has developed a concept and vision of Unnat Bharat Abhiyan (UBA) which was adopted by Ministry of Human Resource Development, GOI in Nov 2014 and launched a nation-wide program

for Higher Educational institute to participate and adopt a cluster of villages around them and work for their development in collaboration with district administration. Presently he is the national coordinator of Unnat Bharat Abhiyan, for a paradigm shift in academic and research environment in the country to make it more inclusive and societal relevant. The action verticals of UBA making a developmental impact are organic agriculture, water management, rural energy systems, rural craft and industries, sanitation, health care, housing, basic amenities, e-governance etc. Presently UBA is operating in 2142 Participating Institute with nearly 11000 adopted villages and plans to cover 7500 institutes across India to cover nearly 40000 villages in next two years.

Unnat Bharat Abhiyan is inspired by the vision of transformational change in rural development processes by leveraging knowledge institutions to help build the architecture of an Inclusive India. The Mission of Unnat Bharat Abhiyan is to enable higher educational institutions to work with the people of rural India in identifying development challenges and evolving appropriate solutions for accelerating sustainable growth. It also aims to create a virtuous cycle between society and an inclusive academic system by providing knowledge and practices for emerging professions and to upgrade the capabilities of both the public and the private sectors in responding to the development needs of rural India.

Through UBA, an understanding within institutes of higher education and an institutional capacity and training relevant to national needs, especially those of rural India would be built. It would improve development outcomes, new professions and processes to sustain and absorb the outcomes of research.

In accordance with the above mentioned vision, Unnat Bharat Abhiyan will strive to pursue the following:

- Develop the necessary mechanism and proper networking among educational institutions, implementation agencies (Panchayati Raj Institutions) and the grass root voluntary organizations to enable effective intervention at the field level.
- Select suitable rural clusters and effectively participate in the holistic development of these clusters using eco-friendly sustainable technologies and local resources

creating sufficient employment opportunities in the process, harnessing multifarious Govt. schemes as well as the efforts of voluntary organizations.

- Simultaneously, reorient the ethos, the academic curricula and research programs in the knowledge institutions to make these more compatible with the national needs including those of rural areas, thus contributing to capacity building towards indigenous development.

Subject Expert Group (SEGs):

The Subject Expert Groups are institutions which have been appointed by the UBA for providing operational expertise sought by the institutions engaged in the rural work. The responsibilities of SEGs are:

- To support PIs through a group of experts in their respective subject area.
- Preparation of the compendium of relevant technologies.

Goals of Unnat Bharat Abhiyan:

To build an understanding of the development agenda within institutes of Higher Education and an institutional capacity and training relevant to national needs, especially those of rural India.

To re-emphasize the need for field work, stake-holder interactions and design for societal objectives as the basis of higher education. To stress on rigorous reporting and useful outputs as central to developing new professions.

To provide rural India and regional agencies with access to the professional resources of the institutes of higher education, especially those that have acquired academic excellence in the field of science, engineering and technology, and management.

To improve development outcomes as a consequence of this research. To develop new professions and new processes to sustain and absorb the outcomes of research.

To foster a new dialogue within the larger community on science, society and the environment and to develop a sense of dignity and collective destiny.

Development of a Solar Drier for Jaggery drying

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Abstract

Jaggery or “Gur” is one of the traditional, unrefined, whole sugars made by the concentration of sugarcane juice without the use of any chemicals/synthetic additives or preservatives and most important agro-processing industries under decentralized sector in India. Recently, the concept of jaggery packaging for ease in handling, transport and distribution, besides hygiene has also received considerable attention in industry. Drying of jaggery up to 5-6% moisture content thus becomes a pre-requisite for the effective packaging. Conventional method of jaggery drying, is in open shed, which is unhygienic and requires longer time to dry. To fasten the drying and hygiene, solar dryer may be quite useful. Most of the villages spread all over, lack facilities of conventional sources of energy (viz. electricity and fossil fuels, etc.) to be used freely for drying as well as other purposes. And the fact remains that solar energy is available in abundance for such purposes free of charge. Experiments conducted has established that temperature in the range of 45-50°C was sufficient for jaggery drying and it is well within the reach of simple and low cost solar energy collecting systems. In view of the above facts a solar dryer, having 100 kg capacity has been developed for drying of jaggery. The developed dryer will be suitable for drying of jaggery in the rural areas where energy crisis is felt. The present paper describe about the same in details.

Keywords: Conventional sources of energy, Renewable energy, Solar energy, Jaggery drying, Energy crisis

Sustainable Bio-based Engineering solution for Groundwater

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Abstract

The presence of heavy metals As (Arsenic) and Pb (Lead) in the geosphere, biosphere, and hydrosphere resulting from the progressive development of urban smart cities and modern industrial technologies, poses a significant threat to human health due to their non-biodegradable and high toxic nature. Silica based polyelectrolyte sorbents such as colloidal silica, biopolymer coated silica, carboxyl-grafted silica, silica nano particles provides various active sites for adsorption for heavy metals and also provide active site for the chemical reaction of contaminants. Silane treated sand (STS), a promising non-toxic silica based chelating sorbents containing several functional groups (di-and tri-methoxy silane) was prepared by mixing of 1% and 5% (w/w) of mono-and di-amino silane solution to 250 g of quartz sand. Adsorption equilibrium was established in an hour interval (60 min). The pseudo-equilibrium process was best described by the pseudo-first-order kinetic ($R^2=0.90$), and Langmuir isotherm model ($R^2=0.94$) with the highest monolayer sorption capacity of 2.65 and 3.57 $\mu\text{g g}^{-1}$ for As and Pb on STS. The removal rate of arsenic gradually decreased (43 to 23%) from 10 to 100 ppb of initial concentration till 60 min of contact period in a single contaminant system, although the effect was non-significant for multiple adsorbent dosage systems and Pb removal system ($p<0.05$; t-test). The pore size distribution and BET surface area of the materials could influence the adsorption of the materials. It can be further stated that the chemical groups, covalent bonding with silanol/silane, crystallinity, and inorganic contents of the materials enhanced the adsorption rate. Therefore, these results clearly validate the feasibility of STS as a potential and promising adsorbent for removing metal contaminant from the percolating water.

Optimizing currency notes waste utilization towards environment protection and waste utilization: Potentialities and prospects in Indian economy

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Abstract

Much of the old currency notes will be now used to make plywood, and soft and hardboards. Plywood, hard board and soft board go into making all kinds of furniture and partitions. Normally, plywood and similar board manufacturing uses wood pulp as a major ingredient to make hard board, press board and soft boards. Western India Plywoods Limited (WIPL) based in Valpattanam in Kerala found that when 7% of shredded currency was mixed with wood pulp and pressed together, it made excellent boards without compromising the strength, density or quality of the boards. And, it was cost effective as well. RBI sold the shredded currency at the rate of Rs 250 per ton to Western India Plywoods Limited (WIPL) based in Valpattanam in Kerala. This paper explores the potential of currency waste utilization towards environmental protection in Indian economy. Banknote printing is the industry that has a deep influence on financial operations on market, reflecting the economic performance of governments. Therefore, it is surrounded by great secrecy even when dealing with production waste and end-of-life products, which are handled very carefully by controlled combustion or incineration after crushing them using special techniques designed to ensure that the waste does not come into possession by third parties. This waste contains significant amounts of cotton, percentage of which sometimes can reach up to 100% of the weight of banknote paper. It is clear that disposal of such waste by simply incinerating it contrary to the principles of sustainability and preservation of wealth. In order to achieve these principles, this research aims to develop a new strategy called “Banknote for Banknote (BFB)”, which aims to recover and refine cotton from Banknote waste and later reuse it again in the production of

banknote paper or reprocess it into cellulose nanocrystals suitable for use in many advanced applications through a sustainable technology.

Keywords: shredded currency, production waste and end-of-life products, principles of sustainability and preservation of wealth, bio-enzymatic pulping.

Artificial Photosynthesis: Metal chalcogenide nanomaterials as a promising photocatalyst for CO₂ reduction into solar fuels

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Abstract

Inspired by what Mother Nature has been doing for billions of years, fuels produced from sunlight through artificial photosynthesis can serve as future energy sources that are an environmental friendly alternative to fossil fuels. As per current global energy and clean environmental policies, the production of alternative green-energy sources while reducing CO₂ emissions without affecting our energy demand is highly challenging. World's geography and climate provide an abundance of solar light and water as free natural resources. We believe that the conversion of CO₂ and water into solar fuels via solar light is an approach capable of tackling both energy and environmental issues and addressing future prospects via efficient, cost-effective solar fuel production. However, efficient implementation of this process, which mimics natural photosynthesis, is technically very challenging, since it involves a combination of processes that can interfere with each other. Several semiconductor materials have been explored for photocatalytic CO₂ reduction. However, all the previously explored photocatalysts are not suitable for commercial requirements due to their low quantum

efficiencies and lack of product selectivity. Last several years, we have introduced several efficient novel nanomaterials and a breakthrough idea to this artificial photosynthesis research. To hunting more efficient photocatalyst system recently the metal chalcogenide based photocatalysts represent an important contribution towards high quantum efficiency (nearly 1%) artificial photosynthesis based on gas phase photocatalytic CO₂ reduction under visible light. The details catalyst material synthesis, photocatalytic performance, quantum yield, product selectivity of solar chemicals and recent work will be discussed in the presentation.

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Fault Prediction of Spacecraft Actuators using Auto Encoder Deep Neural Network Techniques

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Abstract

In this paper, we have developed the autonomous fault prediction techniques for spacecraft actuators using disruptive technologies. These techniques such as artificial intelligence (AI),

machine learning and neural networks; together with the expectations of a future space systems, demand continuous transformation to become virtual platforms.

Remote sensing, weather forecasting and earth observation satellites are the space assets. They are used for forecasting continuous crop coverage, crop prediction, weather prediction (i.e. floods and drought) and disaster prediction. This data is transmitted from these satellites to the ground stations for further processing and send to the village resource centre. The analysis carried out using these data help government agencies to devise the strategies for the rural development.

Considering the need for continuous and seamless data transfer, we have applied the auto encoder deep neural network technique for predicting spacecraft wheel failure in advance. For this we have selected an auto encoder architecture with single input and single out with 100 neurons hidden layer size. The raw data analysis of the on-board spacecraft actuator (i.e. wheels), used for remote sensing satellite attitude control, is carried out. From the on-board data (nearly a month) analysis, it is observed that wheel#1 current data has a mean of 0.557968 A and variance of 0.00040189 A²; whereas, wheel#2 current data has the mean 0.479019 A and variance 0.0284573 A² with a Gaussian profile fit to the data. From the Gaussian fits, it is concluded that the current data did not fit completely in a Gaussian probability density function profile. So we performed an analysis of outliers above 3-ó standard deviations from the local moving average. The nominal wheel current reconstruction errors from the auto encoder were observed and after trial and error threshold is decided as 0.25 A. This pre-trained auto encoder deep neural network is then used with degraded wheel data. The technique in the paper is able to predict the wheel degradation probability at least two days in advance.

So, in this research we have devised a novel method to predict spacecraft actuator failure well in advance using auto encoder deep neural networks. This will help maintain continuity in the satellite services, as the redundant system can be configured autonomously.

Keywords: Spacecraft, Actuators, Wheels, Remote Sensing, Fault Prediction, Auto Encoders, Deep Learning Neural Networks, Machine Learning.

Fungal Bio-deterioration of Concrete and its Prevention using Nanoparticle Coating

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Abstract

The susceptibility of concrete to fungal bio-deterioration was monitored in this study which showed that the propagation of fungal colonies had negative impacts on the inherent properties of concrete. To prevent this phenomena, the usage of nanoparticles was also illustrated, emphasizing primarily on the effectiveness of silicon oxide nanocoating against fungal attack. The nanosilica coating was optimized, applied on concrete cube surface that was in turn infected with *Aspergillus tamarii* and observed for any visual, physical and chemical changes for a period of six months, all of which exhibited positive results for the nanocoated concrete cubes than the bio-deteriorated ones.

Keywords: Bio deterioration, Nanosilica, Concrete, SEM, Stereomicroscope, FTIR, EDXRF

Adsorptive removal of Cu(II) from wastewater using natural bio-adsorbents in continuous column mode and scale-up design

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Abstract

Heavy metal pollution into aquatic environment leads to the damage in the ecosystem because of its toxic effects. Different industrial source discharges various kinds of heavy metals into the surface water, which causes health hazards to live beings. Copper is one of the primary heavy metals which introduces from various industrial sources, like electroplating, mining, petroleum refining, smelting, metal plating, and Cu-based agrichemicals, etc. Though a small concentration of copper is an essential nutrient to living organisms, its presence in higher amount may cause severe health problems. Mucosal irritation, renal damage, gastrointestinal issues, depression, and kidney damage are the various health hazards noted for excessive intake of copper. Industrial workers experienced lung cancer by breathing copper-containing sprays. Discharge concentration of Cu(II) in effluent is restricted up to 3.0 mg/L as per Environmental Protection Rules 1986 (Schedule VI) of the Central Pollution Control Board, Government of India; 1.5 mg/L is the allowable limit of Cu(II) in potable water as specified by the Indian Standard (IS 10500:2012) and 2.0 mg/L specified by the World Health Organization (WHO).

Adsorption became the preferred method over other conventional methods due to its simplicity and low cost. Recently, agricultural wastes and agricultural by-products were used as adsorbents as they were readily available, low priced, and have disposal problems. Thus, the utilization of these wastes in water treatment added value to these wastes. Green adsorbent refers to the natural adsorbents without any physical and chemical treatment is appropriate for heavy metal removal.

Cu(II) adsorption in the continuous column using green adsorbents like peanut, almond, and pistachio shell was investigated. Physical characterization of the adsorbents was done by Point of zero charge (pHpzc) estimation, Scanning electron microscopy (SEM), Fourier transform infrared (FTIR) spectroscopy and Brunauer–Emmett–Teller (BET) analysis.

Various experiments were done to know the behaviour of adsorption breakthrough against different operating conditions. Low influent adsorbate concentration, low flow rate, and larger bed depth were favourable for better Cu(II) ion adsorption.

Langmuir isotherm and Freundlich isotherm were used to fitting with adsorption equilibrium data. Different kinetic models were tried on the experimental result and utilized for scale-up plant designing purpose. Regeneration studies also reveal that the adsorbents had reusability criteria. Safe disposal procedure was also established. Performances of these adsorbents against industrial wastewater have been investigated. The study with industrial wastewater also suggests that these adsorbents may be used for Cu(II) removal. The cost of these adsorbents is very less compared to other modified and synthetic adsorbents, so these can be used in small and medium scale industries of third world countries like India.

Systems Engineering Education and Research: Challenges and Opportunities

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Abstract

Systems engineering is an interdisciplinary field that deals with design and management of complex systems. In this era of technological convergence, an overwhelming majority of systems are increasingly becoming large and complex that necessitates use of systems

engineering principles and practices. Only a few Indian institutions offer systems engineering programmes. Systems engineering is taught as one course or two courses to students of various engineering degree programmes. With no or little support from industry, engineering institutions face a lot of challenges in providing real-life systems perspectives to students.. It is still presumed that students will apply systems engineering principles as they progress in their engineering degree programme and eventually they will practice the above on taking up their engineering assignments in industry.

This lecture first identifies the major challenges of systems engineering education and research in India. Subsequently, it proposes a new approach of teaching-learning systems engineering. The proposed approach suggests spreading of systems engineering knowledge areas throughout the 4-year duration of engineering degree programmes as follows: Envisioning (1st year), Experimenting (2nd year), Engineering (3rd year), Executing and Evaluating (4th year). It provides opportunities to students to gain meaningful insight of various systems engineering knowledge areas at each stage. It also suggests the roles and responsibilities of various stakeholders for enhancing quality of systems engineering education and research programmes in India.

Keywords: Systems Engineering, Complex Systems, Systems Design, Education, Research

Inter Basin & Intra Basin Water Transfer - Unique solution for dual problems (Floods and Drought) in India

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Abstract

Water is treated as liquid gold since it is sacred and precious natural resource for health and wealth of the humanity. It is one and only the life sustaining elements of nature and second to “air” for survival of mankind and live stock on the earth. Earth is the only planet at present

contains liquid water. The spatial and temporal uniformity in rainfall may possibly meet the water requirements for the various sectors such as Agriculture, Power, Industries, Domestic requirements etc, for the overall development of a region or country. If non uniformity is observed it results in the flooding situations in certain areas and drought conditions in some areas which have adverse impacts on the socio economic growth of a developing country. The government of India is spending enormous amount every year as relief for these natural unforeseen calamities. To protect a region or country from floods and droughts, it is inevitable to have a remedy/solution to transfer the water from surplus basin to deficit basins. The concept of Inter basin & Intra basin water transfer can provide unique solution for the dual problems faced by the country like India.

India having geographical area of 328 MHa stands as Seventh largest country in the world. The total water potential of India per annum is 4×10^6 Mm³ (4000 km³) including snow fall, out of which 1.887×10^6 Mm³ (1887 Km³) flows as river water. At present 1.033×10^6 Mm³ (1033 Km³) of water is utilized and balances as 0.854×10^6 Mm³ (854 Km³) flows into sea and oceans. India is blessed with good rainfall in majority of the areas and scanty rainfall in few locations. The magnitude of average rainfall in North Eastern states of India is about 300 cm and less than 15 cm in North Western parts in the arid and semiarid regions. For the effective management of rain water in India the only alternative is to implementing Inter basin and Intra basin water transfer concepts.

As per the studies conducted by NWDA (National Water Development Agency) about all river basis of India, it is remarked that Inter basin Water transfer is quite possible. NWDA proposed linking of Indian rivers under two components namely Himalayan and Peninsular components comprising perennial and non-perennial rivers. Thus 30 links are proposed for benefiting water deficit basins from surplus basins, thereby flooding situations can be reduced and drought impact may be minimized to uplift for social and economical growth of India. The present paper throws a light on present rainfall and water potential scenario of India pertaining to interlinking of rivers which is on the top agenda of the country.

Keywords: Natural Resources, Inter Basin and Intra Basin, Linking of Rivers, Effective Management

Organic molecular and Polymer based Nanocomposite Magnetic Materials

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Abstract

Over a decade or so considerable progress has been made towards making magnets containing organic species as an essential component. Organic polymer material based magnets may have several attributes like low density, flexibility, processability at low temperature, property modulation, solubility, biocompatibility, semiconducting or insulating abilities etc. Magnetic materials are the backbone of modern digital technologies; and of late stretchable magnetoelectronics have gained substantial interest over the last few years. There are reports about the generation of Organic molecular magnets through synthetic routes but such synthesis methods are quite difficult to realise organic magnets. In this backdrop, magnetic materials have been prepared by embedding magnetic nano particles of transition metal like on polymer matrix like PVA using ion beam sputtering (IBS) technique. Characterization of these magnetic materials has been made using advanced instrumental techniques to understand the micro structural properties, chemical state of the nano-particles and magnetic properties. In this 107th Congress, presentation will discuss an overview of evolution and progress of organic molecule based magnetic materials till to date. And also will report the summary of important parts of our research results based on the development of magnetic material through physical method of IBS technique conducted in our lab in recent times.

Key words: Magnetic Materials, Polymer, Nanoparticles, Nanocomposites

The Science behind carryover issues in the LPG Treating units: Technological Challenges & Solutions

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Abstract

Mercaptans present in LPG are odorous, corrosive, and toxic and therefore need to be treated before end-use from an environmental standpoint. Extractive sweetening is the most commonly used catalytic process for this application worldwide. Carryover in LPG treating units is a common problem in such units where the system handles multiple rich caustic streams in a common oxidizer with high and variable mercaptide loadings. The paper discusses a case study of how the problem was resolved cost-effectively by a holistic scientific approach, which includes process parameter optimizations and reformulation of the catalyst by incorporation of suitable additives.

Keywords: LPG, sweetening, mercaptans, catalyst, carryover

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IV

**ABSTRACTS OF
ORAL PRESENTATIONS**

OP-1

Development of Artificial Intelligence Algorithm in Vision based obstacle avoidance for AGV Vehicles

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Abstract

In recent era, there has been a vast scope of research in the field of Autonomous Ground Vehicles (AGV) that draws attention of both researchers and scientists. Today, the world is witnessing the Fourth Industrial Revolution where Artificial Intelligence (AI) has become an essential and most crucial component of AGV. Nowadays, AGVs are being applied in different field of applications, such as in intelligent transportation, adaptive control systems, areas in manufacturing etc. In this paper, a proposed model of fast obstacle avoidance has been investigated. In addition to this, the simulation output of road sign recognition has also been depicted. It is likewise seen from the observation that the theoretical aspect and the simulated outcomes are comparable with each other. The future scope of research like parameters optimization of controllers, model and path optimization in this domain is also highlighted in this paper.

Keywords: AGV, AI, Optimisation techniques, Controller

OP-2

**Solar Energy based Sustainable Living in Residential Buildings:
An Approach towards Zero Energy Buildings (ZEBs)**

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Abstract

Solar energy is proved to be an important resource leading to sustainable living in residential buildings. Active and passive solar are two main technologies by which solar energy can be harnessed for comfortable living in residential buildings. Active solar technologies mainly comprise of solar photovoltaic (for electricity generation) and solar thermal (for heating applications). The electricity produced by solar photovoltaic panels. Passive solar techniques are mainly concerned with the harvesting of solar energy without specific equipment. In passive solar, the design of the building is to be cost effective and for comfortable living without any carbon footprint. In this paper, active and passive solar technologies are discussed and the role of their effective utilization has been analyzed. It is also observed in this paper that the efficient utilization of active and passive solar technologies leads to inexpensive and eco-friendly living in residential buildings. Such buildings, uses these techniques are called as zero energy buildings (ZEBs) which might be vital for Sustainable Development of Society.

Keywords: Solar Energy, Sustainable Living, Active and Passive Solar, Zero Energy Buildings

OP-3

Energy self-sufficiency in villages using locally available biomass resources – Gram Urja Swaraj

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Abstract

With the rapid pace of development in India, the consumption of energy that goes in driving the development has also been increasing at an even faster rate. However, the energy availability scenario has largely been skewed towards the urban areas and industrial sector. The effects of the development haven't adequately percolated to the rural population i.e. 68.8% of the country's total population. Only 70% of the total households in the rural areas are electrified whereas in the urban areas this figure stands around 90%. Also, it is important to note that the available electric supply in rural areas is highly intermittent and unreliable. Moreover, 75% of the rural households still depend upon firewood, agricultural residues and dung cakes for cooking purposes. These figures show that there is a large scope of improvement in providing energy access in rural areas. And India still being an agrarian country in terms of employment with more than 50% of the population being employed in the agriculture sector has a great potential for tackling this problem of energy security by utilizing its large amount of surplus biomass available, estimated to be more than 150 MT per annum. Also at disposal is the waste produced by its huge livestock population of more than 300 million which can be tapped into for bioenergy generation. This huge amount of available biomass can become a major energy producer in rural areas in a decentralized way. The idea behind this work is inspired from Mahatma Gandhi's vision of Gram Swaraj that "Every village should be its own republic, independent of others for its own vital wants and yet interdependent for many others for which dependence is necessary." with the focus on rural energy aspect of it i.e. "Gram Urja Swaraj". This paper aims to provide an approach for the utilization of locally available biomass resources of a selected rural area in an integrated way using bioenergy

conversion technologies for meeting the local energy demands. The approach includes assessment of the resources available from agriculture, horticulture and livestock and determination of the bioenergy generation potential from these available resources. We have also experimentally demonstrated the idea in our research laboratory by developing a localised biofuel production (biogas and biodiesel) and utilization system (diesel engines converted inhouse to dual fuel and 100% biogas engines) which functions as a standalone distributed energy generation unit. Thus, bioenergy generation in rural areas through bioenergy technologies is locally feasible and can have myriad of advantages such as providing energy security, reducing the green-house gas emissions caused by fossil fuels, reducing the health hazards caused by unchecked combustion of biomass resources, reducing our huge oil import bill of more than \$ 70 Billion, providing employment and generating incomes for the rural areas leading to holistic rural development.

Keywords: Biomass, Biofuels, Bioenergy, Rural Areas, Rural development.

OP-4

Mars Missions Failure Report Assortment: Review and Conspectus

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Abstract

Mars has been successfully explored by various space firms. Globally, 44 mission attempts were made and lamentably 27 encountered ineffective. There have been instances where a small misstep in the progressive accomplishment of spaceflight sequence may prompt in extreme loss. In order to refrain this issue, behind every spacecraft loss space agencies mobilizes mishap investigation review board to interpret and release the root basis for the failure of the spacecrafts. However the report, earlier lost space probes lack sufficient and

precise data behind their loss. Hence, In this article we review and encapsulate the root causes of entire collapsed spacecraft directed towards Mars since 1960.

Keywords: Failure, Mars, Spacecrafts, Trajectory

OP-5

Renewable Power Integration and Its Effect on Coal Fired Thermal Power Plant

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Abstract

Conventional Coal fired Thermal Power Plants are designed to operate at base load. Integration of renewable energy sources with the existing power systems, operational flexibility appears to be a significant paradigm shift for conventional thermal power plants when power demand keeps fluctuating. In order to survive in this new commercial marketplace, many coal-fired generators are having little option but to adapt to more flexible operation. This will have a major impact on the cost of power from such plants. In the present study, the effect of additional cost burden, technical issues and challenges are discussed due to flexible load operation of coal based thermal power plant.

Keywords: Flexible Operation, Heat Rate, APC, Part Load, Ramp Rate etc.

OP-6

Fault Detection & Theft Analysing System in Street Light Network

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Abstract

Generation, transmission and distribution of electrical energy involve many operational losses. We can defined the losses in generation technically but distribution and transmission losses cannot be precisely quantified with the sending end information. This illustrates the involvement of nontechnical parameter in transmission and distribution of electricity. Moreover technical losses occur naturally and are caused because of power dissipation in transmission lines, transformers, and other power system components. Technical losses in Transmission & Distribution are computed with the information about total load and the total energy bill. While technology in the raising slopes, we should also note the increasing immoral activities. The system prevents the illegal usage of electricity. At this point of technological development the problem of illegal usage of electricity can be solved without any human control using IoT. With the implementation of this system will save large amount of electricity, and there by electricity will be available for more number of consumer then earlier, in highly populated country such as India, China. Power theft can be defined as the usage of the electrical power without any legal contract with the supplier.

Keywords: Power Theft, Fault Detection, IoT, Street light, Wireless technology.

OP-7

Low Cost Smart Braille Printer: An Aid to Visually-Impaired

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Abstract

This paper describes the design and implementation of a low cost Smart Braille printer that can assist visually impaired. Blind people have various challenges to deal with. Existing Braille readers have restrictions of printing personal documents, notes/lectures etc. Because of the high cost of Braille printers (3 to 60 Lakhs) and also the blind students are not able to pursue their graduation along with normal students because of the difficulty in writing notes. The mechanical assembly, additional electrical components, software and their integration into the printer are outlined in this project. Cost reduction while maintaining the Braille quality is the major priority. With the proposed low cost smart Braille printer, the visually challenged people can effortlessly print their notes and documents in Braille from speech. This device will serve as an accessible tool to produce lecture notes/documents for visually challenged students/employees and it will also help the visually challenged people in their real time communication. The smart Braille printer can convert speech to text and text to Braille and to the printed form. Printing Braille is actually embossing the paper and requires a special embosser. The individual dots embossed on the paper are made by applying force to pins. This device shall serve as an effective tool to take down lecture notes/ documents for visually challenged people from all domains of life and also help the people with visual impairments in real time communication.

Keywords: Braille Script, Embosser, Braille printer, real-time communication, visually challenged.

OP-8

Green Audit in Indian Village Clusters - A must for Today

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Abstract

Green Audit is a tool that organizations use to identify the extent of environmental degradations and its impacts. In the present day's world, the statutory authorities make it mandatory to assess the status of establishments. It also offers the compliance with applicable laws and regulations, as well as with the expectations of stakeholders. A means to identify opportunities to save money, improve health, safety and process efficiency, to increase revenue generation and reduce liabilities.

Our Country has recently celebrated 73 years of Indian Independence. In the global platform India is considered as a developing country. Indian civilization is Village Centric—65% of total population live 6.4 lakh villages. Open defecation, drinking water scarcity, lack of adequate infrastructure, school and health care, access to basic amenities, power shortage are the major challenges there.

In the present paper the methodology of conducting Green Audit for the Cluster of villages has been discussed. All the major components Viz. Air, Water, Solid Waste, Live- Stock, Energy, Carbon Emission Reduction strategies, Optimum utilization of resources and mode of revenue generation have also been adequately reported.

Keywords: Green Audit, Smart Villages, Components of Environmental Audit, carbon emission reduction strategies

OP-9

Suppression of Surface Waves and Radiation Pattern Improvement Using SHS Technology

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Abstract

To reduce the backside radiation due to surface wave propagation from a high dielectric substrate, the use of an SHS has been employed to the design of microstrip patch antennas. The SHS is realized by surrounding the patch with metal via rings whose height must be equal to $\epsilon_0/(4\pi \times 0.5)$. A reduced backside radiation of approximately 10 dB is achieved with the SHS in comparison to a similar design without the SHS at 64.55 GHz. Generally, a large ground plane can also be used to reduce backside radiation, but incorporating the soft surface ring to surround a patch antenna can significantly reduce the size of the antenna, therefore making for a more compact module.

Keywords: Surface wave, SHS Technology, Patch Antenna etc.

OP-10

Enabling the Technologies for Creating Power Reserve for Stand-Alone Microgrid

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Abstract

Microgrid is a leading-edge technology to provide electrical supply of energy and it opens up the possibility of integrating various number of distributed energy resources. The increasing

penetration of renewable resources results abrupt changes in the voltage and frequency parameters at the distribution side. A stand-alone Microgrid faces the issue of inconsistent voltage and frequency due to its low inertia. The sudden change in the voltage and frequency parameter from their nominal value results to disturbance in the sharing of active and reactive power. The work presents the algorithm of voltage customization to reduce the demand of active and reactive power of the standalone microgrid. The IEEE 1547 standard allow the customization of the voltage of the consumer by 10 % and hence, the paper is motivated to develop control strategy by employing adaptive voltage-current droop mechanism to carry out Demand Side Management (DSM). The controller action incorporates outer voltage and inner current loop to achieve the desired value of customized voltage. The paper aims to address the growing demand of power in the new generation by adopting the technology of conservative voltage reduction. A frequency controller is devised for performing the action of Demand side Management and it is utilized to establish the frequency within the predetermined standards. The robustness of the control action is validated through simulation results performed on MATLAB environment.

Keywords: Microgrid, Demand Side Management, Conservative voltage reduction, Voltage-current droop control, Voltage control

OP-11

Band Structures of Different Types of Zinc Oxide Nanostructures and Their Dependence on Efficiencies of Fabricated Dye-Sensitized Solar Cells

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Abstract

Dye-sensitized solar cells (DSSCs) have attracted considerable attention over the past decade as a viable alternate technology for renewable energy due to their high efficiencies and potentially low production costs. Nanostructured ZnO has shown a great deal of research

interest as the electrode material in DSSCs due to some of its fascinating properties. Compared to other semiconductors, it has unique properties such as large exciton binding energy, wide band gap, high breakdown strength, cohesion and exciton stability. In this work, we compared the device properties of DSSC fabricated through different techniques, ZnO nanorods on a ZnO film using sol-gel technique and ZnO nano-powders. Nanostructured ZnO grown by the sol-gel method fabricated with Rose Bengal Dye is analysed for its suitability to be used in DSSC and subsequently used to fabricate the cell. The photovoltaic properties of the ZnO based DSSC samples were systematically investigated. The results were analyzed to those of a conventional ZnO-nanorod DSSC (i.e., ZnO nanorods grown directly on an ITO coated glass). The ZnO nanorods grown by the sol-gel method have more uniform thickness resulting in enhanced photovoltaic properties of the fabricated device.

Keywords: Dye-sensitized solar cells, Zinc Oxide Nanorods, Photovoltaic properties, Sol-gel method.

OP-12

Overall Program POs attainment by using CO-PO Mapping with various Assessment Method

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Abstract

Indian higher education system is the one of the largest system in the world. In India every state has its own specific approaches to find the solution. As per the NBA (National Board of Accreditation) the all have to concentrate on Outcome base education for Students. NBA is outcome based learning education. Faculty has to define Course outcome and then to assess the COs after finding attainment of all COs faculty has to map all Course Outcomes with POs .

In Diploma Engineering the syllabus is design for the Students by Maharashtra State Board of Technical Education (MSBTE) where all Subjects have its own objective and methodology to achieve the Subject Outcomes. Some Subject have Theory with Practical and some have only theory. To achieve the Specific Outcome for the subject, Teachers have to use various Direct or Indirect methods. Due to Time limit of Semester Study its very difficult to achieve all target at same time. So we thought to provide Some simple Measurement tool to find Course Outcome attainment level with direct and Indirect method.

Keywords: COs-Course Outcomes, POs- Program Outcomes, PEOs-Program Educational Outcomes, PSOs- Program Specific Outcomes, Rubrics, Student

OP-13

Studies on Innovative Wastewater Treatment and Reuse for Villages using Reed Bed and Root Zone Treatment

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Abstract

Water, sanitation and hygiene are the three aspects under the purview of Sustainable Engineering & Technology for Rural Development and therefore needs special attention. UNICEF runs WASH programme from block and panchayet level in order to achieve protection of water environment in Indian villages. The program modules sometimes need adequate sustainable engineering counterpart to address the wastewater treatment, its utilization and reuse for real life problems in village level. The Reed Bed and Root Zone treatment, a natural process has proved to be very convenient as it encompasses the interactions of various roots of the reed plants, bacteria, soil, ambient air, and solar irradiation all of which act in synergistic manner.

This particular technology has inherent advantages as it is also cost effective, both from the standpoint of capitalized and operational cost. Elimination of sludge handling problem, promotion of landscaping and greenery, restoration of natural habitat and protection of biodiversity makes the technology this route more appealing.

In the present investigation, Chak Kolarkhal and Kheyadaha were the two model villages, selected for conducting the feasibility of sullage and grey water treatment and reuse by using reed bed and root zone treatment. Both Chak Kolarkhal and Kheyadaha villages are located in Sonarpur Tehsil of South Twenty Four Parganas district in West Bengal. While total geographical area of Chak Kolarkhal is 35.23 hectares with a population of 1,513 distributed over 340 houses, the same of Kheyadaha being 246.03 hectares with 1,930 peoples in about 450 houses. The proximity of both the villages and particularly the later one towards

East Kolkata Wetland, the Ramsar Site of West Bengal justifies the need for undertaking the investigation. The study envisaged the ascertaining of Wastewater generation/Sullage (Chak Kolarkhal 148.3 m³/day and Kheyadaha 196.9 m³/day), the quality of influents (BOD, COD, TKN, TS, SS and metals particularly Chromium and others). The investigation also included analysis of topography of the sites for selection/layout of the proposed plant. A combined flow system design was developed based on pilot study using floating macrophytes viz. Canna Indica, Typha elephantina Roxb. The Hydraulic Retention Time and the area of the unit were calculated to be 5-6 days and 1.2 hectares respectively for both the villages. The quality of the effluent was also analysed in the pilot plant study and the same conformed the CPCB standard. The treated effluent with minor disinfection can also be reused safely.

Keywords: Rural Wastewater Treatment, Root zone Treatment, Natural Treatment using macrophytes, Innovative Engineering Solution in Village Wastewater.

OP-14

Control Panel Monitoring System

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Abstract

The control panel is a cabinet which contains electrical components in order to control mechanical equipment. It is a centralized system which is capable of controlling loads that are located at some distance apart. Often control panels are used in some remote areas which are not easily accessible. E.g. Wind power plants are located far away from main cities. Hence, if there is any fault occurrence in the system, it is not easily detected and the fault location cannot be identified easily. Hence, in order to take quick action based on the fault occurred, the fault finding time needs to be reduced, which is possible with the help of

control panel monitoring system. This project is meant to monitor the electrical parameters such as voltage, current, frequency, temperature, etc in a control panel. We can also monitor the State of the devices. This information is conveyed to the authorized personnel with the help of a notification on the phone. A cloud based server helps to keep track of all the process and the overall monitoring process. Hence, this project makes the fault finding process easy and helps to take a remedial action based on fault.

Keywords: Control Panel, IoT, Cloud Server, Monitoring.

OP-15

Insitu growth of CeO₂ on Si-NWs and Its Application as Supercapacitor Anode

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Abstract

Highly ordered CeO₂ nanoparticles were grown insitu on the chemically etched Si Nanowires and the electrode was used as anodic material for supercapacitors. The structure and morphologies of sample prepared were characterized by X-Ray Diffraction, Field Emission Scanning Electron Microscope. The electrochemical tests were performed using three-electrode work station which exhibits superior electrochemical performance including high specific capacitance and good cycling stability. The electrochemical property is attributed to the redox nature due to which ceria shows good physicochemical properties along with chemical and mechanical stability. Owing to the ease of good electrochemical properties and large scale fabrication, these CeO₂/Si- NWs array would be promising anode material for supercapacitors. The assembled CeO₂/Si-NWs anode exhibited excellent electrochemical specific capacitance of 846 Fg⁻¹.

Keywords: Supercapacitors, Silicon nanowires, Cerium oxide nanoparticles, nanocomposite materials

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V

**ABSTRACTS OF
POSTER PRESENTATIONS**

PP-1

Construction of Electric Generator using Chemicals as fuel

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Abstract

In India there are many states, mostly in the North Eastern region of the country where electricity is not available in many areas till date. As an alternative way in this work we have used a mixture of water and calcium carbide which produces a much amount of hot acetylene (C₂H₂) and that can be used as the fuel for a heat engine to run the piston to and fro connected to the engine, which is again connected to a turbine in such a way that the turbine rotates along with the motion of the piston. This turbine is connected to an AC dynamo and thus electricity can be produced.

Keywords: Calcium carbide, Heat engine, Turbine, AC dynamo

PP-2

Electro-reduction of CO₂ to valuable chemicals - A sustainable solution to global warming

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Abstract

The emission of CO₂ could affect the agricultural sector, mainly in rural area by various ways: directly increasing CO₂ concentration result in lower nutrient content in crops, indirectly

rising temperature cause in reduction in product volumes, while droughts and floods can destroy harvests. The remediation could be either reducing emission or capturing and, subsequently, converting CO₂ to useful chemicals. Among various processes, electro-reduction of CO₂ to chemicals is gaining popularity as it's the cleanest method when energy source is renewable. CO₂ electro-reduction in liquid and gas phase is performed in H-type and Membrane Electrode Assembly electrochemical cell, respectively. The products include CO, CH₄, HCOOH, CH₃OH, C₂H₅OH, C₃H₇OH, etc. Researchers are making an effort to achieve maximum efficiency by optimizing the design parameters such as electrodes, membrane, and cell configuration. Further, research in this area has substantially increased the yield and efficiency enabling electro-reduction to valuable chemicals a reality in future.

PP-3

Design and Analysis of Connecting Rod using Nastran

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Abstract

Now these days the use of machinery like tractor etc. are performing various works in the agriculture and various area, not only in urban but also for rural area. Connecting rod is one of the important part of the IC Engine, so that analyze the various factor which affect the performance of the durability of connecting rod is so important. So for this purpose we have designed and analyzed the CAD model of Connecting rod using Nastran solver in NX 11.0 (Unigraphics). This paper is based on Finite Element Method, and there are various parameter like materials (Al alloy 2014 and 5086), and initial design etc. were changed and analyzed the impact of it on connecting rod. This paper will beneficial for the better design of the connecting rod so that the performance of it will increase.

Keywords: FEM, Connecting rod, Design and Analysis, FEA, CAD, NX, Nastran

PP-4

Preparation of catalyst for alkane isomerization using Zirconia material

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Abstract

Zirconia is a very interesting material zirconia material for the isomerization of n-hexane. Microwave irradiation used to synthesis of zirconia. Sulphation of zirconia was carried out with sulphuric acid. Material has been characterized by various state of art equipment, viz. BET surface area, pore volume, pore size distribution, XRD, SEM, FTIR, NH₃-TPD and H₂-TPR. Surface area and pore volume of zirconia was found to be 135m²/g 0.29 cm³/g respectively. Impregnation of tungstophosphoric acid (WPA) was carried out by wet incipient method. 50 wt % WPA was impregnated over the support and the total acidity was reported to be 0.091 - 0.612 mmol/g. catalyst was tested for the isomerization of n-hexane using fixed bed micro reactor at the temperature range 150-250oC.

Key words: Zirconia; WPA; Isomerization; BET; TPD.

PP-5

A Study on Batch Grinding and regression analysis of Graphite Ore

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Abstract

Graphite is one of the most versatile non-metallic minerals because of its diverse properties. The natural sequence of comminution in the mineral process plant is crushing and grinding. Crushing is the first mechanical stage in the process of comminution in which the main objective is the liberation of the valuable minerals from the gangue. Crushing accomplishes either by compression of the ore against rigid surfaces or by impact against surfaces in a rigidly constrained motion path. Grinding is the last stage in the process of comminution in which particles are reduced in size by a combination of impact, abrasion and attrition of the ore by the grinding media such as balls, pebbles or rods in rotating cylindrical vessels known as tumbling mills. In the present study, graphite ore of hardness 1-2, specific gravity 2.16 has been subjected to grinding test in a ball mill. The experiments were conducted at three feed sizes i.e., (-1/2" +3/8", -3/8 +1/4", -1/4"+3/16") inches and three ball sizes that is 1 inch, 1/2 inch, 3/4 inch. The parameters like: Time of milling, Quantity of feed and energy consumption for unit specific surface area were also studied. For the resulted batch data, regression analysis also carried out.

Keywords: Graphite ore, Batch Grinding, Energy Consumption, Regression analysis.

PP-6

Assessment of Fault in HVDC System

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Abstract

The need for interconnected generation and transmission system in power sector is increasing day by day. This work presents a comparative and illustrative study of protection scheme for HVDC system. *In this regards it is also equally important to ensure that some other issues like load change that could be mistaken as fault should not generate any nuisance for tripping of relay. In this work, HVDC transmission system has been simulated and fault analysis has been done in different conditions. For this purpose FFT based THD and 'db4' mother wavelet based statistical analysis has been performed on the captured current signal to analysis the faulty conditions.*

Key Words: HVDC, Faults, THD, DWT, Skewness, Kurtosis

PP-7

Review on Methodologies for Recycling of Refinery Waste Spent Catalyst

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Abstract

The catalyst used in refining processes gets deactivated in the due course of its utilization. The catalysts have to be regenerated after the catalyst activity decreases below its acceptable

limit but this regeneration process is not always feasible because the activity of catalysts may decrease at very low level after few cycles of regeneration and spent catalyst are abandoned as solid waste. The treatment, transportation, storage or disposal of spent catalyst need permit of environment regulation as spent catalyst is hazardous in nature. The spent catalysts are one of the cheap sources of metals such as Mo, Co, Ni, Va, etc. In this paper methods such as alkali leaching, acid leaching, chlorination, bioleaching, roasting with salts are used at laboratory scale is reviewed.

Keywords: Spent Catalyst, regeneration, leaching, roasting

PP-8

Recent trends in Copper based Electro-catalyst for CO₂ reduction

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Abstract

Conversion of carbon dioxide (CO₂) into value added chemicals by electrochemical CO₂ reduction (ECR) is the best approach to solve this problem. Different metal electrocatalysts are reported to reduce CO₂ into value added chemicals. However, the copper has unique ability to generate hydrocarbons and alcohols. Stability and selectivity of Cu during ECR makes this conversion kinetically challenging. It requires a large overpotential, as a result, the efficiency of ECR is depends on the selectivity and activity of the cathodic electrocatalyst. This paper presents the current status of copper based electrocatalyst for ECR, detailed reaction mechanism, its activity, selectivity and durability.

Keywords: CO₂ utilization, Electrochemical reduction, activity, selectivity, renewable fuel

PP-9

**Thermal Barrier Coated Low Heat Rejection Diesel Engine -
Performance and Combustion Characteristics**

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Abstract

Thermal barrier coatings (TBCs) were used to simulate adiabatic engines with the intention not only for reduced in-cylinder heat rejection and thermal fatigue protection of underlying metallic surfaces, but also for possible reduction of engine emissions. In this research work, the main emphasis is placed on investigating the effect of a TBC on the engine fuel consumption with the support of detailed sampling of in-cylinder pressure. Emission measurements of unburned hydrocarbons and carbon monoxide were also conducted in this study. In the present investigation, the piston crown was coated with the YSZ (Y, Of &ZrO,) ceramic material, using a plasma spraying technique. YSZ (Y, Of &ZrO,) was deposited to a thickness of 250 microns over the piston crown. Investigation showed that, Increasing the brake thermal efficiency, NOx emission and O2 and decreasing the specific fuel consumption, CO and HC emissions for Low heat Rejection engine with thermal coated piston compared to the standard engine. The peak cylinder pressures were increased by a magnitude up to 6 bars in the TBC piston engine, in particular at high engine power outputs, though the exhaust gas temperatures were generally lower, indicating good gas expansion in the power stroke which caused the peak cylinder pressure to raise and that impacted on brake thermal efficiency which is increased by 1.4%.

Keywords: Thermal barrier coating, Low heat rejection engine, Plasma thermal spray.

PP-10

A study on strength properties of Cement mortar by partial replacement of Cement with silica fume and sand with Vermiculite in presence and absence of Plasticizer

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Abstract

Concrete is versatile material prepared using cement, Natural Sand, Coarse aggregate and is used in construction industry extensively. Cement Mortar consists of Cement and Natural sand. Cement is a binder material, binding Natural sand particles and imparts strength to Mortar. Manufacture of cement involves releasing of more poisonous gases in to atmosphere. Increased usage of cement will increase pollution of environment. So there is need for selecting alternative material which can act both like binding material as well as non pollutant of environment. Here silica fume is one of the material which is having binding capability as well as a material, who usage reduces pollution in the environment.

Natural Sand is a filler material which was available in plenty earlier and now it is becoming scarce. In India sand levels are falling down and availability of sand is becoming an issue. So there is every need to go for alternative material for either replacing sand partially or fully. Vermiculite is a material which is having properties of natural sand like it can be useful as filler material. Vermiculite a hydrated magnesium-aluminium-iron silicate mineral imparting fire

resistance, good insulating properties, high liquid absorption capacity, inertness and low density.

In this study exfoliated vermiculite was used in replacement of sand and silica fume is considered to be the most suitable cementitious material for increasing the strength of mortar with a fixed quantity of 10% replacement of cement by Silica fume.

In the present investigation, strength parameters like compressive strength was evaluated before and after soaking in the acid and water absorption test is conducted. The ratio of mortar opted for this investigation was 1:3 ratios with partial replacement of sand by vermiculite by 2.5%,5%,7.5%,10%,12.5% and 15% and partial replacement of cement by silica fume 10% as constant throughout the work and with various water cement ratios 0.45,0.55 and 0.65 were considered in present work. This Article presents a detailed experimental study on compressive strength, at an age of 7, 28, 56 and 90 days.

Keywords: Exfoliated Vermiculite, Silica fume, Cement, Sand, Sp430.

PP-11

On-purpose Propane Dehydrogenation to Propylene

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Abstract

Propylene is one of the most important intermediate petrochemical products. Polypropylene market absorbs more than 60% of propylene produced worldwide. Other important propylene derivatives include acrylic acid, acrylonitrile, cumene or phenol and propylene oxide. Most common means of producing propylene in steam crackers and FCC. However, the substantial amount of shale gas has increased ethylene production from ethane steam cracking, which results in only small amounts of propylene. This has led to substantial increase

in propylene demand, resulting in supply/demand imbalance. In view of this, on-purpose propylene production via propane dehydrogenation (PDH) is increasingly attractive.

Major commercial PDH technologies such as CATOFINTM, OLEFLEXTM or STARTM processes have advanced to a stage where the reaction can run continuously for several years. However, all these processes have serious drawbacks regarding the catalyst and process. For instance, OLEFLEXTM process uses catalyst with high loadings of Pt which require special treatment during regeneration to retain the activity and CATOFINTM requires high loadings of Cr with consequent environmental issues. In addition, the equilibrium propane conversion & propylene selectivity is low due to the fast catalytic deactivation, frequent regeneration is needed which accounts for major operating costs. However, this could be overcome by designing a heat integrated system that minimizes the effort for the regeneration of the catalyst allow full utilization of the catalyst activity.

One of the approach to achieve maximum propylene could be selectively combusting the hydrogen formed during the reaction, thereby overcoming the equilibrium limitations. This can be carried out by oxidative dehydrogenation of propane using “solid oxygen reservoirs” as catalysts, which releases lattice oxygen to combust the hydrogen. Another interesting approach could be withdrawing propylene from the reaction and converting it into value added chemicals such as acrylic acid, propylene glycol and/or oxo alcohols, thereby avoiding the separation cost of propane/propylene. Owing to the high operating temperatures and low rate of reaction, it is necessary to have highly active catalyst. At high reaction temperatures, the formation of coke and deactivation of active sites is inevitable which leads to a significant loss in catalytic activity.

Chromium oxide-based catalysts can afford yields comparable to those obtained using Pt-based formulations. However, Pt-based catalysts can operate at higher space velocities and exhibit lower deactivation rates than chromium catalysts. Although gallium oxide based catalysts may show high initial activity, these catalysts deactivate too fast due to coke deposition and also their activity is irreversible by regeneration. Therefore, there is an urgent need of development of fluid catalytic dehydrogenation platform for effective catalyst regeneration to achieve high space-time yields (i.e., high conversion and selectivity at high space velocity). A fluidized bed is the most efficient way to achieve the steady state in a process as there is an

effective exchange of heat transfer from catalyst particles to gaseous feed in the efficient way with a high heat transfer coefficient. Other possible approaches to shift the reaction equilibrium towards propylene could be development of membrane catalytic reactors which are highly selective to H₂ permeation, thereby removing the H₂ from the product mixture and increase the propylene selectivity.

Keywords: PDH, Fluid Catalytic Dehydrogenation, Solid oxygen reservoirs, Reaction equilibrium shift

PP-12

Rubric to Validate Program Outcomes

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Abstract

Identify the purpose and process of assessment, including how assessment data might be used to identify strengths, weaknesses, and gaps within a curriculum that can be addressed to improve student learning. As academic organizations improvement towards including various methods of e-learning in their program, one of the main systems which are being applied in universities is the Learning Organization System. Every organization may have a different set of necessities based on the number of students, the resources and technical support available. Making a choice about which Learning Management System to use can be complex. In this paper, we have presented a rubric which evaluates Education Management System against a set of weighted criteria, thereby enabling universities to make a choice on which Education Management system to implement. Research on rubrics for assessing performance was originally searched online in the Educational Resources Information Center (ERIC). The search for rubrics/educational rubrics/scoring rubrics gave thousands of hits, which demonstrates that the word is embedded in the vocabulary of teachers and educators. The

rubric seems to be a standard area in the Learning method, and at learning conferences, which is seen by the body of literature that has accumulated in the past time on design, structure, logic, and use of rubrics as a tool for assessment of performance. Several benefits of using scoring rubrics in performance assessments have been projected, such as increased reliability of scoring, the possibility to facilitate valid judgment of complex capabilities, and raise of learning.

Keywords: Educational Resources Information Center, Learning Organization System, Rubrics, Program Outcomes(POs), Program Specific Outcomes(PSOs)

PP-13

Review of Course Outcome Attainment

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Abstract

Teaching method comprises the principles and methods used by teachers to enable student learning. These strategies are determined partly on subject matter to be taught and partly by the nature of the learner. For a particular teaching method to be appropriate and efficient it has to be in relation with the characteristic of the learner and the type of learning it is supposed to bring about. National Board of Accreditation (NBA) is outcome based learning education. NBA accreditation recognises the innovations and achievements of higher learning institutes. The accreditation of NBA helps higher educational institute to know its strengths, weaknesses and opportunities. In NBA terms Programme refers to Branch/ Discipline, Course refers to Subjects.

Keywords: NBA, PO, CO, blooms taxonomy, CAS

PP-14

Effects of Sphericity and Void Fraction on Stratification in a Packed Bed Solar Energy Storage System

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Abstract

The packed bed generally represents the most suitable energy storage unit for air based solar systems. The overall performance of solar air heating system having a packed bed is influenced significantly by the temperature distribution in the rock bed energy storage unit. Stratification provides higher temperature at top of the bed and coolest at bottom. This allows the warmest air to be delivered from the top of packed bed. An experimental setup has been designed and fabricated to achieve the desired objectives. A packed bed solar energy system with large sized elements has been investigated in low void fraction range. Five different types of storage elements of concrete were used and investigated to discuss the stratification for different values of void fraction and sphericity. The experimental data was taken and the value of stratification coefficient was calculated to investigate the effect of the bed parameters namely, sphericity and void fraction on the stratification coefficient. The results are presented in the form of stratification coefficient and it has been found that stratification coefficient is maximum at the lowest void fraction and for bed of spherical elements.

Keywords: Packed Bed, Sphericity, Void Fraction, Stratification

PP-15

Impact of Carbon nanotubes on the characteristics of concrete / mortar

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Abstract

The microstructure and mechanical properties of concrete/mortar can be enhanced by employing nano materials. These have the great potential to act as filler in concrete which reduces the chances of permeability. Different types of nano materials such as nano metakaolin, nano SiO₂, nano TiO₂ and carbon nanotubes are used for augmenting the characteristics of concrete or mortar. The objective of this paper is to review the role of carbon nanotubes in concrete or mortar. Carbon nanotubes are defined as the allotropes of carbon having the cylindrical structure which consists of single or multiple layers of graphite sheets in the nano size. These are further classified into: Single walled carbon nanotubes (SWCNTs) and Multi walled carbon nanotubes (MWCNTs). The properties of concrete or mortar can be increased by using MWCNTs. This augmentation in the properties of concrete or mortar is ensured by the uniform dispersion of MWCNTs and good bonding between the MWCNTs and the surrounding material. MWCNTs also double the service life of any structure. In this paper, several studies have been discussed which involve MWCNTs, used to improve the characteristics of mortar/concrete.

Keywords: Carbon nanotubes, Concrete, Dispersion and Nano materials.

PP-16

Analysis of a Microstrip Antenna with Negative Capacitor and Negative Inductor for Bandwidth Enhancement

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Abstract

In this paper two different types of active matching circuits using negative inductance and negative capacitance for transmitting microstrip antenna applications have been proposed. A simple rectangular microstrip patch antenna (RMSA) operating at 10.5 GHz has been utilized as a reference antenna. The impedance bandwidth of the antenna has been enhanced by using negative capacitance and inductance compensation networks from 12.22% to 16.96% and 24.50%, respectively. In addition, it has been shown that the active compensation significantly improves the radiation pattern.

Keywords: Negative capacitance, negative inductance, Radiation Pattern, Transmitting Antenna etc.

PP-17

MIMO QFT on multiple link flexible manipulator

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Abstract

The fast, rest-to-rest positioning of flexible articulating structures is a challenging control problem. This study presents the application of quantitative feedback theory (QFT) multi-input multi-output (MIMO) to control a flexible multi-link manipulator. The manipulator uses a actuating system consisting of a DC motor providing spatially discrete actuation and a piezoelectric ceramic bonded to the surface providing spatially distributed actuation. In the presence of significant parametric and non-parametric structured uncertainty, the efficacy of the sequential MIMO QFT methodology for articulating flexible structure control is investigated using the flexible manipulator test bed, with the control system designed to achieve fast, rest-to-rest positioning of the manipulator tip. To validate the synthesized control system and the combined discrete-distributed actuation scheme, numerical simulations and experiments are used. Using recent theoretical and design improvements, conservatism in the MIMO QFT methodology are identified and partially alleviated.

Keywords: Active vibration control, flexible manipulator, piezoelectric, quantitative feedback theory, robust control

PP-18

CO₂ Utilization: An Industrial Perspective

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Abstract

Rapid industrialization resulted in alarming increase in anthropogenic carbon dioxide (CO₂) level in atmosphere causing global warming. This has led to considerable interest in pursuing research on utilization of CO₂ to reduce its levels in the atmosphere. Conversion of CO₂ to value added chemicals, is one of the most important ways to achieve this target. Huge amount of CO₂ is generated from the refineries during the processing of hydrocarbon. The liberated CO₂, if captured and stored effectively can produce a few industrially important chemicals. The presented work is an analysis of techno-economic feasibility for synthesis industrially important chemicals using CO₂ as raw material such as mono ethylene glycol (MEG), soda-ash, formic acid, methanol and organic carbonates.

PP-19

Robotic Vehicle for Agricultural Harvesting

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Abstract

The presence of robots in agriculture has grown significantly in recent years, overcoming some of the challenges and complications of this field. This chapter aims to collect a complete and recent state of the art about the application of robots in agricultural harvesting. Traditional

harvesting of fruits and vegetables for fresh market is a labor-intensive task that demands shifting from tedious manual operation to a continuously automated harvesting. Increasing the efficiency and reducing labor dependents of harvesting will ensure high-tech food production yield and competitiveness. In spite of the advances in agricultural robotics, million tons of fruits and vegetables are still hand-picked every year in open-fields and greenhouses. Other than the high labor cost, the availability of the skilled workforce that accepts repetitive tasks in the harsh field conditions impose uncertainties and timeliness costs. For robotic harvesting to be cost-effective, fruit yield needs to be maximized to compensate the additional automation costs. This leads to growing the plants at higher densities which make it even harder for an autonomous robot to simultaneously detect the fruit, localize and harvest it.

Keywords: Agricultural Robotics, Digital Agriculture, Simulation Software, Multi-Robots, Greenhouse.

PP-20

Effect of Okra Plant Retting Condition upon Optical Properties of Okra Fibers

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Abstract

Optical property is one of the crucial criteria for bast fibers for their grading. On the basis of optical appearance decision about blending and cost of the product are taken. The study has been made to identify the effect of retting condition (plant life of 120 days) upon the optical appearance of the okra fibers. 120 days old harvested crop waste have been subjected to different retting time periods in different water conditions. Optical property such as whiteness index of okra fibers obtained from different retting time periods and different retting conditions were measured by spectrophotometer. This study revealed that the optical appearance in terms of whiteness index is not only depends upon the number of days for the

retting but also retting condition, especially, it depends upon the retting medium amount and its flow-ability.

Keywords: Okra plant, Okra fiber, Retting, Whiteness index, Pectin

PP-21

A Review on enhancement of Forging on Aluminum Matrix Nano Composites

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Abstract

The Aluminium matrix composites are finding widespread applications in engineering, automobile, aerospace, defence and recreation industries. For last two decades Nano composite, have emerged as high strength advanced materials for the industrial applications. The post processing like forging, rolling, extrusion of these composites further improves their properties in addition to the confirmation to the final shape and size. The present paper discusses the effect of forging of aluminium matrix Nano composites AMNCs. The forging process results in aligned grain flow pattern and smooth metal flow. The recent work reported on Aluminium matrix Nano composites developed by different fabrication processes and further forging process have been reviewed. It has been reported that the best result of forging of AMNCs with SiC reinforcement were found at temperature of 450oC to 500oC. The Powder metallurgy suggested for decent mixing of aluminium and Nano ceramic particle.

Keywords: Forging, Aluminium alloys, Al₂O₃ particles, Aluminum matrix nano composites.

PP-22

**Degradation of Synthetic Domestic Wastewater in Hybrid
Anaerobic High Rate Reactor**

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Abstract

Anaerobic processes are an attractive technology for wastewater treatment as the high costs of aeration and sludge handling associated with aerobic sewage treatment are dramatically lower as no oxygen is needed and the production of sludge is 3–20 times lower. In the present study an attempt is made to observe the degradation of synthetic domestic wastewater (SDWW) in a laboratory scale hybrid anaerobic high rate reactor .i.e. Upflow Anaerobic Filter Blanket Reactor (UAFBR). After start up period, the reactor was fed with synthetic domestic wastewater having chemical oxygen demand (COD) of 200 milligram per liter (mg/l) at three different Hydraulic Retention Times (HRTs). The degradation extent of the reactor was compared with respect to length of operation at different HRTs. The performance of the reactor was determined by taking out the samples from inlet and outlet ports to measure pH, chemical oxygen demand (COD), ammonical N₂, chloride, sulphates, and phosphates. The COD removal varied from 72% to 67% at different HRTs, the maximum being achieved at 8 hour HRT. The nutrient levels exhibited an increasing trend during the treatment.

Keywords : Anaerobic Treatment, Hydraulic Retention Time, Synthetic Domestic wastewater, Upflow Anaerobic Filter Blanket Reactor

PP-23

Case Study on Oleum Spillage during Transfer from Road Tanker to Oleum Storage Tank

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Abstract

Incident : In a Soap Detergent Manufacturing Plant situated in thickly populated area in a Metropolitan city massive spillage of Oleum (35%) took place on the floor of a Oleum storage tank (capacity about 20 MT) during transfer from the road tanker to Oleum storage tank due to overflow of the said tank. Sulphur trioxide from the spilled Oleum travelled according to direction of wind near the ground outside the plant affecting large no of people in its path of flow in a rainy day. People were treated in nearby hospital but there was no fatality and after treatment they were released from hospital. Attempt was made to neutralize spilled Oleum but before neutralization started an adequate amount of sulphur trioxide from oleum spread outside the plant according to the direction of wind. Due to heavy rain on that day suffered some hindrance and people were not in large number on the road. Had it not been a rainy day more people would have been affected.

How the incident happened

Oleum was brought in the plant on the said day of the incident by road tanker. The level of oleum in the tank was observed by the movement of a float inside the tank which gives the reading in a vertical scale outside the tank. The operator connected the road tanker to the pump for unloading oleum from road tanker to the static oleum storage tank in the plant and started unloading. The operator was aware how much oleum have to be transferred tfrom the road tanker to oleum storage tank but he forgot to stop the pump after the desired level of oleum in the static oleum tank, ultimately which helped overflow of oleum from the static oleum storage tank. When the operator noticed the overflow of huge quantity of oleum

below the storage tank, he stopped the pump and informed the higher authority regarding this huge spillage. Higher authority took the steps for neutralization of the spilled oleum by using neutralizing media, but the time gap before neutralization spreading of sulphur trioxide from oleum outside the plant according to the direction of wind affecting large number of people in the path of the gas outside the plant. No person was affected inside the plant as this storage area was close to boundary walls.

What was wrong in the operating procedure?

No high level alarm was in the tank. Also, no supervision was there to see such a risky unloading operation. To make matters worse, no stand-by storage tank for transferring the spilled liquid and no confinement followed by absorption arrangement were there for sulphur trioxide gas. No effective emergency plan was inside the plant for controlling this type of hazardous situation without loss of time.

How effect of this type of incident can be controlled and confined without affecting any person or environment

One stand-by tank of oleum of equal capacity of the existing tank has to be provided. Both the tanks should be in storage room whose two sides have fixed walls and two sides have remote-controlled doors and there should be concrete roof above this storage room. There should be a small catch-pit at the corner of the storage room provided with pumping arrangement of accumulated oleum after spillage for transferring to stand-by storage tank. There should be flexible hose hanging from the top up to the floor level of the storage area for sucking the sulphur trioxide gas with the help of induced fan and this gas will go to a scrubber where concentrated sulphuric acid will be used as scrubbing medium for absorbing the sulphur trioxide gas. This type of system development may control and confine the spillage of oleum during transfer in case of overflow of oleum from the tank. In addition, immediately both the emergency doors to be closed automatically. Acid transfer pump from the catch-pit inside the storage area should start along with the blower and absorption system. Simultaneously the emergency alarm will have to operate to declaring emergency.

Keywords: Oleum, storage tank, spillage, sulphur trioxide

PP-24

Investigation of Water Quality Surrounding to Puliyanthangal Lake, One of an Industrial Effluent Discharge Area in Ranipet

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Abstract

Ranipet Municipality is reported as one of the Asia's most polluted area having large number of tanneries, ceramic, refractory and chromium chemicals. Puliyanthangal Lake, a perennial water body, located within Ranipet municipality, receive huge amount of industrial effluent mostly untreated from the surroundings is our study area. As lakes cannot undergo self-purification process like rivers, contaminants have higher probability to get confined to that area. Hence a study was carried out to assess the extent of contamination in lake water as well as ground water in the surrounding area. Fifteen water samples (Including lake water, government bore wells, residential bore wells and open dug wells) were collected from pre-determined locations and analysed for major physico-chemical parameters such as pH, turbidity, total alkalinity, total hardness, total dissolved solids, chlorides and sulphates; found that most of the parameters are beyond drinking water standards. Elements and heavy metals are analysed in Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Strontium, Rubidium, Sodium, Calcium, Magnesium, Aluminium, Chromium, Iron and Manganese are found in significant concentrations in lake water samples; whereas Sodium, Calcium, Magnesium, Zinc, Strontium, Rubidium, Manganese and Aluminium are found in groundwater samples with traces of Barium, Copper, Iron and Lead; making the water unfit for drinking. Water quality indexing is performed by using Canadian water quality indexing; showed overall water quality of the lake and surrounding area groundwater is poor.

PP-25

**Treatment Of Wastewater With Simultaneous Energy Generation
Using Two Stage Constructed Wetland Microbial Fuel Cells**

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Abstract

Constructed Wetland systems are a combination of physical and biological processes, which are being used effectively for treatment of wastewater from different sources like domestic, industrial, agriculture, mine drainage, sewage dewatering due to its low operational cost, economical installation and minimum maintenance required. Microbial fuel cell (MFC) coupled with constructed wetland (CW) is one among the promising technologies in its domain because of its bioelectricity generation potential during wastewater treatment. In this study, for the first time, we have fabricated and operated two identical CW-MFC in series for treatment of domestic wastewater with and without plants. Two CW-MFC setups with and without plant were operated in upward flow mode. The plant species *Canana India* has been used for its adaptability in adverse aquatic environment. The treatment efficiency of wastewater from both the setups was analysed based on the comparison of physico-chemical parameters such as COD, TS and TSS, and COD loading rate. We have also evaluated the energy generation potential and reliability through optimization of external resistance for maximizing the voltage generation. We have further identified the fraction of the biomass actually responsible for generation of energy through Coulombic efficiency and NER calculation. Maximum and average voltages derived from system-1(a) [upper setup with plant], system-1(b) [lower setup with plant] were found to be more than maximum voltage derived from system-2(a) [upper setup without plant], system-2(b) [lower setup without plant]. Maximum overall COD, TDS and TSS removal efficiencies obtained from system-1 were also found to be more than system-2 after 30 days monitoring of the setup. Results showed that subsequent setups with plant (System-1) performed better than the setups without plant (System-2).

PP-26

Mechanical Check Dam Gate in Odisha

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Abstract

A Country can't prosper without the strength of its military and farmers. Indian National Legislation as well as European Directives aim for a better situation of our rivers and therefore the need for river restoration, by giving more space for the river, solving the problem of losing water, ground water recharge, a major part of water management projects deals with overcoming sluices and Gate weirs. However, along with the research Mechanical Check Dam Gate is used to counter act erosion by reducing water flow velocity. which dams up a small river or nallah in order to break the flow of water during the monsoons. Mechanical Gate in general is a structural steel frame consisting of end vertical girder with properly spaced horizontal girder between them. The spacing depend on the design water pressure and on the dimension of the Gate.

Keywords: Storage Capacity at FRL, Maximum discharge, Catchment area, Design ayacut, Full Reservoir Level, Design life of Project in years, Perennial/sub- Perennial.

PP-27

Comparison of Concurrent Mobile OS Characteristics

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Abstract

In today's world, everybody from a lay man, Surgeon, to an industrialist uses mobile phone. It is challenging for the mobile industry to provide best features and user interface by satisfying the varying demands of its wide spread customer base. With rapid advancement of technology,

the mobile industry is also continuously growing. However, perfection is the key requirement of the mobile users which needs continuous technology refinement in course of time, with change in customer outlook. This review will help user distinguish between cell phones on the basis of OS user interface, security, memory utilization, processor, architecture. Experiments Performed: In this OS comparison, we will take mobiles of different OS, and compare their power efficiency in the later time frame.

Keywords: Mobile OS, Security, GUI, Mobile Architecture. Processor, Memory

PP-28

Influence of dopant on the selective hydrogenation of CO₂ by Reverse Water-Gas Shift Reaction over Fe-based catalysts

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Abstract

The worldwide concern for carbon dioxide emission is growing due to accelerated pace of growth and energy consumption. The accumulation of CO₂ in the atmosphere has the potential to initiate unprecedented changes in climate systems, leading to “severe ecological and economic disruptions”. Utilization of CO₂ as a carbon feedstock for fuel and chemical production has some potential to reduce CO₂ in the atmosphere. J3-Gasification Complex at Reliance Industries Limited (J3-RIL) provides opportunities for monetization of CO₂ at sizable scale. RIL envisage overcoming the existing barrier for the full-scale exploitation of the potential CO₂ use to both high volume and high price chemicals. However, the potential utilization of CO₂ for chemical production is often limited due to its thermodynamic and kinetic stability. The high energy materials such as hydrogen or electron donor species are often capable of CO₂ conversion [1]. One of the promising route for CO₂ utilization is to convert CO₂ to carbon monoxide (CO) via the reverse water-gas shift (rWGS) reaction as shown in Eqn. 1. $\text{CO}_2 + \text{H}_2 \rightleftharpoons \text{CO} + \text{H}_2\text{O}$ (Eqn. 1)

CO being electrophile, is a versatile and valuable carbon feedstock due to its high reactivity [2]. The commercial Fe-Cr oxide catalyst used in water-gas shift (WGS) could be used for rWGS reaction. However, under reducing atmosphere and high temperature prevailing in rWGS, Fe₂O₃ phase reduced into metallic iron (Fe⁰) which results in the loss of activity and poor selectivity [3]. Therefore, it is necessary to maintain active oxide phase of iron during rWGS reaction by introduction of dopant like Ni, Co etc. during catalyst synthesis. Recently, our group has published alumina supported Co and Ni- doped iron oxide catalysts for rWGS reaction at temperatures range of 450–650 °C and atmospheric pressure. It was observed that oxide phase of iron was active for the rWGS reaction. Further, noticed that introduction of Co- or Ni- in iron oxide catalyst significantly enhanced the activity as compared to the undoped Fe/Al₂O₃ catalyst. However, among the doped catalysts, Co-Fe/Al₂O₃ showed highest CO yield (48%) and stable time-on-stream performance for 40 h at 3:1 H₂/CO₂ feed ratio and space velocity of 1000 mL/gcat.min at 650 °C and atmospheric pressure. The excellent performance of Co-Fe/Al₂O₃ catalyst results from improved reducibility of iron-oxide after doping of Co- and formation of mixed oxide, which is non-selective for methane formation under the rWGS reaction conditions.

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PP-29

Minimum fluidization velocities - Solid binary mixture and ANN Modeling

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Abstract

In fluidization, the process occurs when a fluid (liquid or gas) is passed up through the solid material. Due to their large contact area between phases, which enhances chemical reactions and transport processes, fluidized beds are used in many industrial processes.

The fluidization columns are made of perspex and had an inside diameter of 54 mm and 72 mm with a height 1690 mm and 1200 mm respectively. Simple U-tube inclined manometers containing mercury beneath the water are used for the measurement for pressure difference across the column against various liquid velocities which is measured by rotameter and sometimes by volume time method when liquid velocity reading is not clear in rotameter. Experimental investigation of the fluidization behavior in unary and binary solid-liquid fluidized beds of non-spherical particles as solid phase and water as the liquid phase were done in different diameters perspex column. Different average particle size from 3.057×10^{-3} m to 7.74×10^{-3} m was used to prepare the mixed solid beds in a different weight ratio of 0%, 20%, 40%, 60%, 80% and 100% for fluidization. The pressure drop across the fluidized bed and the porosity were measured at different liquid velocities. These data were analyzed to determine the minimum fluidization velocity (U_{mf}) for mixed solid bed–liquid by graphical method. The effect of different operating parameters, like particle size, sphericity, column diameter, rheological properties of the liquids on minimum fluidization velocity has been investigated. The minimum fluidization velocity (U_{mf}) increases with the increase in average particle size of mixed solid bed. For mixed solid bed minimum fluidization velocity (U_{mf})

increases with increasing the fraction of smaller diameter particle due to particle drag force, which makes the larger particle fluidized in lower liquid velocity. It has been observed that as the sphericity of the particle decreases, minimum fluidization velocity increases. The experimental values were compared with the correlations available in the literature, and an empirical correlation has been developed. Applicability of the artificial neural network modeling using gradient descent and Levenberg-Marquardt algorithm has also been successfully tested.
Keywords: Fluidized bed, sand mixtures, Minimum Fluidization velocities, sphericity, ANN, Levenberg- Marquardt algorithm

PP-30

Design of different latches and flip-flops in Digital Electronics using nanotechnology based Quantum dot Cellular Automata

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Abstract

A lot of research has been going on for implementing digital systems at nano-scale level. Quantum-dot based Quantum Dot Cellular Automata (QCA) is a promising as well as emerging technology for implementation of digital systems at nano-scale. By taking full advantage of the unique features of this technology, it is possible to have device which functions consuming ultra low power and very high operating speeds. In this paper, we have selected few basic Latches flips-flops like RS Latch, RS Flip-Flop, JK Flip-Flop, T Flip-Flop and studied them well. Using the computational tools “QCA Designer” proposed for designing QCA based digital circuit; we have designed the QCA circuits of flip-flops. The correctness of the proposed circuits is also verified using simulation result.

Keywords: Quantum Dot, QCA, QCA Designer, Latches, Flip-Flops

PP-31

Green and sustainable Dimethyl Carbonate synthesis from CO₂

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Abstract

The increasing concentration of CO₂ in the atmosphere and the resulting global warming have compelled human society to seek effective ways to convert CO₂ into valuable fuels and chemicals to achieve an anthropogenic and sustainable carbon cycle. Development of environmentally benign industrial processes for conversion of carbon dioxide (CO₂) into useful chemicals is of contemporary interest. Among the target compounds for its non-reductive conversion include organic carbonates like dimethyl carbonate (DMC), which is an environmentally benign substitute for phosgene and dimethyl sulfate which are used as carbonylating and methylating agents, respectively. DMC is employed as electrolyte in Li-ion batteries, raw material for polycarbonate resins, and additive in gasoline fuel. Currently, DMC is produced through phosgene route, oxidative carbonylation of methanol, and transesterification of cyclic carbonate. As these processes employ highly toxic and corrosive components, direct synthesis of DMC from CO₂ and methanol is an environmentally sustainable alternative. As compared to conventional production process, the proposed DMC synthesis process' use of CO₂ reduces the global warming potential by 4.3 times and ozone layer depletion by 13 times. Direct synthesis route, however, suffers from thermodynamic limitations. The free energy of DMC formation is positive, although the enthalpy is slightly negative. The in-situ removal of water co-produced during the reaction can enhance the DMC yield by enhancing the forward rate of reaction. Therefore, the direct synthesis of DMC from CO₂ and methanol is an eco-friendly, safe, cost-effective approach as compared to the hazardous conventional routes in operation. In this work, we have developed a stable heterogeneous catalyst for the continuous DMC production at mild temperature and pressure using a water-scavenging agent that enhances the yield and selectivity of DMC.

PP-32

Segregation and Recovery of Active Catalyst Fraction from the FCC Equilibrium Catalyst

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Abstract

Fluidized catalytic cracking (FCC) process is used to upgrade the gas oils to gasoline and lighter olefins. The process operates on inherently maintained pressure and heat balances. Catalyst and additives used in the process continuously undergo deactivation because of the severity, metals in the hydrocarbon feed and sintering. To maintain consistent activity, fresh catalyst is added to the system to a range of 1-3 wt.% of the total catalyst inventory in the FCC unit. At the same time, similar amount of the catalyst discarded from the unit termed as equilibrium catalyst (E-cat), is of no value and generally sent for landfill, that is becoming a concern to the environment. On the other hand, the E-cat consists of the particles aging from hours to days to months. The particles with lower age still possesses higher activity compared to the highly aged particles. This work pursued to segregate and recovery of lower aged particles which are having higher catalytic cracking activity from the E-cat and to reuse in the FCC unit so that fresh catalyst make-up rate /opex will be minimized which in turn reducing the amount of landfill.

RIL R&D has come up with a unique process for segregation and recovery of active fraction wherein fluidization technique is used to separate the lower density /lower particle size distribution (fresh catalyst) from the E-cat (higher age distribution) whose density is relatively high. Also, the particles with lower density and lower size distribution are having low terminal velocities, thus these particles leave the fluidized bed at lower fluidization medium velocities. The same idea was employed initially to segregate the catalyst particles in a fluidized bed and recover the particles from top of the fluidization column.

Proof-of-concept data generated using a systematic technique and protocol, wherein process parameters were optimized to obtain the recovery of fresh catalyst up to 40% from the spent catalyst. Subsequently, performance evaluation of recovered fraction has been taken and the results have been compared with that of spent catalyst as well as fresh catalysts. These results confirm that the recovered fraction is having higher activity than the E-cat and the discarded fraction and was similar to that of the fresh catalyst.

Overall, this exercise facilitates to minimize the fresh catalyst make up by 30%, in addition to the landfilling minimization.

Keywords: FCC, Equilibrium Catalyst, Spent Catalyst, Segregation, Recovery, Fluidization

PP-33

Analytical Study of Dielectric Material

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Abstract

The Dielectric property of material has gain significance in industrial application in recent decade. Electrical characteristics of every material are different to each other which are dependent on its dielectric properties. These properties provides the valuable information which helps researchers and engineers to utilize these data into their design or for the purpose of material characterization or for monitoring process quality. Among various techniques, to opt an appropriate method it is required to consider various factors. In this paper main characteristic of these properties followed by brief introduction of measuring technique is presented. In later part, a comparative analysis of important techniques is outlined.

Keywords: industrial application, various techniques, monitoring process

PP-34

Structural Response of Repaired RCC Beams in Flexure

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Abstract

RC structural components exhibits the distress due to over loading, corrosion or due to other causes, such kind of unserviceable structures requires enquiry into the cause and needs suitable remedial measures to bring back their functional use again.

This strengthening and enhancement of the performance of such structural elements in a structure as a whole is referred to as retrofitting. Some retrofit requirements would address the issue of life safety, while acknowledging that some structural damage may occur. Ferro cement as a retrofitting technique can be much useful because it can be applied easily to the surface of the damaged element without the requirement of any special bonding material and it requires less skilled labour, as compared to other retrofitting techniques. Ferro cement construction has an edge over the conventional reinforced concrete material because of its lighter weight, low weight, thinner section as compared to RCC & high tensile strength which makes it a favourable material for prefabrication also. In this current paper RC beams are initially stressed to a prefixed percentage of the safe load are retrofitted using Ferro cement to increase the strength of beam in both shear and flexure, the woven square mesh is placed along the longitudinal axis of the beam. In the present paper RC beams initially stressed to a prefixed percentage of the safe load are retrofitted using wire mesh and nitto bond to increase the strength of beam in flexure, the woven square mesh is placed along the longitudinal axis of the beam. From the study it is seen that the safe load carrying capacity of rectangular RC elements retrofitted with woven square mesh along with the nitto bond gives sufficient strength to the exiting RC structure.

Keywords: Woven square mesh, Nitto Bond, Ferro Cement

PP-35

3D Printing in the Context of Rural Development

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Abstract

For the past several years, 3D printing has gained significance in the industry for its ability to manufacture parts from any possible digital designs and availability of open source, low cost 3D printers, thereby enabling users to produce customizable finished products. This processing technique promises various applications in the context of rural economy. This paper provides a detailed review of the current technologies available in 3D printing, products and applications being researched keeping in mind rural requirements (i.e. manufacturing agricultural tools, healthcare applications, low energy solutions, fluid engineering and water management, decrease in carbon footprint by eliminating product shipments, equipment for weather forecasting, mobility devices). This study further provides insights around the roles being played by entrepreneurs, policy makers, governments, researchers and corporates across the globe in providing solutions for consumers with products that boost quality of rural life.

PP-36

Color Image Compression Using Golomb-Rice Algorithm

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Abstract

Data-computing applications such as image processing has a barrier of massive data storage especially color images which requires high memory suffer from complicated movement between memory and processing units compared to gray scale image. Aim of this work is to develop an algorithm for reducing the requirement for post application and processing. DWT and IDWT are used to compress and decompress the input image. Raster file produces differential data of high efficiency when compared to Differential-Differential pulse coded modulation (DDPCM). Fast Efficient & Lossless Image Compression System (FELICS) is used to produce unary code which is necessary for implementation of Golomb-Rice algorithm. The proposed algorithm was implemented using MATLAB, and validated with different standard images and their compression ratios, PSNR, and memory size is calculated. The image is compressed by DWT techniques, encoded by GR algorithm and the image obtained after the decoding and decompression is found to be satisfactory.

Keywords: Image compression, PSNR, Compression ratio

Abbreviation: Discrete Wavelet Transform (DWT), Discrete Wavelet Transform (IDWT), Differential-Differential pulse coded modulation (DDPCM), Fast Efficient & Lossless Image Compression System (FELICS), Peak Signal-To-Noise Ratio (PSNR)

PP-37

Heavy Metals Recovery from Gasification Petcoke Cinder

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Abstract

Gasification at high temperature (~1400 °C) concentrates all inorganics in the form of molten slag as a by-product. In case of petcoke gasification, feed petcoke is produced from crude oil refining which contains valuable heavy metals such as vanadium, nickel etc. The gasifier slag contains about 6 to 10 wt. % of vanadium (V) and 1 to 3 wt. % nickel which are having high commercial value. These metals recovery from complex structured molten slag is a challenging task. On the other hand, refinery spent catalyst from hydrotreaters contains significant amount of metals, such as V, Ni, Mo, Co, etc. Hence, it is important and essential to extract these metals from these waste materials in a commercially viable manner before its disposal.

Vanadium is the most important metal of present interest which is produced from metallurgical slags with 64 %, V-rich ore with 24%, and 12% of V produced from spent catalysts. The major market of V is 87% in steel manufacturing industries, 7 wt. % in titanium-aluminum alloy and 6 wt. % in chemical application as it contains high tensile strength, hardness, and fatigue resistance. Moreover, there is significant potential use for V in vanadium redox battery. In the conventional technology process, V is extracted from ore or spent catalyst through acid or alkali leaching and roasting with sodium chloride. Hydrometallurgy is a conventional leaching technology used for the extraction of heavy metals with acid or alkali leaching which is a high opex-capex intensive process as large amount of acid/base consumption and huge amount of volumes need to be handled. On the other hand, pyrometallurgy demands a very high temperature (>1600 dig C) for efficient serrations of these metals in reducing atmosphere. It would demand more capex and opex if we adopt the pyro metallurgy directly for recovery

of vanadium as it has to process entire feed (>95 wt. %) at very high temperatures. Moreover, this process demands a high ratio of V/Si (>1) whereas this V/Si ratio for petcoke slag is ~0.2. Hence, it is essential to develop a customized, simple and commercially viable for the extraction of V and Ni.

Reliance R&D has developed a novel green hybrid process for V metal recovery from silica-rich gasifier petcoke cinder using hybrid salt roasting technique with cheap alkali salt as a roasting agent followed by water leaching for the extraction of vanadium in the form of iron vanadate which can be further reduced to ferro vanadium by using conventional thermic reduction process. Overall, this hybrid process flow diagram is capable to recycle all intermediate streams and net alkali and water make up would be very low compared with the conventional processes. The primary advantage of this process is to lower the capital and operating expenses by a minimum of 30% when compared with conventional processes. R&D has completed the pilot scale studies at 5 kg/hr feed rate and obtained V recovery of >80% with >99% purity in final product i.e. iron vanadate was achieved with the developed process. All the process parameters were optimized such as salt dosage, roasting temperature, amount of water leaching, and the conditions of desalination and vanadium precipitation. This in-house developed process is capable of recovering the vanadium in the oxide from the complex structural cinder with simple processing steps with mild operating conditions. The developed novel process for the extraction of V and Ni from the gasifier slag is also equally applied for metallurgical slag, ores, spent catalyst, etc. Further, R&D planned to complete the demonstration studies by Q1'2020

Keywords: Vanadium, Extraction, Gasication petcoke cinder, Roasting

PP-38

A Low Temperature, Continuous Process for Catalytic Conversion of Waste Plastics to Transportation Fuels

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Abstract

The growing production and usage of plastic has made it an indelible part of MSW (Municipal Solid Wastes), thus affecting the environment by causing air, water, and soil pollution. The global production of plastic was recorded to be 1.3 MT (million tons) in 1950, the production reached 245 MT by 2006 and crossed 322 MT in 2015, further it is expected to go up to 550 MT by 2030. In India, the consumption of plastics was 1.6 MT in 1988, and has gone beyond 15 MT in 2014. The strict present-day regulations on traditional waste management practices like incineration and landfill have led the researchers to find a practical route for plastic disposal.

Plastic is a polymer of hundreds of linked hydrocarbon monomers which degrades into number of smaller fragments under conditions of high temperature and pressure, in the presence or absence of a suitable catalyst. These fragments undergo rearrangement and reformation to form valuable hydrocarbon fractions. The degradation of plastic into olefins, lighter fractions, BTX and other valuable hydrocarbons is considered as chemical recycling or pyrolysis. There are several pyrolysis processes developed for the conversion of waste plastic into fuel/olefins/BTX. In addition, pyrolysis reaction can be fostered through the employment of an effective catalyst and a high heating rate to a temperature greater than twice the melting point of the plastic material, so as to ensure complete vaporization

Although there are various studies done worldwide and reported several processes, there are several issues such as product quality, stickiness, agglomeration, leakages, gum formation, choking, sticky char and tar formation on the inner surface of the reactor, de-fluidization and

obstructions to the flow, leakages between moving and stationary parts (in case of rotary kiln reactors, etc. are yet to be resolved. In addition, the yields of oil products (mainly gasoline and diesel oil) are low and its quality is poor and every process has its own merits and demerits. The gasoline obtained contains large amounts of olefins and has a very low RON value. The diesel oil produced is high in freezing point and low in cetane value. It has to be upgraded further to blend with the commercial fuels.

Hence, there is a need of continuous, commercially viable process which can address all the operating issues along with product qualities. A superior catalyst is also required to address all issues reported in conventional processes.

The present study demonstrates the development of a highly reliable and viable process for continuous catalytic conversion of waste plastic in to liquid fuel by using a rotary kiln reactor at significantly low temperatures in the range of 350 – 550 oC. RIL R&D has developed a simple and innovative process for the conversion of waste plastic feed by using an improved catalytic rotary kiln reactor system wherein The novel design helps to process as-received waste plastic converting primarily in to liquid product (>80%) high-quality liquid fuel (Gasoline >50-70%, LCO 20-30, CSO: 5-15 wt. %) in presence of a low-cost proprietary catalyst while eliminating all the operational issues reported in conventional processes.

Depends upon the type of feedstock, operating temperature, catalyst dosage there is a formation of 5-10 wt. % of gas and 5 to 10 wt. % of char as a byproduct. Product gas can be used as heating medium to provide the heat for kiln reactor burring externally. This process is capable to overcome agglomeration, lumps / tar formation, coke layer formation along with the inner walls of the reactor even at lower temperatures (50 deg C less than the conventional processes) and capable to produces higher liquid yields continuously without any other operational issues. Depends up on the heat demand and market value of the product gas, char can be burned in a separate vessel thus hot flue gas is passes through the outer surface of the kiln reactor for its heating and hence catalyst regenerated. RIL completed the pilot scale studies and tested variety of feeds including different type of waste plastic feedstocks and planning to carry out further scale up studies. Overall, this process is is most reliable and commercially viable route for the conversion of waste plastic in to high quality

liquid fuel without any operation difficulties and it is capable to provide a promising solution to the waste plastic disposal issues and efficiently bring back the waste plastic in to hydrocarbon pool in a commercially viable manner.

PP-39

Compressed Air Car- A Review on Environmentally Benign Locomotive

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Abstract

In the face of the climate crisis, petroleum dependence and volatile gasoline prices, it is imperative to explore possible opportunities in non - conventional alternative fuel vehicles. Mankind is always looking for efficient and pollutant-free way of powering their machine. One such option is the compressed air vehicle (CAV). The use of compressed air for storing energy is a method that is not only efficient and clean, but also economical. Research is going on to find a light weight vehicle which does not pollute the environment. One of the alternatives is the use of compressed air to generate power to run an automobile. Due to the unique and environmental friendly properties of air, it is considered as one of the future fuels which will run the vehicles. The present study was focused on compressed air technology. Literature review has been performed on the modified engine to study its effectiveness. This paper describes the working of a cylinder in engine which can run on pneumatic power as by compressed air. Since it is an old technique which can attract many scientist as well as Engineer's for many years. Since engine is operated by Compressed air which contribute to reduce the air pollution and tend to zero pollution level of atmosphere and making a great environment. While developing it, some parameters like temperature, density, input power, emission control have been mastered for development of safety. Since the Gasoline is a thing

of past so the main advantage of CAV is no hydrocarbon fuel is required i.e., No combustion process may occur.

Keywords: Compressed air Technology, Valve, Compressed air Tank, Heating filament, Pneumatic motor, Storage tank, Compressed air engine, Emission output, Eco friendly, Energy released.

PP-40

A perspective on Oxidative Desulfurization of fuel oil

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Abstract

With the increasing concerns for global warming and environmental pollution, sulfur specification has been made more stringent in transportation fuel. Hydrotreatment, the conventionally used process in the refineries, is energy and capital intensive. Moreover the process demand the usage of high purity hydrogen. In this context, oxidative desulfurization (ODS), can reduce the sulfur at a low temperature and atmospheric pressure by reacting with an active oxidant to oxidise the sulfur species to sulfones and sulfoxides. ODS is typically a two-step process, where in the first step involves the oxidation of refractory sulfur compounds to sulfones and sulfoxides; while the second step is associated with the extraction of sulfones and sulfoxides using a polar solvent. Although, ODS has some of its intrinsic challenges; mild operating conditions, low operational cost and high specificity are some of its advantages. This study is aimed to highlight the advantages and challenges of ODS as a suitable alternative of hydroprocessing in refineries for sustainable resource development.

Keywords: Transportation fuel, air pollution, oxidative desulfurization (ODS)

PP-41

Diesel Engine Performance using Coconut Oil as Biofuel Material

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Abstract

Biodiesel is an alternative fuel mainly produced from vegetable oil or animal fats. It is a renewable substitute of regular fuel. As a replacement of petroleum fuel it is much cleaner alternative. Its physical components are much similar to diesel fuel. Renewable sources are used to create biodiesel. Sources like new or used vegetable oil and animal fats are not toxic and can be broken down by living organisms using a special process. To complete the process an alcohol, mostly methanol is used to create a chemical reaction with these oils and fats. After the reaction, we get a new liquid substance called fatty acid methyl esters. We call it biodiesel when we use it as fuel. Coconut oil is used as biofuel in the present paper. It is used directly or can be mixed with diesel as a blend and is used to find the performance of four-stroke diesel engine.

Keywords: Biodiesel, coconut oil, Performance, Diesel engine.

PP-42

Integrating project management in engineering curricula: A Knowledge Management Perspective

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Abstract

Most of the organizational activities could be categorized as either operations or projects. With ever increasing demand for growth and innovation, the share of projects is on the rise in every sector. Even though projects involve unique and temporary initiatives, there are important learning outcomes from previous projects which could potentially impact success of future projects. The 21st century projects typically have to deal with large and complex systems where boundaries are getting blurred and societal issues are dominant over technical issues. Therefore, engineers must stretch themselves beyond their technical domains and develop abilities to understand non-technical aspects of problems faced by the society.

The importance of project management cannot be over emphasized for engineering graduates especially from fast growing economies like India. The project-based learning approaches are fast gaining acceptability in universities apart from rush for collaboration between universities and industry. Indian universities have huge potential to serve as local knowledge hubs for technological developments and deployments towards catering to the needs of industry and society at large. Going beyond subject-oriented approach, engineering institutions should create an ambience to sustain the doing and support the learning. Multifaceted problems

and possible solutions should become an essential part of engineering education. Engineering students hardly have opportunities to work towards solving real-world problems as industry does not share case studies of project failures with academia. This paper proposes a framework to integrate project management in engineering curricula and to enable strategic engagement of stakeholders with engineering institutions from knowledge management perspectives.

Keywords: Project management, Project-based learning, Knowledge management

PP-43

Energy Efficient CO₂ capture technology developed in continuous fluidized-bed pilot plant

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Abstract

India is the fourth highest emitter of carbon dioxide in the world owing to the strong economic growth. International Energy Agency (IEA) found that India's carbon emissions grew by 4.8% during 2018, mainly due to sustained growth in oil and gas use. The CO₂ level in the atmosphere will likely continue to rise in the coming decades, as the world population and the energy consumption continue to increase and rely on fossil fuels. The increasing level of atmospheric CO₂ may be the universal challenge of climate change and grown to such proportions that urgent action to sharply cut carbon emissions is crucial, and all countries, including India, must act quickly. At COP-15 Paris convention, India pledge under the Paris agreement to cut energy intensity of GDP by 33-35% by 2030, over 2005 levels, through pursuit of proactive policies. As carbon pollution, temperatures, and climate destruction continue to rise, and public backlash mounts, the carbon capture technology can offer large reductions in emissions by means of simple absorption/adsorption methods.

Globally there are strong interest in carbon capture technologies and new emerging solutions are being closely watched, as industry recognizes the need for sustainable growth. Reliance Industries Limited (RIL), in pursuit of matured vision for a climate-resilient and low-emission future developed an adsorption based “Energy Integrated Circulating Fluidized Bed Process for CO₂ Capture”. The breakthrough innovations in sorbent and process were instrumental in achieving minimum OPEX and CAPEX. RIL’s hydrated sorbent for CO₂ capture process has the following attributes as compared to conventional amine process: (i) excellent sorbent textural properties, (ii) higher adsorption capacity [1,2], (iii) excellent heat transfer and faster kinetics (iv) lower temperature differential between adsorption-desorption, (v) utilization of flue gas heat to compensate partial heat demand [3,4], (vi) heat pump concept for upgradation of low quality waste heat for sorbent regeneration [3], (vii) lower energy requirement due to partial regeneration [5], (viii) minimal reliability issues etc. RIL’s CO₂ capture process with significant lower energy demand lead to reduction in carbon capture cost to one-third as compared to conventional amine route. The development of high capacity sorbent and heat integrated fluid bed process had provided potential efficacy and scalability of this process for capturing carbon from major industries sources.

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Application of Differential Evolution Algorithm for Reservoir Operation

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Abstract

In the Paper, an evolutionary based optimization algorithm namely Differential Evolution (DE) is utilised in a case study of Ravishankar Sagar Reservoir, Chhattisgarh, India, in order to reduce the deficit of water and meets the demand in best possible manner. Basic variant of DE was analysed with varying population sizes, crossover constants and weighting factors. Results so obtained are later compared with solution obtained from Particle swarm optimisation algorithm (PSO).

Keywords: Reservoir Operation, Differential Evolution algorithm, Monthly Release Policy, Reduction in deficit.

PP-45

Development and Demonstration of ZSM-5 Additive for Propylene maximization in Fluid Catalytic Cracking (FCC) Unit

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Abstract

Fluid Catalytic Cracking (FCC) is one of the most important processes in the refinery to convert low-value Gas oil into value-added products, namely, propylene. Besides, propylene from FCC is the most economical vs other technology options. FCC catalyst and ZSM additives are high-value materials in the refinery catalyst segment. There was a strong need to have increase in propylene yield higher than 10 wt% in commercial FCC units to maximize the profit margin of the refinery. These challenges could not be achieved for more than 10 years despite the best efforts from leading catalyst suppliers in the world. Hence, challenge remain for the catalyst community to make high active ZSM additive with improved activity, stability and attrition properties.

RIL has developed formulations, scaled up from 5 Kg to 2 MT and then to 400 MT commercial product successfully. The process and the signature of the product were patented in India, US, Europe and obtained FTO. The slurry containing 40-50% ZSM-5 zeolite, phosphate, silica-rich binder and clay slurry was spray-dried to obtain microspheres. Subsequently, this spray dried product was subjected to controlled calcination to obtain attrition resistant ZSM-5 additive. The catalytic performance of the additive was evaluated by mixing with FCC catalyst (Y based) in 75:25 ratio, in Fixed-Fluid bed unit at 540 °C by cracking VGO at different catalyst/oil ratios. The performance data showed that ~1.5% higher propylene yield over the incumbent. The characterization of additives by surface area (SA), XRD, NH₃ TPD, NMR and XRD. The higher surface area and acidity of steamed additive samples were related to its catalytic performance. The challenges in the scale-up and commercial

production was successfully overcome to make 400 MT finished product, as per the specification, in India based on in-house technology. This paper describes the basic chemistry of stabilization and challenges in commercial production of additive. The successful commercial FCC plant trial has no negative effect and the propylene yields were improved marginally. This is one of the major successful catalyst plant trial based on in-house catalyst technology and ~20% cost savings was achieved on the additive cost alone.

Keywords: FCC, ZSM-5 additive, binder, Propylene maximization

PP-46

Silicone Rubber Composites - Mechanical, Tribological and Dielectric Properties

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Abstract

In this research work, Methyl Vinyl Silicone Rubber (MVSR) composites were prepared by adding exfoliated graphite (EG) as the reinforcing fillers by two-roll mixing method. The effect of EG on the mechanical, tribological and dielectric properties of the elastomeric composites was systematically investigated and analysed. Further SEM study on the fracture tensile surface and worn surface is presented to understand interfacial adhesion between filler and rubber matrix and wear mechanism respectively. The reinforcement effect of EG in MVSR is confirmed by the Kraus plot analysis. An enhancement in the mechanical, tribological and dielectric properties was observed with an increase in filler loading. Optimum mechanical and tribological properties of the composite were achieved with 7phr of filler loading. Overall, it could be concluded that EG was successful in reinforcing the rubber matrix and the developed material will be a promising candidate for further research in area of elastomeric composites and its applications.

Keywords: Silicone Rubber, Exfoliated Graphite, Mechanical, Tribology, Dielectric.

PP-47

Enhancing the Efficiency of Reverse Osmosis Desalination Plant

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Abstract

Water scarcity has now become an alarming issue worldwide. Majority of water resources are used to cater agriculture, domestic and industrial purposes. With the current scenario in India, frequent water scarcity is affecting daily lives; moreover, a little amount is being recycled or reused. To combat such problems new desalination plants are being proposed for commissioning. Desalination by Reverse Osmosis (RO) membrane process is the most widely adopted technique in the world due to its low energy consumption compared to other conventional processes. Despite the great advances made in terms of the permeate flux and rejection, fouling and scaling on RO membranes remain among the major problems that greatly affect the performance. As per the case studies cleaning frequency of RO membranes doubled after 1 year of operation and desalination efficiency decreases ~7% per year due to membrane fouling. This paper focuses on different ways to improve the efficiency of desalination plant. An overview of development in membrane materials, hybrid RO desalination processes along with conventional / non-conventional pre-treatment technologies and their relative attributes are presented. Further, to identify the nature and extent of membrane fouling, autopsy study is discussed with suitable solutions to uplift the performance.

PP-48

Techno-Economic Perspectives and Importance of Renewable Energy Technologies

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Abstract

Renewable energy technologies offer a great advantage of using the available energy sources more effectively and economically. Renewable energy is the most propitious energy option particularly for long term implementation of the same. Even though the capital cost incurred while installing the renewable energy systems like wind mills, solar photovoltaic cells, biogas plants, etc. but the life cycle analysis demonstrates them as a highly competitive option considering the environmental implications. Awareness about such renewable energy alternatives can definitely provide a contrivance to brawl against conventional options of fuel and power, making self-sustainable growth of the society. The current paper describes the energy scenario of the country in current context and the importance of the advanced options relevant to the renewable energy technologies to meet the long term energy requirements.

Keywords: Energy density; Energy efficiency; Renewable energy, Nanomaterial

PP-49

Low Cost Aerogels Derived From Conductive Carbon Black Reinforced Cellulose Nanofibers with Excellent Microwave Absorption and Heat Dissipation

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Abstract

A Series of conductive aerogels from conductive carbon black (CB) reinforced cellulose nanofiber CNF were fabricated via a facile freeze drying process. The hydroxyl groups on the surface of CB forms strong intermolecular hydrogen bonding with CNF and the fabricated aerogels exhibited a high DC conductivity of 1.24 S/cm. The interaction between CB and CNF was confirmed from FTIR, XRD and TEM analysis. These aerogels also exhibited high electromagnetic interference shielding of ca. -35 DB (<99.9% attenuation) in the X band (8.2-12.4 GHz region) which makes them suitable candidates for defence and telecommunication sectors. These aerogels are quite cheaper and have high prospects for being translated into industrially scalable product with a low density of 0.125 g/cc.

Keywords: Cellulose, Nanofibers, Aerogel, Conductive Carbon Black, Microwave absorption, EMI shielding.

PP-50

Role of Power Electronics in Microgrid Systems

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Abstract

A microgrid behaves basically as an assistant to the main utility grid. A microgrid is like an energy grid with control abilities, so that it can disconnect from the main utility grid and

operate independently. A microgrid can be powered by generators, batteries and/or renewable resources like solar panels, etc. Power electronics finds its usage in building and maintaining a microgrid, since the power/energy available through renewable resources have to be harnessed in a proper and well-defined manner to be made usable to the utilities. Power/energy conversion in the microgrid systems with efficient energy management is the area where power electronics finds its applications.

Keywords: MLI, FPGA, MPPT, DC-DC Converter

PP-51

Attitude Determination and Control of Gravity-gradient controlled Nano-satellites

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Abstract

The demand of high precision and set-point trajectory tracking of small-satellite system has increased in the recent years. Major challenges in the system satisfying the above requirement are the insufficient knowledge about the disturbances and improper modeling. The structure and flexibility of small satellites, especially nano-satellites, vary according to the purpose and space mission. The nano-satellites are grouped in the category of 10-100 kgs and is launched in the Low Earth Orbit (LEO) region. It is more prone to external circumferential disturbance torques. Uncertainty and Disturbance Estimator (UDE) method is an influential strategy to take up the above-mentioned challenges and at the same time ensuring desired tracking performance. A feedback linearization based control design is implemented with UDE to achieve robustness at three Euler's angle of the satellite. The controller requires the velocity measurement apart from angular position of the spacecraft. A UDE-based controller-observer design is proposed to overcome this issue. The highlight of the proposed method is that it does not requires the complete information about the plant structural design and the

uncertainties affecting the model. Closed-loop stability of the system is evaluated. The efficiency of the proposed design is demonstrated on the dynamics nano-satellite in Matlab. A comparative study of the satellite system is analyzed with other existing control methods.

Keywords: Feedback gain control, input-output linearization, non-linear control, Uncertainty and Disturbance Estimator, Nano-satellites

PP-52

Energy and Cost Analysis of Solar Greenhouse Dryer with Heat Storage Material

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Abstract

The demand of fossil fuel has been increased up to the larger extent in the past few years. So the prime concern is to move towards the renewable energy. Solar energy is one of the forms of renewable energy and solar drying method is one of the forms of use of this energy. Solar drying method not only reduces the consumption of fossil fuel but also save the crops from post-harvest loss. In the present study environ-economical parameters like energy analysis, embodied analysis and CO₂ emission rate has been analysed for the proposed system. The embodied analysis for the proposed set up of the given system is found to be 530.4976 kWh.

Keywords: Greenhouse dryer, CO₂ Emission, Energy Analysis, Embodied energy analysis.

PP-53

Up conversion nanoparticles as a contrast agent for swept source optical coherence tomography

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Abstract

Here, we present swept source optical coherence tomography (SSOCT) as a non-invasive, non-contact bio-imaging technique based on Michelson interferometry [1]. Sweep-source laser having a central wavelength of 1060nm with imaging rate of 100kHz (105A-scan s-1) provide high speed and high resolution (~1 μ m) imaging platform offering a unique advantage in the means of sensitivity, reduction of motion artefacts, etc [2]. We use Up-conversion nanoparticles (UCNPs) as contrast agent due to its unique features which are an anti-stoke shift, sharp emission band, biocompatibility, low photobleaching effect, and high-drug loading capacity [3]. SSOCT imaging performed over tissue phantom after application of UCNPs to resolve high contrast images. An amplitude modulated laser beam is used to excite the UCNPs. The modulated phase vibration extracted from the tissue and separated as a presence of UCNPs. In this study, we observed UCNPs as a contrast agent for SSOCT imaging supported with scattering coefficient and contrast to noise ratio (CNR) results. This will further be implemented as targeted theranostics application.

Keywords: Michelson interferometry, swept source optical coherence tomography (SSOCT), Up-conversion nanoparticles, Scattering Coefficient, Tissue imaging.

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PP-54

Improving the Adsorption Efficiency for Removal of Phenol from Wastewater by Rice Husk Ash over Rice Husk

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Abstract

Phenol is considered as a serious environmental pollutant and therefore the study for its removal from wastewater by adsorption has gained momentum with time. The purpose of this research is to study the phenol adsorption efficiency using rice husk and rice husk ash. Initially, the characterizations of the adsorbents using SEM, XRD, FTIR, BET are performed. The phenol removal percentage is then investigated in batch experiments with the change of process variables, e.g., initial phenol concentration, contact time, initial pH, adsorption temperature and adsorbent dose. The batch experimental results show that at optimum conditions the maximum phenol removal percentage for rice husk and rice husk ash is 94.72% and 94.23% respectively. The results are then tested using several isotherms, kinetic and thermodynamic models.

The test of kinetic models shows that pseudo-second-order model is fitted better than the pseudo-first-order model for both the adsorbents. The test of isotherm models shows that

the Langmuir isotherm is better for rice husk ash whereas the Freundlich isotherm is better for rice husk. The thermodynamic study shows that the adsorption process is spontaneous, random and endothermic for both the adsorbents. The scale-up designs based on the experimental results and the safe disposals of the spent adsorbents are also deliberated in this study. The research discovers that the adsorption efficiency for phenol removal is better for rice husk ash in comparison to rice husk. The novelty of this study is that the paper has included exhaustive analysis using testing of numerous models viz. pseudo-first-order model, pseudo-second order model, Reichenberg model, Fick model, Furusawa and Smith model, Elovich model, Boyd model, Langmuir model, Freundlich model, Temkin model and Dubinin–Radushkevich model.

Keywords: Rice husk, Rice husk ash, Adsorption, Phenol, Wastewater

PP-55

Biosorption of Safranin dye using husk of *Lathyrus sativus* and its activated forms

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Abstract

Husk of *Lathyrus sativus* (HLS), particle size 500-300 µm, has been identified as a potent biosorbent for removal of safranin dye from aqueous solution. Efficiency of dye removal can be improved by applying sulphuric acid and phosphoric acid treatment of HLS which may

remove more than 99 percent dye from aqueous solution. Adsorption process is optimized by analysing effects of physico-chemical conditions like initial pH, initial adsorbate concentration, incubation time, adsorbent doses and adsorption isotherm at different temperatures. Adsorption process is optimum at pH 4 using untreated HLS (UHLS), where as an optimum range of pH (7-10) favours adsorption process and removes safranin dye maximally when activated forms of HLS such as phosphoric acid treated HLS (PHLS) and sulphuric acid treated HLS (SHLS) are applied as biosorbents. Initial dye concentration is selected as 50 mg/L for effect of pH, kinetics study and adsorption doses study, where as adsorption isotherm study is conducted between 25 mg/L and 500 mg/L for 3hr of contact time in a thermostatic shaker with a rotation speed of 100-115 strokes/minutes at 300C, 400C and 500C for untreated and acid treated adsorbents. Equilibrium isotherm indicates that the adsorption process follows both Langmuir and Freundlich isotherm models. Adsorption process is initially rapid and it reaches equilibrium at 75 min, 90 min and 60 min by applying desired amount of UHLS, PHLS and SHLS respectively following pseudo-second order rate kinetics. Removal percentage and adsorption capacity are greater at higher temperature which shows that warm condition can remove safranin dye more successfully. Removal percentage as well as adsorption capacity are also enhanced by applying activated forms of HLS than untreated HLS.

Keywords: Adsorption, Safranin dye, husk of *Lathyrus sativus*, Phosphoric acid treatment, Sulfuric acid treatment

PP-56

**Assessment of Forging Technology Awareness in Auto parts
manufacturing Industry of Punjab**

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Abstract

The aim of this study was to create a new approach for awareness analysis by means of Taguchi Signal-to-Noise Ratio to assess Forging technology performance to effectively improve technology awareness. In the present study the Taguchi Signal-to-Noise Ratio approach was applied to process the Ordered Categorical Data, and acquired into account at the same time the effect of mean and variance as well as awareness and no awareness information to suitably pinpoint the enhancement direction of technology attributes. With Punjab, 86 MSMEs as the research theme, this study deliberated the approach and benefits of using Taguchi Signal-to-Noise Ratio to technology awareness analysis. The less aware forging technology attribute was identified. Results explicitly describes that Forging die lubricants is the less aware technology attribute of new technology and more aware attribute is the Temperature control forging furnaces.

Keywords: Technology awareness, MSMEs, Taguchi Signal-to-Noise Ratio, New technology performance.

PP-57

Biodegradation Kinetic modelling of Grafted and Ungrafted Blends and Composites of Polypropylene in Composting Conditions

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Abstract

Six films of grafted and ungrafted polyactide/pro-oxidants/compatibilizer blend/composite polypropylene were prepared and then aerobically degraded to compute the carbon dioxide evolution in composting conditions. A mathematical model containing flat lag phase was postulated. The evaluated parameters showed two different kinetic regimes. In the first regime, three grafted films reveal low degradation rate due to slowly and moderately hydrolysable carbons. It showed low degradability value in the range of 1.8-2.7% in 45 days due to high amounts of slowly hydrolysable carbon. In the second regime, three films with pro-oxidant involve the moderately and readily hydrolysable carbons. It revealed high degradability values in the range of 8.1-9.0 in 45 days.

Keywords : Biodegradability; Blend; Biodegradation kinetic modelling; Composting; Polypropylene; Polyactide

PP-58

**Non-destructive restoration technique for conservation
of building materials**

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Abstract

Ultraviolet radiations are now used as non-destructive method for conservation of building materials. The objective of this paper was to prevent fungal bio-deterioration of concrete and marble cubes using UVC ($\lambda=254\text{nm}$). Towards this aim, concrete and marble cubes were inoculated with pure cultures of *Aspergillus* sp. isolated from damp wall. The results showed very little reductions of weight for UVC exposed cubes whereas compressive strength loss for marble cubes 3.35% compared to bio-deteriorated cubes. The Scanning Electron Microscope images distinctly exhibited considerable change in the surface deterioration and fungal colonization of bio-deteriorated cubes more than the UVC exposed cubes.

Keywords: *Aspergillus* sp., Bio-deterioration, Ultraviolet radiation, Concrete, Marble, Compressive strength.

PP-59

Effect of Hydrogen Enrichment on Flame Stability and Emission in a LPG Vortex Combustor

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Abstract

In this paper, effect of hydrogen enrichment on emission, temperature and flame stability in an novel vortex Combustor. It was observed that as hydrogen content increases, the visible flame shape contracts a little bit. The pollutants such as CO, CO₂ and NO_x increase up to a definite percentage of hydrogen and then decreases gradually to certain lower value. The marginal increase in CO emission level is observed when hydrogen is added to LPG, as the size of the reaction zone and residence time fall, due to quenching of CO oxidation. The addition of hydrogen to LPG also improves flame stability, allowing the Combustor to work at overall leaner conditions as compared to pure LPG fuel.

Keywords: Liquefied Petroleum Gas, NO_x emission, Lean Flame Stability, Exit Gas Temperature.

PP-60

Smart Rehabilitation Glove

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Abstract

Doctor which cure paralysis they advise the patient to perform exercise on the affected part, the exercise can be performed by patient or care taker which isn't convenient, so we have approached to create an automatic glove. In this project, a sincere study is done on the innovative way of replicating the hand motion and trying to recreate in a form of automatic glove, which increases the rate if memory regeneration. We have designed an automatic Glove which acts as an exercising tool for patients suffering from Paralysis. The gloves can be either switch controlled, controlled by the other non-paralytic hand or controlled by Brain signals. The motion would be generated by servo motors.

Keywords: Paralysis, Servo, Memory regeneration, Glove.

PP-61

Reduction of Lube Oil Consumption in Petrol Engines

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Abstract

The reduction of lubricating oil consumption in the internal combustion engines is important for clearing the emission standard and environmental problem, especially the hydrocarbon and particulate matter. Recently, it is reported that lubricating oil which exist near the piston

ring or piston crown effects strongly for occurrence of Pre-ignition in highly supercharged spark ignition engines. This paper describes results of a study on the mechanism of lubricating oil consumption from the top ring with piston motion. The experimental and data show that it is effective the surface treatment of piston ring to reduce lubricating oil consumption. The project is aimed at improving the wear resistance of the piston rings (Oil ring) which is used in the internal combustion and many other applications. Gas nitriding process has been used for fulfillment of project objectives. The study has been conducted to observe the change in hardness before and after gas nitriding of piston rings which in turn impact on wear resistance of piston rings.

PP-62

A Three Stage Sliding Ladder for Performing Jobs at Higher Elevation Safely

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Abstract

The system consists of three sets of concentric ladder of reducing widths applying small dia pipes for facility of reciprocating within each set of pipes.

The outer set is C-type aluminium channel within which slides two sets of ladder of circular pipes of reducing concentric diameter with facility to draw upward or lower down and fixed with clamps (inserting locking member within encirculated holes) as per need of the required height. The difficulty of controlling height was modified by imposing winch-drum.

There are two set of winch-drum (wheel) on base of the ladder on its both side to wind up metallic chord, fixed on base of the circular pipe, just below the notch or groove on outer side of second set of ladder, passing through set of pulleys fitted on top of channel (on both sides), connected on winch-drum for lifting the second set of ladder smoothly and locked

within hole of winch-drum for fixing the ladder in required height. Similarly, third set ladder connected on its lower base with another metallic chord through another set of pulley fitted on top of outer side of second set ladder – the third or top set ladder moves upward while winding the left hand winch-drum. Similarly, on rewinding the winch-drums, two sets of ladder come down in original lower height to store in its original form within space of height 11'-0" to 12'-0".

PP-63

Improving Fuel Quality through Improved Understanding of Hydro-treating Catalytic Process

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Abstract

Crude oil contains several impurities like heavy metals, complex sulfur and nitrogen molecules, polynuclear aromatics (PNAs). These impurities, if not removed, will lead to the formation of particulate matters, SO_x, NO_x during combustion in vehicle engines and thrown out to the atmosphere causing severe increase in particulate matters, smog causing critical health issues. With stringent environmental regulations following the Paris Agreement to curb rising environmental pollution due to vehicle emissions, hydrotreating technologies plays a key role in reducing the impurity levels in gasoline, diesel and ATF. In the hydrotreaters, the impurities like sulfur, nitrogen, polynuclear aromatics, heavy metals are effectively removed through heterogeneous catalytic reaction with hydrogen in trickle bed reactors. The process requires high temperature between 320oC – 360oC and moderate pressure 40 – 80 bar. The catalyst plays a key role in this process and determines the overall performance of the unit and product specification.

In hydrotreaters, typically bi-metallic Cobalt-Molybdenum (CoMo), Nickel-Molybdenum (NiMo) or tri-metallic Cobalt-Nickel-Molybdenum catalysts are used to carry out the hydro-desulfurization (HDS) to remove sulfur, hydro-denitrification (HDN) to remove nitrogen, hydro-dearomatization (HDA) to remove polynuclear aromatics, and hydro-demetalation (HDM) to remove the heavy metals which are present in the crude oil. Two key parameters determine the catalyst performance in a hydrotreater – 1) start-of-run (SOR) performance and 2) Deactivation. While the SOR performance depends on the initial activity of the catalyst, the cycle length depends on the resistance of the catalyst to deactivate. Deactivation of catalysts happens due to lack of hydrogen, presence of coke precursors like polynuclear aromatics, heavy metals which deposit inside catalyst pores. For a scientist to effectively develop a good hydrotreating catalyst, it is important to understand the deactivation mechanism by the above impurities.

In a commercial hydrotreater, apart from the catalyst type, catalyst loading also plays a critical role in the unit performance. CoMo catalysts are more effective to remove sulfur atoms than NiMo by the hydrogenolysis route while NiMo catalysts are better for hydrogenation and hence more effective to remove difficult sulfur. However, due to more hydrogen demand, NiMo catalysts are used only for units which operate at moderate to high pressure. An effective catalyst loading would comprise of CoMo and NiMo combination to take advantage of both without reducing the cycle length. We have conducted several catalyst loading studies in bench-scale fixed bed units with actual feed and process conditions used in commercial units. Based on the studies, we optimized the catalyst loading that produced better products by increasing HDN and HDA for a lower SOR temperature with only marginal increase in the deactivation rate. Thus, understanding the chemistry of hydrotreating and optimizing the catalyst loading led to substantial improvement in the hydrotreater performance.

PP-64

Cleaner-Cum-Washer: A Utility Machine for Sugarcane Juice and Jaggery

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Abstract

In India, sugarcane is processed for making sugar, jaggery (gur) and khandsari. Out of total sugarcane production, about 20 per cent is used for jaggery and khandsari. For quality jaggery making, sugarcane needs to be cleaned before crushing. A sugarcane cleaner-cum-washer (SC-c-W) has been developed at ICAR-Indian Institute of Sugarcane Research (IISR), Lucknow for cleaning and washing of sugarcane prior to crushing for jaggery making. The unit consists of six rollers; two feed rollers having rubber flaps for gripping and cane feeding and four scrapping rollers (two sets of two rollers each) having steel wire brush for removal of impurities sticking to sugarcane stalks. Water spray arrangement has also been provided at two places. The unit was evaluated for its performance. Three combinations of roller speed were evaluated. It was found that the best combination of roller set was that in which upper rollers moved with 50.63 and 75.95 rpm and lower rollers moved with 60 and 90 rpm in 1st and 2nd set respectively. It was due to differential speed of rollers which gave best rubbing and scrapping action. Maximum capacity (613.61 kg/h) was obtained with this combination with three canes feeding in single pass. Impurity removal increased with number of cane feeding at a time and maximum (4.338g) impurity was removed with 3-cane feeding. SC-c-W, when used with water spray, appeared giving better results based on visual observation of cleaned canes.

Keywords: Sugarcane, jaggery, sugarcane cleaner-cum-washer, sugarcane juice.

PP-65

Comparative Evaluation Study on Raw Mango Slicer over Manual Raw Mango Slicing Knives Used for Raw Mango Processing

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Abstract

Experiment was conducted to evaluate the performance of raw mango slicer over locally available manual raw mango slicing knife used in the raw mango processing industries of South India. The four varieties viz ,Rajgira, Mallika, Mulgoa and Totapuri of raw mangoes were used for evaluation study and the results were statistically analyzed. The study indicated that the capacity of mechanical raw mango slicer is 10 times higher than manual slicing technique. It was observed that the capacity of mechanical slicer was (600 kg/hr) significantly superior over manual slicing at P(0.01) for all the varieties compared to manual slicing knife (60 kg/hr). The labour required for slicing one ton of raw mango using mechanical mango slicer was significantly less (3 person) as compared to manual slicing (17 person) for the varieties studied.

Keywords: mango slicer, traditional knife, slicing capacity, mango ring cutting, processing

PP-66

Methanol Economy for India – A Drive towards Energy Security & Zero Carbon Footprint

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Abstract

India will be the 3rd largest consumer of gasoline and diesel by 2030 to cater countries growing energy demand (3.5% CAGR) as it advances on the path of 'Make in India'. 40%

of India's total primary energy demand is imported whereas the import dependence of crude oil and natural gas has increased significantly in last few decades with current import bill on account of crude oil ~85 billion \$. Hydrocarbon fuels adversely affect the environment with greenhouse gas (GHG) emissions and India is the 3rd highest energy related CO₂ emitter country in the world. To reduce the import bill and also to drive the green fuel campaign we need to have our own 'Indian fuel of global relevance'.

Blending of C1 & C2 alcohols in fossil fuel is a global trend now and mandatory in many countries to make the fuel greener besides its ability to enhance the engine efficiency. Methanol is the cheapest clean burning drop in fuel which can utilize in transportation as well as cooking fuel. Methanol burns efficiently (RON 102) in all IC engines without any particulate matters (PM) and soot. Almost nil SO_x & NO_x generation sorts methanol as a near zero pollution making fuel. The gaseous version of methanol – DME (dimethyl ether) can be blended with LPG for excellent substitute of diesel in public transportations. Methanol can be produced from natural gas, Indian high ash coal, bio mass, MSW, etc. and cost wise much cheaper than C2 alcohol which is currently being added to the gasoline (E10) as per govt. mandate. In this paper production of methanol / DME in India and also its utilization as a blending component in gasoline / LPG and replacement of diesel in India for energy security, pollution control and economic benefits are discussed. An overview of Indian scenario for Methanol Economy by targeting significant reduction in country's annual oil import bill is also presented.

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PP-67

Applications of 2D Layered Semiconductors in Excitonic Solar Cells

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Abstract

Photo-current in third generation solar cell technology depends on photon absorption of dyes or quantum dots which significantly contribute to the performance. Further, photo-responsive characteristics of emerging 2D layered semiconductors, such as MoS₂, can be integrated into optical absorption of traditional dye and quantum dot based solar cells in which the performance can be enhanced. 2D layered MoS₂ exhibits layer dependent optical and electrical characteristics which play different roles in excitonic solar cells; depending upon the number of layers present in the stack. The band-edge alignment between 2D MoS₂ and electron acceptors used in excitonic solar cells is a critical factor that defines the role of 2D layers in excitonic solar cells. Studies show atomically thin layers could serve as photo-absorber on the surface of electron acceptor while thicker layers act as alternate low-loss charge transport medium in the bulk of electron acceptors. It is foreseen that applications of 2D layered semiconductors in excitonic photovoltaic technology is inevitable as an additional photo-absorber, alternate charge transport layer and also electrodes.

Recent Publications

1. G. Gopakumar, A. Ashok, S. V. Nair, and **M. Shanmugam***. “Atomically thin 2D layered MoS₂-enabled photo-current characteristics in TiO₂ nanoparticle films.” *Applied Nanoscience* (2019)1-9.
2. A. Ashok, S. N. Vijayaraghavan, G. E. Unni, S. V. Nair and **M. Shanmugam*** “On the Physics of Dispersive Electron Transport Characteristics in SnO₂ Nanoparticle Based Dye Sensitized Solar Cells” *Nanotechnology*, 29(2018) 175401.

3. G. Gopakumar, H. Menon, A. Ashok, S. V. Nair and M. Shanmugam* “Two Dimensional Layered Electron Transport Bridges in Mesoscopic TiO₂ for Dye Sensitized Solar Cell Applications” *Electrochimica Acta* 267(2018)63-70.
4. M. Shanmugam, R. Jacobs-Gedrim, E. S. Song, and B. Yu, “Two-Dimensional Layered Semiconductor/Graphene Heterostructures for Solar Photovoltaic Applications,” *Nanoscale* 6(2014)12682 – 12689.
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PP-68

Repair and Rehabilitation of RCC structures

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Abstract

Concrete is extensively used for the construction of buildings, structures or any other project. However with the passage of time, the structure starts getting older and starts showing some signs like cracking, splitting, delaminating and corrosion of steel etc. which results in shortening of life and strength of structure. As it was well known fact that the structure has been constructed for a service life of more than 50 years but in reality, this life remains elusive. So apart from the regular maintenance, extensive repair and rehabilitation of structures are necessary. In some cases, the repair of the structures are neglected or delayed due to lack of proper knowledge and financial ability which may lead to serious hazards. There is urgent need to understand which repair materials /methods is the best or to be used for a particular structure thus saving enormous time and money. In this paper, different materials and methods used for the repair and rehabilitation of structures have been reviewed. Case studies pertaining to repair and rehabilitation of structures have also been discussed.

Keywords: Concrete, Repair, Rehabilitation and Structures.

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