# EVERYMAN'S SCIENCE

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**COVER PHOTOGRAPHS** ***(Left to Right)***

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| | |
|---|---|
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| **4. Prof. M. Afzal Husain** | **(1946)** |
| **5. Pandit Jawaharlal Nehru** | **(1947)** |





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# EDITORIAL

## COME WITH THE WIND

If India is to become a developed nation by 2020 then it is necessary to sustain the present growth rate of 9-10 percent in the GDP. This will require increasing amounts of energy. The major sources of energy are coal, oil and natural gas which must undergo combustion for releasing energy and this produces Green House Gases (GHG). On the other hand, India is a signatory to Kyoto protocol of UNFCC that requires the country to reduce overall GHG emission by at least 5.2 percent below 1990 levels by 2008-2012. There is a dilemma here.

How will the country meet the energy demand and, at the same time, reduce GHG emission? The answer is blowing in the wind ; some part of energy will come from wind energy.

Ten years ago the annual commercial energy consumption was 190 million tons oil equivalent (mtoe) of which nearly 65 percent came from coal, 20 percent from oil and natural gas and the rest from sources such as hydel projects, nuclear plants and some renewable sources. Wind energy was negligible. Today the scene is changing.

### WIND ENERGY

Wind power is conversion of wind energy into more useful form, usually electricity, using wind turbines. At the end of 2006, worldwide capacity of wind powered generators was about 74000 mega watts (MW) which met roughly only 1 percent of the world energy consumption. However, it already accounts for 20 percent in Spain. Denmark has plans to raise the figure to 50 percent soon. Wind power generation has quadrupled in the period 2000-2006, world-wide and India has become a leader in Asia producing in 2006, 6270 MW to rank fourth behind Germany (20,622 MW), Spain (11,615 MW) and the U.S.A. (11,603 MW) in a world total of 74330 MW. Behind India are Denmark (3146 MW) and China (2604 MW).

For centuries European countries used the older technologies of wind mills to convert wind energy into mechanical energy to crush grain or pump water. From time immemorial ships have crossed oceans exploiting wind blowing against bulging sails. However, use of large scale wind farms for national electrical grids is of recent origin. So is use of small individual turbines for rural electrification in isolated locations. Wind power provides an answer to growing demands of clean renewable energy.

India, the 6th largest energy consumer in the world accounts for only 3.5 percent of world's annual consumption at present. In terms of energy production it ranks lower down in the 11th position, accounting for only 2.5 percent of world's total. The imbalance is due to the fact that 2/3rd of petroleum consumption is met by imports. Much of this is for the transport and aviation industry as well as for defence. As regards electricity generation of the total 118 × 10 MW produced in 2005, 70 percent came from coal, slightly over 20 percent from hydel projects and the rest from other sources. Nuclear power plants and wind power each generated 3-4 percent.

The installed capacity of wind power in India is expected to be around 8300 MW by 2009 which will still be less than 10 percent of the total capacity.

### SOME MAJOR ISSUES

All electricity generation facilities are capital intensive and wind power is no exception. However, wind energy costs less than 1/5th of what it did 25 years ago and the downward trend continues. In wind power and hydel power, the 'fuel' costs are close to zero, maintenance cost is low and project life is long, over 20 years for wind power. Operational and manpower costs are also low and, hence, the payback period is comparatively less. The mapped potential of wind power at 50m height is 45000 MW and, therefore, a substantial part of our energy demand can, at least in theory, be met by wind power.

Some facts about wind power are astonishing. An estimated 1-3 percent of the energy from the Sun that hits earth is converted into wind energy and this is 50-100 times more energy than what is converted into biomass by all the plants on earth through photosynthesis. The potential wind power available on land and near shores alone is over 5 times the world's current energy use and 40 times the world's electricity consumption. However, most of the wind energy can be found only at higher altitudes to continuous wind speeds of over 160 km per hour.

The wind power avaliable is proportional to the cube of the wind velocity and almost 50 percent of the energy of the wind passing through can be extracted, provided the towers are set apart sufficiently to eliminate interference. Typically turbine blades will be located at a height of 50-60m and power generation requires a minimum blade speed of 10-12 rotations per minute. Because so much power is generated by higher wind speeds, much of the average power comes in short bursts, typically 50-60 percent in 15 percent time.

## LIMITATIONS OF WIND POWER

There are, of course some limitations. Wind energy is not dispatchable as for fuel fired plants and additional output cannot be supplied in response to load demand. For any wind farm, the ratio of actual productivity against installed capacity will be about 30-35 percent, compared to approximately 90 percent for nuclear plants, 70 percent for coal based plants and 30 percent for oil plants. Great attention needs to be paid about location ; a 30 m difference can double or halve the output. On shore the location should be on hills or ridges where the wind accelerates. Sea shores are preferable because they are often windy because of differential cooling of land and the sea. However, this may not be desirable from the point of view of aesthetics and/or safety of bird life. Ideally plants should be located off shore but these will cost more. There are also plans for airborne wind turbines at high altitudes, the aerial turbines being tethered to the ground and suspended using helium balloons.

In every plant, energy generation will vary from hour to hour, daily and seasonally and, therefore, it can only be used as a supplementary source unless energy can be stored. For storage one can employ rechargeable flow batteries and flywheel storage devices, but the problem has not yet been solved satisfactorily. As is obvious, wind energy is not evenly distributed and generation source may be far from demand centers and national grid subsidies. Maintenance may be a problem as is evidenced by nonfunctional turbines in some locations. There are, however, solutions for most such problems.

## SMALL PLANTS

Wind turbines can be used for household electricity generation in conjunction with battery storage and plants with capacity of 1 KW or more are now functioning in several countries. These are light weight units (~ 16kg) with 2m dia fans that respond rapidly to wind gusts typical of urban settings. Easy mounting is like that of TV antenna. If the wind velocity is too high then rotor speed can be regulated by dumping excess energy as heat. The brakes if installed indoors will provide internal heating, so valued in cold climates. Apparently in China alone some 300,000 small wind turbines are already generating electricity.

Initiatives, some commendable, have been taken in India also. Manganese Ore (India) Ltd., Nagpur has set up a 5 MW plant in Nagda hills near Dewas in Madhya Pradesh. It was commissioned in mid 2006 at a cost of 22 crores. It generates 9.4 m units/year and generates nearly 5 crores in revenue. Taking into account tax savings (the Government gives tax exemption for 10 years) and depreciation, the estimated pay back period is 5.5 year only. The company is now planning 100 crore investment in setting up 2 wind firms of total capacity of 23 MW.

Wind power leads to a special advantage. Since it reduces GHG, it accrues certified emission reduction credits (CER) expressed in equivalence of 1 tonne $CO_2$ reduction. The credits can be used to contribute to the emission reduction commitment of the nation. A 5 MW plant accrues a carbon credit of 9600 CER/year and for this the benefit revenue is over 3 crores in 10 years, 100 percent of which qualifies for tax rebate.

The wind has been blowing for ages and it will continue to blow inviting mankind to exploit its energy.

***Hem Shanker Ray***

***A closed mind is a dying mind.***

***—Edna Ferber***

## PRESIDENTIAL ADDRESS

# THE CLASSICAL DETERMINISM AND THE QUANTUM THEORY

PROF. S. N. BOSE

I wish to express sincere thanks for the great honour you have done me. The Presidentship of the Science Congress is a great distinction, and I confess, I have my own misgivings about the wisdom of your choice. Your first decision had raised high hopes. Many of us expected that a deliberate programme of the future scientific activities of the country would probably be a feature of the opening speech of this Congress. Pandit Jawaharlal had studied the needs of the country. Many of our front-rank scientists and industrialists had met under his leadership, not long ago, and given to questions of future reconstruction much time and anxious thought. The results of this deliberation would have been invaluable at the present moment. My regret is keen that chance has deprived us of the benefits of a sustained and careful study of the problems of the day. I would have liked to present here the results, if they were available. Unfortunately they are not, as most of the reports are inaccessible to me.

One of your former Presidents had remarked that "a scientist is apt to become a man that knows more and more about less and less, so that his opinion upon subjects outside his field of special study is not necessarily of special value". I realise the wisdom of this warning and hope to have your indulgence, if I seem to be more at home with doubts and criticisms than with useful knowledge.

I would like to present before you certain aspects of Modern Physics and draw your attention to the profound changes in the principle of scientific explanation of natural phenomena brought about by the quantum theory. The last fifty years record remarkable discoveries. I need only mention the electron and the neutron, X-rays and radioactivity to remind you of the increase of our knowledge. Our equipment has gained in power range and accuracy. We possess powerful telescopes to scan the farthest corners of the universe, also precise and delicate instruments to probe into the interior of the atoms and molecules. The alchemists' dream of transmutation has become a reality. Atoms are now disintegrated and synthesised. X-ray reveals invisible worlds and wireless links up the farthest ends of the earth with possibility of immediate inter-communication. These discoveries have their repercussions in the relam of ideas. Fifty years ago the belief in causality and determination was absolute. Today physicists have gained knowledge but lost their faith. To understand properly the significance of such a profound change it will be necessary to discuss briefly how it all came about. Classical Physics had begun with the study of Astronomy. With his laws of gravitation and his dynamics, Newton had explained planetary motion. Subsequent study has shown astronomical prediction to be possible and sure. Physicists had taken the equations of celestial mechanics as their model of a universal law. The atomic theory had in the mean time gained universal acceptance ; since matter had resolved into a conglomeration of

* General President, 30th Indian Science Congress held during 31st January to 5th February, 1944 at Delhi.

particles, the ideal scheme was to explain all phenomena in terms of their motions and interactions. It was only necessary to set up a proper set of equations, and to take account of all possible mutual interactions. If the mass, position, and velocity of all the particles were known at any instant, these equations would theoretically enable the physicist to predict the position and motion of every particle at any other subsequent moment.

The phenomena of light did not at first fit into this simple scheme. To regard it as a stream of particles was impossible due to the discovery of interference. Accordingly the wave theory of light was originated by Huyghens and perfected by Maxwell. With the discovery of the electron as a universal constituent of matter, the electromagnetic theory of Maxwell was converted into an electronic theory by Lorentz. To the dynamical laws were added the electromagnetic equations and the two together apparently gave an exact and ideal formulation of the laws of causality. In the forces of interaction henceforth, were to be included not only the gravitational forces but also those interactions which depended on the charge and the motion of the particles. These interactions were brought about by influences which spread out as waves with the velocity of light. They superimposed, interfered and constituted the field of force in the neighbourhood of the particles, modified their motion and were in turn modified by them. The motions of all particles throughout the universe were thus interlocked. These outgoing influences also constituted light, invisible radiation, X-rays and wireless waves. Thus a set of universal laws was supposed to have been discovered and we had only to apply them sutiably to find explanations of all conceivable natural phenomena. In Physical Science we do not however always proceed in the above way and turn, to the "microscopic" equations whenever we have to explain events. We often study materials *en masse*, consisting of an enormous number of corpuscles, and we use either the principle of the conservation of energy or the laws of thermodynamics to explain their behaviour. These laws were however regarded either as simple consequences of the fundamental equations or as statistical laws derivable from them by a suitable averaging. Though in the latter cases we talk about probabilities and fluctuations, it was more or less a matter of faith to maintain that if it were possible for us to obtain all the necessary data by delicate observations, universal laws would enable us to follow each individual molecule in this intricate labyrinth and we should find in each case an exact fulfilment of the laws and agreement with observation. The above in brief forms an expression of faith of a classical physicist. We see that it involves as necessary consequences, belief in continuity, in the possibility of space-time description of all changes and in the existence of universal laws independent of observers which inexorably determine the course of future events and the fate of the material world for all times.

A few remarks about the general equations will perhaps enable us to follow better the criticisms that have been levelled against the system. The structure of the mechanical equations of particles is different from the field-equations of Maxwell and Lorentz. The principles of conservation of energy and momentum were first discovered as consequences of the mechanical equations. Mass and velocity of the corpuscle furnish means to measure its momentum, and its energy, if we leave aside the potential energy which resides in the field. To maintain the integrity of the principle of conservation, the field must also be considered capable of possessing energy and momentum, which however, being associated with wave-motion, must spread out in all directions with the waves. The transfer of energy from the field to the particles must thus be a continuous process, whereby, a finite change should come about only in a finite interval and the process should theoretically be capable of an exact description in space and time.

Physics being essentially concerned with relations between quantities, these should all be capable of exact measurement. We measure always intervals of time or inter-distance between points, hence the specification of the reference frame is just as important as the units of measure. Newton had not analysed closely the conception of mass and time. This vagueness persisted in the dynamical equations for the particles. The field-equations which form the basis of the wave-theory of light have a different origin. With the discovery of the principle of the least action, a common derivation of both has been attempted. But a difference in the choice of reference frame in the two apparently subsisted. The wave-equations assumed a fixed ether whereas the material laws contemplated a Galilean inertial-frame. An immediate deduction from this distinction was the possibility of measuring the relative velocity of the observer with reference to ether. The experiment of Michelson and Morley showed it to be unrealisable in practice and formed the starting point of the celebrated Relativity Theory. Einstein had subjected the conception of time-measurement to a searching examination and showed the impossibility of conceiving a time independent of an observer, or an absolute simultaneity of events happening at two different places. The same space-time reference should be chosen for the dynamical equations as well as the equations of the field, this being supplied by the observer. In spite of this apparent limitation Einstein demonstrated the possibility of formulation of natural laws independent of all axes of reference and pointed out that the necessary auxiliaries existed already in the invariant theory and the tensor Calculus of mathematicians. In spite of its apparently revolutionary character, the theory of relativity upheld the ideal of causality and determinism. Einstein himself has continued to seek with great earnestness a unifyig field theory which will combine gravitation and electromagnetism and render unnecessary a separate formulation of the dynamical equations. No such theory as yet exists.

The development of the quantum theory has raised fundamental issues. Facts have been discovered which demonstrate the breakdown of the fundamental equations which justified our belief in determinism. A critical examination of the way in which physical measurements are made has shown the impossibility of measuring accurately all the quantities necessary for a space-time description of the motion of the corpuscles.

Experiments reveal either the corpuscular or the wave nature for the photon or the electron according to the circumstances of the case, and present us with an apparently impossible task of fusing two contradictory characters into one sensible image. The only solution suggested has been a renunciation of space-time representation of atomic phenomena and with it our belief in causality and determinism.

Let me briefly recapitulate the facts. In 1990 Planck discovered the quantum of action while studying the conditions of equilibrium between matter and the radiation field. Apparently interchange of energy took place in discrete units whose magnitude depended on $h$ and the frequency of the radiation emitted or absorbed by matter. Photo-electric emission had similar disquieting features. Einstein therefore suggested a discrete structure of the radiation field in which energy existed in quanta instead of being continuously distributed in space as required by the wave theory. This light-quantum however is not the old light-corpuscle of Newton. The rich experimental materials supporting the wave theory preclude that possibility altogether. Moreover the fundamental relation, $E = hv$, and $p = hk$, connecting energy and momentum of the photon with the frequency $v$ and the vector wave number $k$, makes a direct reference to idealised plane wave so foreign to the old idea of a corpuscle. Soon afterwards Bohr postulated the existence of radiationless stationary states of atoms and showed how it led to a simple explanation of the atomic spectra. The extreme simplicity of the proposed structure and its striking success in correlating a multitude of experimental facts at once revealed the inadequacy of the ordinary laws of mechanics and electro-dynamics in explaining the remarkable stability of the atoms.

The new ideas found application in different branches of Physics. Discontinuous quantum processes furnished solutions to many puzzles. Suitably modified, the theory furnished a reasonable explanation of the periodic classification of elements and thermal behaviour of substances at low temperature. There was however one striking feature. It was apparently impossible to characterise the details of the actual transition processes from one stationary state to another, that is, to visualise it as a continuous sequence of changes determined by any law as yet undiscovered. It became clear that the dynamical laws as well as the laws of electromagnetism failed to account for atomic processes. New laws had to be sought out compatible with the quantum theory capable at the same time of explaining the rich experimental materials of Classical Physics. Bohr and his pupils utilised for a time a correspondence principle, guessing correct laws for atomic processes from analogy with the results of the classical theory. In every case these appeared as statistical laws concerned with the probabilities of transition between the various atomic states. Einsein tackled the problem of the equilibrium of matter and radiation on the basis of certain hypotheses regarding the probabilities of transition between the various states by absorption and emission. A derivation of the Planck Law was obtained by Bose by a suitable modification of the methods of classical statistics. Heisenberg finally arrived at a satisfactory solution and discovered his matrix mechanics and a general method for all atomic problems. Dirac and Schrödinger also published simultaneously their independent solutions. Though clothed in apparently dissimilar mathematical symbols, the three theories gave identical results and have now come to be looked upon as different formalisms expressing the same statistical laws.

I have mentioned that the photon gave a simple explanation of many of the properties of radiation and thereby presented its corpuscular aspect while the well-known properties of interference and superpossibility brought out its wave character. That the same dual nature may exist in all material corpuscles was first imagined by De Broglie. His phase waves found quick experimental verification, and raised a similar problem of the real nature of the corpuscle. The formulation of wave mechanics by Schrödinger, once raised a hope that by a radical modification of our usual ideas about the corpuscle it might be possible to re-establish the law of causality and classical determinism. Subsequent developments have shown such hopes to be illusory. His waves are mathematical fictions utilising the multi-dimensional representation of a phase space and are just as incapable of explaining the individuality of the electron, as the photon is incapable of explaining the superpossibility of the field. The true meaning of his equations appear in their statistical interpretation.

The adherents of the quantum theory interpret the equations in a peculiar way. They maintain that these equations make statements about the behaviour of a simple atom and nothing more than a calculation of the probabilities of transition between its different states is ever possible. There is nothing incomprehensible about such a statistical law even if it relates to the behaviour of a single particle. But a follower of determinism will interpret such statements as betraying imperfect knowledge, either of the attendant circumstances or of the elementary laws. We may record the throws when a certain die is cast a large number of times and arrive at a statistical law which will tell us how many times out of a thousand it will fall on a certain side. But if we can take into account the exact location of its centre of gravity, all the circumstances of the throw, the initial velocity, the resistance of the table and the air and every other peculiarity that may affect it, there can be no question of chance, because each time we can reckon where the die will stop and know in what position it will rest. It is the assertion of the impossibility of even conceiving such elementary determining laws for the atomic system that is disconcerting to the classical physicist.

Von Neumann has analysed the statistical interpretation of quantum mechanical laws and claims to have demonstrated that the results of the quantum theory cannot be regarded as obtainable from exact causal laws by a process of averaging. He asserts definitely that a causal explanation of quantum mechanics is not possible without an essential modification or sacrifice of some parts of the existing theory.

Bohr has recently analysed the situation and asserted that we cannot hope any future development of the theory will ever allow a return to a description of the atomic phenomena more conformable to the ideal of causality. He points out the importance of the searching analysis of the theory of observation made by Heisenberg, whereby he has arrived at his famous principle of indeterminacy. According to it, it is never possible for us to determine the simultaneous values of momentum, and positional coordinates of any system with an accuracy greater than what is compatible with the inequality $\overline{\Delta}p\,\overline{\Delta}q > \frac{h}{4\pi}$.

This natural limitation does not affect the physics of bodies of finite size but makes space-time descriptions of corpuscles and photons impossible. When we proceed to study the behaviour of the elementary particles, our instruments of measurement have an essential influence on the final results. We have also to concede that the contributions of the instrument and the object, are not separately computable from the results as they are interpreted in a classical way with the usual ideas of coordinates and momentum accepting thereby a lack of control of all action and reaction of object and instrument due to quantum effects.

It is in this imperative necessity of describing all our knowledge with the usual classical ideas, that Bohr seeks an explanation of the apparently irreconcilable behaviour of corpuscles and radiation in different experiments. For example, if we set our experiments in such a fashion as to deterimne accurately the space-time coordinates, the same arrangement cannot be simultaneously used to calculate the energy momentum relations accurately ; when our arrangements have pushed the accuracy of determining the positional coordinates to its utmost limit, the results evidently will be capable only of a corpuscular representation. If, on the other hand, our aim is to determine momentum and energy with the utmost accuracy, the necessary apparatus will not allow us any determination of positional coordinates and the results we obtain can be understood only in terms of the imagery of wave-motion. The apparently contradictory nature of our conclusions is to be explained by the fact, that every measurement has an individual character of its own. The quantum theory does not allow us to separate rigorously the contribution of the object and the instrument and as such the sum total of our knowledge gained in individual cases cannot be synthesised to give a consistent picture of the object of our study which enables us to predict with certainty its behaviour in any particular situation. We are thus doomed to have only statistical laws for these elementary particles and any further development is not likely to affect these general conclusions.

It is clear that a complete acceptance of all the above conclusions would mean a complete break with the ancient accepted principles of scientific explanation. Causality and the universal laws are to be thrown simultaneously overboard. These assertions are so revolutionary that, no wonder, they have forced physicists to opposing camps. There are some who look upon causality as an indispensable postulate for all scientific activities. The inability to apply it consistently because of the limitations of the present state of human knowledge would not justify a total denial of its existence. Granted that Physics has outgrown the stage of a mechanistic formulation of the principle, they assert that it is now the task of the scientists to seek for a better formulation. Others of the opposing camp look upon old determinism as an inhuman conception, not only because it sets up an impossible ideal, but also as it forces man to a fatalistic attitude which regards humanity as inanimate automata in the hands of an iron law of causation. For them the new theory has humanised Physics. The quantum statistical conception of determinism nestles closer to reality and substitutes a graspable truth for an inaccessible ideal. The theory has brought hope and inspired activity. It constitutes a tremendous step towards the understanding of nature. The features of the present theory may not all be familiar but use will remove the initial prejudice. We are not to impose our reason and philosophy on nature. Our philosophy and our logic evolve and adjust themselves more and more to reality.

In spite of the striking success of the new theory, its provisional character is often frankly admitted. The field theory is as yet in an unsatisfactory state. In spite of strong optimism, difficulties do not gradually dissolve and disappear. They are relegated to a lumber room, whence the menace of an ultimate divergence of all solutions neutralises much of the convincing force of imposing mathematical symbols. Nor is the problem of matter and radiation solved by the theory of complementary characters. Also we hear already of the limitations of the new theory encountered in its application to nuclear problems.

The quantum theory is frankly utilitarian in its outlook ; but is the ideal of a universal theory completely overthrown by the penetrating criticism of the nature of physical measurements?

Bohr has stressed the unique character of all physical measurements. We try to synthesise their results and we get probabilities to reckon with instead of certainties. But how does the formalism $\frac{h}{2\pi i}\frac{\partial\psi}{\partial t} = H\psi$ emerge as a certain law ? The wider the generalisation, the less becomes the content. A universal law would be totally devoid of it. It may nevertheless unfold unsuspected harmonies in the realm of concept. More than ever now, Physics does need such a generalisation to bring order in its domain of ideas.

## DO YOU KNOW ?

Q1. How big can a raindrop be ?

Q2. During a football match a crowd of 50,000 people makes roaring noises for an hour. How much energy is there in the sound ? For example how much water can be raised to the boiling point with that energy ?

# PROCESS SELECTION FOR TREATMENT OF INDUSTRIAL WASTES

P. K. Jena*

**Industrial wastes, particularly those from mineral, chemical and metallurgical industries, are generating a lot of polluting materials in our environment. Most of these wastes are hazardous in nature and, at the same time, contain a lot of valuable materials. In order to protect our environment, it has been essential to properly treat these wastes for their safe disposal. In this process, toxic and valuable byproducts can be recovered and utilized in various ways. In this paper, an account of different types of wastes generated in chemical and metallurgical industries and the criteria for selection of processes to treat these have been discussed with typical examples. The steps to be taken regarding selection of a waste treatment process, as well as minimizing the generation of the wastes, have been outlined.**

## INTRODUCTION

Since the Second World War, with rapid industrialization and better socio-economic conditions, there has been a sharp rise in human population in different parts of the world. Naturally, there has been large increase in consumption of different types of materials in our day to-day life. As a result, there has been a significant increase in generation of various types of industrial wastes, particularly in chemical, mineral and metallurgical sectors. At present there are many types of wastes generated in these industries and their quantities are huge. Most of these wastes are hazardous in nature. The wastes which are corrosive, easily ignited or highly reactive, explosive in nature or toxic, when thrown on ground or in water or exposed to the atmosphere, become hazardous to human beings, plants and other animals. The inorganic aqueous wastes like spent sulphuric acid from galvanizing plants, organic aqueous wastes like the washings of chemical reactors and formulation tanks, organic liquids such as distillation residues from production of chemical intermediates, used cutting oils from machinery manufacture, metallurgical industry sludges and solid wastes like flue dusts, sludges of electro winning and plating industries, and flue gases of acid plants like the oxides of sulphur and nitrogen are some typical examples of industrial hazardous wastes.

Due to ignorance and sometimes carelessness, when these wastes are dumped into water and land or let out to the atmosphere, they cause a lot of harm to plants and trees, water systems, human beings and also other animals. Around 1953, hundreds of cases of paralysis and sensory loss were reported amongst people consuming contaminated fishes obtained along Minamata Bay in Japan due to the discharge of methyl mercury waste sludge into the sea. Some years back, the "Love Canal" incident in the state of New York, USA, resulted in serious intoxication of hundreds of children and adults in a residential cum school area, which was once a dumping yard of the wastes of organic chemical industries. During the same

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period, a beach in Missouri, USA, became highly contaminated with Dioxine wastes of a chemical industry and caused serious health problems to a large number of people in that locality. In recent past, the big nuclear accident at Chernobyl in the former USSR, resulted in spreading of intense radioactivity to a very large area and brought fatal injuries to thousands of people in the area. One of the biggest environmental tragedies, which took place in India about three decades back was due to the escape of highly poisonous methyl isocyanate from an Union Carbide plant in Bhopal. This killed thousands of people while they were in sleep. A huge number of inhabitants of that region were made permanently invalid. These and many other such incidents have brought alarming signals to mankind, with the choice for taking immediate steps for living in a clean environment with prosperity, or to perish with miseries and sufferings.

There is no doubt that, after the industrial revolution, particularly during the second half of the twentieth century, science and technology have brought a lot of prosperity to mankind including increased life expectancy and a higher living standard for more people in the world than ever known before. But industrialization and modern living style have also brought the risk of global calamity and impairment of human health. The environment pollution problems and the destruction of the echo system that we are facing today, are an accumulation of the effects of improper mangement of our industrial, commercial as well as domestic wastes. The cost of restoring these is beyond our reach. However, at least from now onwards, we should make sincere efforts for avoiding any further destruction of our environment. This can be achieved through proper mangement of the wastes in general and the industrial wastes in particular.

In view of these, during the last three decades, the national governments all over the world, are imposing various rules and regulations to treat the industrial wastes for their safe disposal to the surroundings or to use those for some other purposes as far as possible.

## TYPES OF WASTES

Invariably, all the chemical and metallurgical industries produce some wastes in some form or other out of the total materials used. This is so because no production process can transfer all input materials into products or services. The wastes are generated in the form of solid, liquid and gas. Most of the chemical industries generate a considerable amount of aqueous and organic liquid wastes, sludges and also gases most of which are toxic in nature. Similarly, the mineral processing and metallurgical industries generate a lot of tailings, slimes and sludges, leached residues, slags, smelter and converter dusts, drosses etc. These, in most cases, contain heavy metals and toxic compounds. For example, the paint manufacturing industries generate 4 to 6% of hazardous wastes, the electric arc furnace for steel making produces 1 to 2% flue dusts containing heavy metals like Zn, Pb and Cd, the printing ink production industry liberates about 1% of toxic waste out of their total products.

The Industrial wastes are generated at various stages of production process through different sources. The input materials, which have been used for a number of times and no longer serve the purpose without reprocessing, is a type of waste and this is called "Spent Material". In a particular industry, besides the desired product, the other products are generally called "By-products" when they can be used as such, otherwise these are considered as wastes. Another type of waste is generated during industrial operation like cleaning of equipments, accidental spills or leakage, failure to meet the manufactured specifications, as residues from containers of raw materials or products or outdated shelf life etc. Some major categories of such wastes with examples are given in **Table. 1**

**Table 1 : Engineering Classification System for Hazardous Wastes**

| Major Category | Characteristics | Examples |
|---|---|---|
| Inorganic aqueous wastes | Liquid waste composed primarily of water but containing acids/ alkalis and/or concentrated solutions of inorganic hazardous substances (e.g., heavy metals, cyanide) | — Spent sulphuric acid from galvanizing<br>— Spent caustic baths from metal finishing<br>— Spent ammoniacal etchants from manufacturing electronic components<br>— Rinse water from electroplating<br>— Spent concentrates from hydrometallurgy |
| Organic aqueous wastes | Liquid waste composed primarily of water but containing admixtures or dilute concentrations of organic hazardous substances (e.g., pesticides) | — Rinse water from pesticide containers<br>— Washing of chemical reactors and formulation tanks. |
| Organic liquids | Liquid waste containing admixture or concentrated solutions of organic hazardous substances. | — Spent halogenated solvents from mental degreasing and dry cleaning<br>— Distillation residues from production of chemical intermediates. |
| Oils | Liquid wastes comprised primarily of petroleum-derived oils. | — Used lubricating oils from internal combustion engines.<br>— Used hydraulic and turbine oils from heavy equipment operations<br>— Used cutting oils from machinery manufacture<br>—Contaminated fuel oils. |
| Inorganic Sludges/ Solids | Sludges, dusts, solids and other non-liquid waste containing inorganic hazardous substances. | — Wastewater treatment sludge from mercury cell process of chlorine production<br>— Emission control dust from steel manufacture and smelters<br>— Waste sand from coking operations.<br>— Lime sludge from coking operations.<br>— Dust from debarring of chromium parts in fabricated metal industry |
| Organic Sludges/ Solids | Tars, sludges, solids and other non-liquid wastes containing organic hazardous substances. | — Sludges from painting operations.<br>— Tar residues from production of dyestuff intermediates.<br>— Spent filter cake from production of pharmaceuticals.<br>— Distillation bottom tars from production of phenols.<br>— Soil contaminated with spilled solvents.<br>— Oil emulsion solids. |

**CRITERIA FOR SELECTION OF WASTE TREATMENT PROCESS**

The management of various types of wastes of chemical and metallurgical industries is certainly a complex process. However, the imposition of strict environmental regulations has compelled these industries to find out some suitable methods to treat the wastes to remove the toxic materials and then dispose the resultant harmless wastes safely. It is always desirable to examine various possibilities to convert these wastes to by-products through recovery of values. For example, Electric Arc Furnace (EAF) dusts can be recycled after recovering the heavy metals like Zn, Cd and Pb. The heavy metals are even better value added products. Thus, the waste EAF dusts when properly processed can be considered as a value added by-product.

In addition to environmental protection, other benefits are also derived through treatment of industrial wastes. The recovered metals and chemicals certainly add to the economy of the concerned industry and in many cases, substantial conservation of the resource is achieved. The environment friendly residues, particularly in case of mineral and metal-based industries, can be utillized for preparing road and building construction materals, as well as for land reclamation and development of wasteland.

In order to find out a suitable process to treat the hazardous industrial wastes, a number of relevant aspects have to be considered. Some of these are as follows.

(a) Time to time systematic analysis of the wastes.

(b) Examination of Physical and Chemical properties of the wastes.

(c) Estimation of the cost of the treatment process.

(d) Possibility of treating similar types of wastes together.

(e) Possible utillization of the avaliable infrastructure for treating the wastes.

(f) Recycling the recovered materials in the industry of origin.

(g) Energy consumption of the proposed process and

(h) Possible market for the recovered materials.

**(a)** The waste to be treated has to be properly analyzed at first in order to find out the types of toxic materials and other valuable compounds present in it and their respective quantitites. This will assist in selection of the recovery process and the values which are worth recovering. For example, at Smederevo Metallurgical Comany[2] (Yogoslavia), a typical flue dust contains 22 pct. Fe, 17 per cent Zn and 0.2 per cent Pb. This waste is treated with 30 per cent NaOH solution at 40°C, with solid liquid ratio of 1:5, to leach out preferentially most of the zinc. The leached solution is electrolysed, to recover 90 per cent zinc of high purity. As in this case, the EAF dust contains a very small quantity of lead; the process did not aim at recovering it. But another type of EAF dust where the Pb and Cd percentages are higher, a process like the Flame Reactor Process[3] of the Horsehead Industries, seems to be the more suitable one. In this process, the EAF dusts are fed into a coke fired reducing flame reactor in presence of oxygen-enriched air. The metals are oxidized and collected in a dust catcher. The recovery of Zn, Pb and Cd are found to be 90, 97 and 99 percent respectively.

**(b)** Sometimes, it is convenient to select the recovery process, after analyzing the physical and chemical properties of the constituents present in the waste. These properties will indicate the use of right type of reagents in order to separate preferentially the desired constituents either by a physical or a chemical process from the rest of the wastes. For example, a typical copper converter dust contains toxic metals like Pb, Bi, Sb, As, Zn, Cd along with some copper. This type of waste has been successfully treated on a commercial scale for recovering the metal values[4]. In this process, the dust is leached with $H_2SO_4$, leaving the insoluble sulphates of Pb, Bi and Sb in the residue and dissolving As, Cu, Zn and Cd in to the leached solution as sulphates. The residue is processed in the lead smelting furnace. Arsenic in the solution is preferentially precipitated as iron arsenic compound by addition of Polly ferric sulphate with aerial oxidation. This precipitate is then leached with $H_2SO_4$ and the As present in the solution is precipitated as sulphide by addition of NaHS. The rest of the solution is neutralized with NaOH to precipitate the hydroxides of Zn, Cu and Cd, which are processed in the zinc smelter.

An example of the application of a simple physical process to recover the values from the wastes is the treatment of aluminium alloys. The Al alloy dross, which is produced during casting process, contains the alloyed aluminium along with the oxides of Al and other metals. The alloy is completely separated from the oxides in melts of $BaCl_2$ – NaCl – NaF (with > 33.3 mole per cent of $BaCl_2$), in which the liquid alloy floats up and the oxides sink down. From the oxides dissolved in the melt, the Al is produced by electrolysis in a subsequent stage by the conventional process.

**(c)** One of the major criteria for treating industrial waste is to estimate the cost involved in treating it and the market price of the recovered materials.

If the amount and price of the materials to be recovered, are very low and at the same time it is necessary to be treated from environmental point of view, it would be better to convert the material in to an inert compound. For example, the arsenic present in copper refining sludge is quite low in quantity. Economically it is not worthwhile to recover it. In such a case, the arsenic can be made inert by hydrothermal precipitation at a temperature in the range of 170° – 200°C. In this process, the presence of Fe (III) is necessary for combination with As (V) to form the crystalline hydrated ferric arsenate (Scorodite, $FeAsO_4$, 2 $H_2O$), in which the As is effectively immobilized. This inert material can be safely disposed in the land.

On the other hand, if the waste contains sufficient amounts of valuable constituents, it would be better to recover those in order to economise the treatment process. For example, the catalysts used in chemical and metallurgical industries, are quite expensive and at the same time, spent catalysts considered as toxic wastes. Therefore, these need to be treated to recover the metal values while making the treated wastes free of toxicity. The metal values such as Ni, Co, V, W, Ti, Cr, Cu etc. present in various types of spent catalysts, can be recovered by prior thermal treatment at 600°C followed by selective chlorination of the samples, using different gaseous mixture, at a temperature between 300° – 600° C. From the chlorination residues and volatile metal chlorides, it has been possible to recover up to 98 pct. each of Ni, Co, Mo, Ti, and W and 80 pct. of V compounds, contained in the condensation products.

**(d)** The most important criteria for selection of a process to treat the waste, is economic viability. It is very often necessary to examine the economics of the process involved. Further, it is also desirable to explore the possibility for treating similar types of wastes collectively, to further reduce the cost particularly when the individual wastes are small in quantity. For example, Copper smelter dust from copper producing plant and copper dross obtained from a lead smelter, are both hazardous materials. These can be suitably treated together and the recovered metal values can be used by concerned industries. The Cu dross and more easily the Cu dust can be leached in sulphuric acid. At the Naoshima Smelter and Refinary in Japan, the combined treatment of the dust and dross has been possible by charging the dust to the dross-leaching tank near the end of dross leaching. The leached residue is recycled to the lead operation. Cu and

Cd are recovered from the solution by neutralization and cementation respectively. The remaining solution is sent to the wastewater treatment plant[7]. The combined treatment has resulted in avoiding duplications of infrastructures and also achieving significant reduction in the operating cost. It is reported that, a plant with a capacity to treat 300t / month of copper dust and 200t / month of the dross, has been operating successfully and economically.

**(e)** Another important factor in connection with minimizing the cost of waste treatment operation is maximum utilization of the existing infrastructures in the concerned idustry. In this case, while appreciably decreasing the processing cost, the operation becomes easier with the available personnel and equipments.

Some years back, the Hitachi Refinery of Nippon Mining and Metals Co. Limited, has installed a reverberatory type-recycling furnace to treat indsutrial wastes such as copper smelting dust, galvanizing sludges and hydroxide slimes[8]. These are smelted with pyrite, where sulphidized Cu, Fe and precious metals are transformed into matte and the rest of the metal values are oxidized and retained in the slag. The matte is transported to their Saganoseki smelter, where copper and precious metals are recovered by the conventional process steps.

**(f)** The possibilities of using the recovered constituents in the industry of their origin or sister concern should be taken into consideration while selecting the waste treatment process. This avoids the process of finding external market. It rather helps in supplementing the raw materials used in the concerned industry.

The carbon steel EAF dust contains considerable amounts of a number of heavy metal like Zn, Pb, Cu, and Cd along with Fe. A process has been developed to leach this waste with acetic acid to dissolve most of the heavy metals and calcium. The residual iron oxide is recycled in the steel-producing furnace. Hydrogen sulphide is used to precipitate the heavy metals, potentially salable to a zinc plant. Calcium is precipitated as gypsum from the rest of the solution, which has a possible market. The impurities present in regenerated acetic acid are removed by ion exchange process. The pure acetic acid is brought to desired concentration by distillation and then recycled.

**(g)** While selecting a waste treatment process, due importance should be given to the energy consumption in the concerned process, as the price of fuel in general, is going up very fast. For example, Elgersma and Zegers[10] have made a detailed analysis of five different process designs for integrated jarosite treatment in a typical hydro metallurgical zinc plant. Jarosite is the main residue obtained during the leaching of the oxidized zinc ore in sulphuric acid. The objective is to recover completely the desired metal values from the jarosite, with consumption of comparatively minimum amount of energy and also producing an inert residue for its disposal. The processes are designed to treat jarosite, generated during the production of 200,000 tons of Zn per year and also for treating extra 80,000 tons per year of 'historical' jarosite. After detailed analysis, they have suggested an integrated pyro-hydro process, which would need comparatively less energy and generate a hazard free residue.

**(h)** The treated waste or the values recovered from waste, should have a ready market. This would help in immediately getting some return without storing at the treatment site for long period, particularly when the regenerated compounds are toxic in nature.

For example, the tin producing plants in some countries, generate slags containing appreciable amounts of refractory metals like Nb, Ta, Zr, Hf etc. along with some tin. But, as some countries like Brazil, have primary source of sufficient quantities of these metals, generally they ignore processing of their tin slag to recover these metals. However, from environmental consideration and resource conservation points of view, some suitable processes should be developed to upgrade the slag with respect of its refractory metal contents. This would help them to export the upgraded products to countries who have little resource of these metals. Jena et al, have developed recently a low temperature carbon tetrachloride process, to recover most of the refractory metals, along with tin, from the slag[11].

**CONCLUDING REMARKS**

Chemical and metallurgical industries produce a variety of wastes, which are considerably harmful for the environment. The toxic wastes are not only harmful to the workers of the industry but also to men, animal and plants of the region. Now-a-days, it is mandatory to process these wastes to separate out the toxic materials before their disposal. In view of this, serious efforts should be made to develop economic processes to treat these wastes for recovering the values and making the remaining inert wastes useful for some other purposes.

Selection of waste treatment processes should be done very carefully, keeping in view various factors, like complete recovery of toxic and high valued metals, reuse of recovered materials in the concerned industry, utilization of existing infrastructures for processing the waste, minimization of energy consumption in processing, the economics of the treatment process etc. The final objective of the concerned industries should be to generate minimum amount of non hazardous wastes.

**REFERENCES**


1. M D. La Grega et. al, The Environment Resources Management Group; Hazardous Waste Management, McGraw Hill International Editions, (Civil Engineering Series), New York, p. 15, 1994.
2. Milan Lj Stamatovic and N. J. Thermelis; Proc. Intl. Symp. on Extraction and Processing for the Treatment and Minimization of Wastes; TMS, San Francisco, Calf. USA, pp. 533-542 Feb, 27 – March 3, 1994.
3. J. F. Pusateri, C. O. Bounds and L. W. Lherbier; *J. of Metals*, pp. 31–35 Aug. 1998.
4. M. Tomita, M. Higashi, S. Oto and H. Okamoto; Proc. Symp. On Residues and Effluents Processing and Environmental considerations; Edtd. By R. G. Reddy *et. al.*; TMS, San Diego Calf. USA, pp. 282-293 March 1-5, 1992.
5. M. Ueda, M. Amamiya, T. Ishikawa, T. Ohtsuka; *J. Jpn. Inst. Met.,* **63**, 3, 279-283, 1999.
6. I. Gaballah, S. Frreia, F. Garcia–Garcedo, D. Siguin and M. Djona; *Rev. Metal*. **31**, 4, 215-221, 1995.
7. T. Shibasaki and N. Hasegaw, *Hydrometallurgy*, **30**, 45-57, 1992.
8. K. Assai, J. Hino and Y. Kawasaki; EPD Congress 1997 (Proc. Conf.) Orlando, Florida. USA. pp. 523-532, 9-13 Feb, 1997.
9. E. C. Harrett. E. H. Nenniger and J. Dzie Winski; *Hydrometallurgy*, **30**, 59-68, 1992.
10. F. Elegersma and T. W. Zeegers, Proc. Symp. On Residues and Effluent Processing and Environmental Consideration; Edtd. By R. G. Reddy et. al., TMS, San Diego, Calf. USA, pp. 413-448, March 1-5, 1992.
11. P. K. Jena, E. A. Brocchi and M. P. A. Carvalo; *Trans–Indian Inst. Metals,* 2000.

# PLASTIC WASTE – A HAZARD TO ENVIRONMENT

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**Plastics are low molecular weight organic materials, that are non-degradable in natural environment. Generation of plastic waste which constitutes a major part of Municipal Solid Waste, creates a lot of environment pollution, which in turn affects ecosystem and human health. The solution to tackle this dreadful situation lies in following the 3 R's–namely Reduce, Reuse and Recycle. Waste plastics can be recycled and used in several ways including construction of roads. This article discusses the current scenario focuses much on degradable biopolymers, an ecofriendly concept to protect the environment.**

## INTRODUCTION

Plastics are a subspecies of a class of materials known as polymers. These are composed of large molecules, formed by joining many, often thousands, of smaller molecules (monomers) together. Other kinds of polymers are fibers, films, elastomers (rubbers), and biopolymers (i.e., cellulose, proteins, and nucleic acids). Plastics are made from low-molecular-weight monomer precursors, organic materials, which are mostly derived from petroleum, that are joined together by a process called "polymerization[1]."

Plastics owe their name to their most important property, the ability to be shaped to almost any form to produce articles of practical value. Plastics can be stiff and hard or flexible and soft. Because of their lightweight, low cost, and desirable properties, their use has rapidly increased and they have replaced other materials such as metals and glass. They are used in millions of items, including cars, bulletproof vests, toys, hospital equipment and food containers.

It is estimated that approximately 4-5% post-consumer plastics waste by weight of Municipal Solid Waste (MSW) is generated in India[2]. The plastics waste constitutes two major categories of plastics; (1) Thermoplastics and (2) Thermoset plastics. Thermoplastics constitute 80% and Thermoset constitutes approximately 20% of total post-consumer plastics waste. The Thermoplastics are recyclable plastics which include; PET, LDPE, PVC, HDPE, PP, PS etc., however, Thermoset plastics contains Alkyd, Epoxy, Ester, Melamine Formaldehyde, Phenolic Formaldehyde, Silicon, Urea Formaldehyde, Polyurethane, Metalised and Multilayer Plastics etc. and 'these can not be recycled. The packaging industry contributes a good deal of plastic waste.

Packaging is defined as any material, which is used to contain, protect, handle, deliver and present goods. Items like glass bottles, plastic containers, aluminium cans, food wrappers, timber pallets and drums are all used as packaging materials. Among these packaging materials, plastic containers form a major source of pollution owing to its over

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utilization in wide variety of sectors. Packaging waste can arise from a wide range of sources including supermarkets, retail outlets, manufacturing industries, households, hotels, hospitals, restaurants and transport companies.

## POLLUTION PROBLEMS

The basic reasons that make plastics a source of pollution are the following.

1. Plastics are non-degradable.
2. Plastics prevent or reduce the seepage of water into the soil.
3. These clog / block the domestic pipelines and sewage lines.
4. Direct burning of plastics lead to the emission of toxic fumes and gases, which in turn affects human health.
5. Emission of carbon dioxide during burning of waste plastics adds to the causes which raise earth's temperature (Global warming).
6. Incorporation of synthetic coloring dyes (Azo dyes) to manufacture plastics pose a threatening health hazard to workers and consumers.
7. Continuous accumulation and dumping of plastics, in due course of time reduces cultivable land. Accumulated plastics invite additional wastes and these dumps are aesthetically disturbing and potential health hazards.

Industrial practices in plastic manufacture can lead to polluting effluents and the use of toxic intermediates, the exposure to which can be hazardous, for example, there have been problems in the past resulting from workers being exposed to toxic vinyl chloride vapour during the production of polyvinyl chloride.

Much progress has been made in developing "green processes" that avoid the use of detrimental substances. For example, phosgene, a toxic "war gas", was formerly used in the manufacture of polycarbontes. Above all many chemical ingredients of plastics were highly carcinogenic. Problems with their use largely result from the presence of trace amounts of non-plastic components such as monomers and plasticizers. For example, the use of polyacrylonitrile for beverage bottles was banned at one time because the traces of its monomer, acrylonitrile, were a possible carcinogen. There has been concern about endocrine disruption from phthalate-containing plasticizers used for plastics such as polyvinyl chloride (PVC)[3].

## REMEDIES TO MINIMISE POLLUTION

The popular 3 R slogans, which means Reduce, Reuse and Recycle can be adapted to tackle this problem.

**Reduce :** Over utilization of plastics and its derivatives can be minimized or reduced by using plant based biodegradable materials for packaging and as containers. For example jute bags can be a very good alternative instead of polythene bags.

**Reuse :** Once used materials should not be thrown as waste, in contrast it can be reused to an optimal level. For example it can be used as containers for nurseries, for making artificial ponds, bunds so as to retain water for various agro based works, as roof materials etc.

**Recycle :** Recycling of plastics is desirable because it avoids their accumulation in landfills. While plastics constitute only about 8 percent by weight or 20 percent by volume of municipal solid waste, their low density and slowness to decompose makes them a visible pollutant of public concern.

Over 1.5 million pounds of plastic bottles were recycled in 2000, representing a four-fold increase in the amount of plastic recycled in the previous decade. Nonetheless, the capacity to recycle bottles appreciably exceeds their supply by about 40 percent, so local governments and environmental groups need to encourage greater participation in this practice among consumers. Profitable operations are currently in place for recycling polyethylene terephthalate (PET) from bottle sources and converting it into products such as fibers. Polystyrene (PS) is another potentially recyclable polymer.

The initiative to popularise a simple technology using waste plastic to lay roads has received a shot in the arm with the Central Pollution Control Board (CPCB) approving it for wider application. In Tamil Nadu, the District Rural Development Agency (DRDA) had laid 1,200 km of plastic roads in 28 districts.

## POLYMER WASTE-BITUMEN MIX FOR ROADMAKING

Main types of resins used to make plastic products in the US are :

1. PET, polyethylene terphthalate, from 2-1 soda bottles.
2. HDPE, high-density polyethylene, natural, from 1 gallon milk jugs, grocery bag.
3. HDPE, high-density polyethylene, colored, from bottles.
4. PVC, polyvinyl chloride, various bottle, pipes, flooring.
5. LDPE, low density polyethylene, from film and trash bags, rigid containers.
6. PP, polypropylene, from some food containers, battery cases, medical containers.
7. PS, polystyrene, from carryout containers, some food containers, vitamin bottles.

It will be ideal for roads that have to bear the brunt of continuous rainfall, like those in Mumbai. According to officials, though the technology has proved to be beneficial, it can be adopted nation-wide only with the approval of the Central Road Research Institute (CRRI).

The plastic waste (bags, cups, Thermocole) made out of PE, PP, and PS are separated, cleaned and shredded to small pieces (passing through 4.35 mm sieve) The granite aggregate is heated to 170°C and the shredded plastic waste is added, which softens and coat the aggregate. Immediately the hot Bitumen (160°C) is added and mixed well. As the polymer and the bitumen are in the third state, they get mixed and the blend is formed at surface of the aggregate. The road is laid using this mixture. This new material has the following salient features.

- Road strength is nearly doubled.
- There is improved resistance towards water stagnation i.e. no potholes are formed;
- There is less bleeding during summer;
- Plastics waste need not be burned.
- No extra machinery is involved;
- Cost of road construction is not increased.
- It helps to reduce the consumption of bituminous mix reduce and thus cost.
- It is a low-cost, simple technology for spot utilization of waste plastic.

Several communities and states have examined and utilized plastics for other uses related to highway and road construction, including fences or sign posts, sign blanks, barricades, delineators or cones, and plastic timbers, tables, and benches.

Among plastic ingredients utilized in 2002, PET comprised the largest amount with 42 percent, HDPE a slightly lesser amount with 33 percent, and other plastics with 25 percent. Generation rates provide data on the actual amount of waste that is generated by households and commercial properties. A national study by the American Plastics Council estimates that 200 pounds of glass and 35 pound of plastics are generated per household per year.

## TRASH TO ENERGY

Degradable polymers may have limited use in the reduction of litter and production of flushable plastics. Degradation leads to the loss of most of the potential energy content of plastics that might be recovered by trash-to-energy procedures.

A method of plastic disposal with more positive environmental implications is burning and recovering the energy for power generation or heating. However, it is possible to construct a "high-tech" incinerator designed to operate at appropriate temperatures and with sufficient air supply that these problems are minimized. Remaining toxic substances in fumes may be removed by scrubbing, and studies have shown that no significant air pollution results.

## BIOPOLYMERS AND PLASTICS

Biopolymers are present in, or created by, living organisms. These include polymers from renewable resources that can be polymerized to create bioplastics. Bioplastics are plastics manufactured using biopolymers, and are biodegradable. Biopolymers and bioplastics are not new products. Henry Ford developed a method of manufacturing plastic car parts from soybeans in the mid-1900s. However, World War II sidetracked the production of bioplastic cars. Today, bioplastics are gaining popularity once again as new manufacturing techniques developed through biotechnology are being applied to their production.

The main work in this field at present is on the polysaccharide alginate, which has several commercial applications. Due to its gelling, water-binding and viscosity-enhancing properties alginate is widely used in foods, and has other industrial applications as different as in textile printing and welding rods. It is also used for medical purposes, such as encapsulation of cells[4].

Alginate over-producing mutants of *Pseudomonas fluorescens* and their genes involved in the production of the polymer were extensively studied. In addition to *Pseudomonas fluorescens, Azotobacter vinelandii* is also employed for mass production of alginate, the degradable polymer[5].

Condensation polymers like cellulose, produced by bacteria have properties similar to polyethene. Polyhydroxybutyrate (poly-3-hydroxybutanoate) and Polyhydroxyvalerate (poly-3-hydroxy-pentanoate) (PHV) are polyesters produced by a number of different bacteria (*Allcaligenes spp., Pseudomonas spp.*) are used as food storage material, an effective alternative plastic packaging material.

**Microbial Cellulose :** Cellulose is the earth's major biopolymer and is of tremendous economic importance globally. Among the bacteria, one of the most advanced types of purple bacteria is the common vinegar bacterium, *Acetobacter*. This non-photosynthetic organism can procure glucose, sugar, glycerol, or other organic substrates and convert them into pure cellulose[6]. *Acetobacter xylinum* is Nature's most prolific cellulose-producing bacterium.

**Microbial cellulose finds its use in the following :**

- The unique gel-like property of microbial cellulose makes this an attractive food base.
- Used in audio speaker diaphragms.
- As a liquid loaded pad for wound care
- As binding material in papers, it adds great strengths and durability to pulp, which in turn integrate into paper.
- Mass-produced in bioreactors by fermentation method, the brand name is *Cellulon*.

## POLYHYDROXYBUTYRATE

The microbial polymer poly-3-hydroxybutrate (PHB) and related poly-hydroxyalkanoates, such as poly-3-hydroxyvalerate and poly-3-hydroxyoctanoate, are unique biodegradable thermoplastics of considerable commercial importance[7].

## SPECIALTY POLYMERS

Natural polyesters are "biocompatible" and can be used to make surgical thread and for other medical applications; if left behind in the body, they will easily be degraded with no harmful effects. The properties of PHB-PHV blends are such that they could replace polypropene for many applications.

## REFERENCES


1. *The College Street Journal,* Mount Holyoke College, January 24, 1997.
2. Central Pollution Control Board Report September 2006.
3. T. U. Gerngross, S. C. Slater, *Scientific American* August. (2000).
4. M. Gimmestad, H. Sletta, S. Valla *J. Bacteriol.* **185**, 12, 3515-3523, 2003.
5. M. Ertesvag, F. Erlien, G. Skjak-Braek, B. H. Rehm, S. Valla, *J. Bacteriol*. **180**, 15, 3779-3784, 1998.
6. R. M. Brown, J. H. M. Willison, C. L. Richardson, *Proc. Nat. Acad. Sci. (U.S.A.)* **73**, 12, 4565-4569, 1976.
7. A. Edwin Daves, *Biosci. Rep*. **8**, 537-547, 1988.


## DO YOU KNOW ?

Q3. A champion sprinter of international standards can cover 100 metres in about 10 seconds. Assuming that he is about 2 metres tall, he thus covers per second 5 times his body length. How does the common housefly compare in speed?

Q4. Do snakes eat flowers and leaves ?

# ENERGY EFFICIENT AND ENVIRONMENTALLY SOUND RURAL KITCHEN : DESIGN AND DEVELOPMENT

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**Kitchen is the most important work zone where homemakers spend maximum time and energy. A housewife spends approximately one third of her life span in the kitchen.[1] Rural kitchens are the most neglected area of rural houses as they are usually dark, polluted, ill ventilated and ill lighted. The tools and equipment are also outdated. The need to renovate for kitchens convenience is often neglected and not appreciated in development planning. The overall goal of this study was to design convenient and environmentally healthy rural kitchens.**

## INTRODUCTION

Rural kitchens are generally dark, dingy, ill ventilated, poorly planned with improper storage areas. The sizes are also too small. The major problem of these types of kitchens is air pollution. It is therefore, needless to emphasize that well designed, well planned, well ventilated, well lit and pollution free work area, will not only increase the total work output, but also definitely reduce time and energy demands and improve the health of the worker.[2] The long term consequence to a women's life of adaptation to stressful environmental conditions may deteriorate their physical and mental health and sense of well being which in turn may cause greater damage to environment.[3]

Heaven is where home is. But not when homes are heavily polluted with smoke that threatens life.[4] This problem becomes worse when solid biomass such as cow dung cake and agricultural residues are used in chimney-less stoves in poorly ventilated kitchens. Thus, women and children are exposed directly to the pollutants of large accumulated poisons and harmful gases.

In general, kitchen pollution is far worse than the allowed standards. Windows are to small for air ventilation and fuels are so wet. In some locations many families still cook with old types of stoves that produce a lot of smoke and dust. In order to reduce smoke, dust, toxic gases, kitchen air pollution and save fuels and time for cooking, it is essential to introduce improved cook stoves, ergonomical principles that should improve environmental conditions better equipment design and workplace lay out on the same floor in these kitchens. The study was undertaken with the following objectives :

1. To design and develop some selected rural kitchens into energy efficient and environment friendly enclosures through : (a) commissioning devices and (b) organizing work centers.
2. To judge the technical feasibility of the rennovated kitchens.

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## MATERIALS AND METHODS

The work was done in the following phases to collect the required information.

Phase I : Household observation to judge the existing rural kitchen.

Phase II : Household experiments for pre-testing the energy efficiency and environmental conditions of rural kitchen.

Experiments were conducted to measure the existing status of the following parameters :

**A. Energy Efficiency**

| Sl. No. | Parameters | Name of the equipment used |
|---|---|---|
| 1. | Amount of fuel used and time consumed in selected activity while using traditional and improved chulhas. | Physical balance and stop watch |
| 2. | Thermal efficiency of both the chulhas in performance. | Temperature recorder |
| 3. | Physical cost of work by measuring energy consumed in performing selected standard activity (through heart rate of the home maker). | Heart rate monitor |
| 4. | Time consumed in the selected standard activity | Stop watch |

**B. Environmental Conditions**

| Sl. No. | Parameters | Name of the equipment used |
|---|---|---|
| 1. | Indoor air pollution to gaseous Analysis | MX 21 gas detector |
| 2. | Measurement of ventilation through<br>● Air movement<br>● Humidity temperature and time | <br><br>Anemometer<br>Hygro-thermometer clock |
| 3. | Light intensity | Lux meter |
| 4. | Odour | Odour intensity scale |

**Note :** Standard activity in this study is considered as preparing one full meal for a family of 4-6 members.

Phase III : Commissioning of devices and reorganizing work places for design and development of energy efficient and environment friendly kitchens.

It was done by the following measures :

1. Reorganization of work centres
2. Installation of improved cook stoves (Udairaj model : developed and tested by Department of Renewable Energy Sources, College of Technology and Engineering, MPUAT, Udaipur.)
3. Installation of appropriate cleaning corners
4. Installation of windows and sky lights.

Phase IV : Assessment after taking measures for improvement.

This study was conducted in one village of Udaipur district using a sample size of 30 rural households. From among these 30 households, 6 kitchens (3 each of *kuchcha* and semi *pucca* categories) were selected for the purpose of commissioning of various devices and reorganization of work centers. All the informations/ data collected in each phase of the study were converted into comprehensive tables and percentages were calculated. Mean scores of the experimental readings were calculated. To measure the significant difference between the results of pre and post tests, paired t-test was applied on the collected information at a suitable level of significance.

## RESULTS

The major findings were as follows.

53.33% of total selected households had 6-10 persons per family and 46.67% had 1-5 members in each family. 50% families were of low income group (LIG) whereas 26.67 were under the category high income group (HIG). Pucca house had larger plot area than semi pucca and kuchcha houses. 50 per cent houses had an area of 101-200 sq. ft. as the size of their rooms, whereas 33.33% had room size of 201 sq. ft. and above. Majority of the kitchens (66.67%) had only one door of below 6 ft height and 23.33% kitchens had single door of 6 ft. height. 36.67% houses had no window in their kitchens. Mostly *kuchcha* kitchens had no window. 66.67% households did not provide any ventilator in their kitchens. 76.67% kitchen had only storage space but unorganized. All *kuchcha* and most of semi *pucca* kitchens were without of a cleaning center. 53.33% houses had poor lighting conditions. About 40% of households were using wood, coal and dung cakes as their fuel. There were mainly *kuchcha* kichen. Among all the selected kitchens not a single kitchen had improved chulhas 53.33% kitchens had no problem of stagnation of water whereas 46.67% had this problem. In 66.67% kitchens, odour of different intensities was present, especially in *kuchcha* and semi *pucca* kitchens. Out of total selected kitchens about 50% were poorly maintained.

The thermal efficiency of the improved chulha was found to be 21.45% as against 10% for traditional chulhas. This clearly indicates that the improved chulha was 11.45% more efficient. Similarly, the consumption of fuel in improved chulha for preparing one time meal was 3.60 Kg. firewood, which is almost 2 Kg. less than the traditional chulha. Further, the time consumed in cooking was 2.65 hours in traditional chulha whereas it was only 1 hour in the case of improved chulha **(Table 1)**.

**Table 1 : Comparative Scores for Thermal Efficiency, Fuel and Time Consumption.**

| Sl. No. | Type of chulha | Thermal efficiency (%) | Fuel consumption | Time consumed |
|---|---|---|---|---|
| 1. | Traditional | 10.00 | 3.50 Kg | 2.65 hours |
| 2. | Improved | 21.45 | 1.60 Kg | 1 hour |

**Tables 2 and 3** show that the reorganization of work centers in all the selected kitchens reduced energy expenditure of the homemaker. The highly significant difference of 12.22 Kj/min and 6.219 Kj/min both 1% and 5% level of significance was found in energy expenditures and time consumed of the home makers of both *kuchcha* and semi *pucca* kitchens, respectively. After reorganization, energy consumption cooking was reduced in each kitchen but in kuchcha kitchens this reduction in mean scores was found to be more significant, whereas time consumption in semi pucca kitchens showed significant difference at 5% level of significance.

The highly significant difference in t-value was found in four selected gases i.e. CO, $NH_3$, $NO_2$,

**Table 2 : Comparative Mean Scores for Energy Expenditure in Selected Kitchens**

| Sl. No. | Total energy expenditure | Means pre-scores for energy expenditure in existing kitchens (KJ/min) | Mean post-scores for energy expenditure in renovated kitchens (KJ/min) | Mean difference (KJ/min) | 't' value |
|---|---|---|---|---|---|
| 1. | Energy expenditure in *kuchcha* kitchens | 11.84 | 6.54 | 5.30 (44.76) | 12.22** |
| 2. | Energy expenditure in semi *pucca* kitchens | 11.53 | 5.96 | 5.57 (48.30) | 6.29* |

- In parenthesis, percentage is given

* Significant at 5% level

** Significant both at 1% and 5% levels

**Table 3 : Comparative Mean Scores for Time Consumption in Performing the Selected Standard Activity in Selected Kitchens**

| Sl. No. | Total time consumed | Mean pre-scores for time consumption in existing kitchens | Mean post-scores for time consuption in renovated kitchens | Mean difference | 't' value |
|---|---|---|---|---|---|
| 1. | Time consumption in *kuchcha* kitchens | 150.00 min | 105.00 min. | 45.00 min. (30) | 2.95 |
| 2. | Time expenditure in semi *pucca* kitchens | 128.33 min | 63.33 min. | 65.00 min. (50.65) | 4.33* |

- In parentheses, percentages are given

* Significant at 5% level.

**Table 4 : Comparative Mean Scores for Smoke Content in Selected Chulhas**

| Sl. No. | Smoke content | Prefect burning | | | | Imperfect burning | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre mean scores (ppm) | Post mean scores (ppm) | Difference in mean scores (ppm) | t-value | Pre mean scores (ppm) | Post mean scores (ppm) | Difference in mean scores (ppm) | t-value |
| 1. | CO | 25.86 | 1.23 | 24.63 (95.24) | 174.443** | 31.73 | 1.73 | 30 (94.54) | 180.624** |
| 2. | $NH_3$ | 2.78 | 1.16 | 1.62 (58.27) | 13.307** | 3.83 | 1.48 | 2.35 (61.35) | 21.315** |
| 3. | $NO_2$ | 2.60 | 1.62 | 0.97 (37.30) | 6.500** | 3.73 | 2.14 | 1.61 (43.16) | 13.307** |
| 4. | $CH_4$ | 2.76 | 1.33 | 1.43 (51.81) | 13.814** | 3.93 | 2.62 | 1.25 (31.80) | 23.924** |

- In parentheses, percentages are given

* Significant at 1% level

**Note :** Pre-mean scores are for traditional chulha and post-mean scores are for improved chulha.

$CH_4$ in pre and post study which was more in the smoke of traditional chulha specially during imperfect burning (**Table 4**). Likewise, bad odour was reduced after installation of cleaning centre with proper drainage facility, windows and improved cook stove (ICS). All selected kitchens showed increase in air flow rate after installation of windows which meant that the ratio of air exchange between fresh air from outside and polluted air inside was very high resulting into good indoor air quality in rural kitchens (**Table 5**).

**Table 6** reveals that natural light intensity was increased after installation of sky light and window. It is evident that mean differences are highly significant at 1% and 5% level of significance for both *kuchcha* and semi *pucca* kitchens.

**Table 5 : Comparative Mean Scores for Air Flow Rate**

| Sl. No. | Air flow rate | Mean pre-scores for air flow rate in existing kitchens (meter/sec.) | Mean post-scores for air flow rate odour in renovated kitchens (meter/sec.) | Mean difference (meter/sec.) | 't' value |
|---|---|---|---|---|---|
| 1. | Air flow rates in *kuchcha* kitchens | 0.06 | 0.15 | 0.09 | 26.00** |
| 2. | Air flow rates in semi *pucca* kitchens | 0.06 | 0.17 | 0.11 | 11.00* |

**Significant both at 1% and 5% levels.

**Table 6 : Comparative Mean Scores for Intensity of Natural Light**

| Sl. No. | Intensity of natural light | Mean pre-scores for natural light intensity in existing kitchens (Lux) | Mean post-scores for natural light intensity in renovated kitchens (Lux) | Mean difference (Lux) | 't' value |
|---|---|---|---|---|---|
| 1. | Intensity of natural light in *kuchcha* kitchens | 247.33 | 345.33 | 98.00 | 9.17** |
| 2. | Intensity of natural light in semi *pucca* kitchens | 295.67 | 403.00 | 107.00 | 18.11** |

**Significant both at 1% and 5% levels.

All selected kitchens were showing reduction in temperature after installation of window. It was found that there was a great reduction in humidity of selected kitchens after installation of window and proper drainage facility. Significant difference at 5% level of significance between pre and post mean scores of humidity was found in *kuchcha* kitchens, whereas semi *pucca* kitchens showing highly significant difference at 1% level of significance (**Fig. 1**).

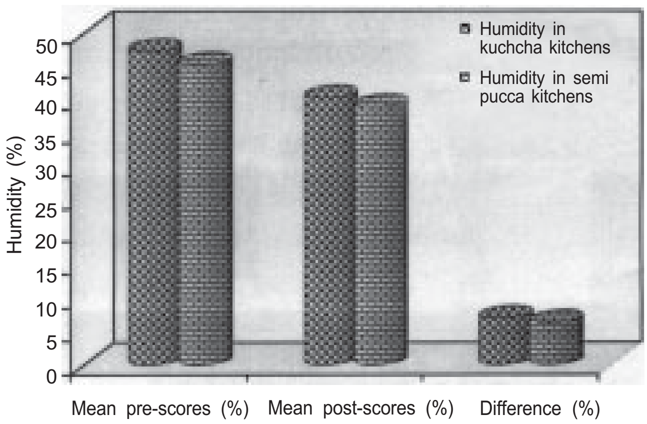


*Fig. 1 : Comparative Mean Scores for Humidity*

## CONCLUSION AND RECOMMENDATIONS

It can be concluded that temperature, air, humidity, ventilation, lighting, noise not only inproves environment but also affect the cost of work. This means that proper design of the kitchen and work place is very important to improve the work output and make the person comfortable and healthy. Besides these advantages, it will also improve the attitude of housewife towards work and make her happier.

Commissioning of energy efficient devices such as improved cook stove, cleaning centers with proper drainage facility, window and skylight for adequate ventilation and natural light and reorganization of work centers can effectively convert a dark, dingy, ill ventilated, ill lit, humid and extremely polluted rural kitchen into an energy efficient and environment friendly rural kitchen.

## ACKNOWLEDGEMENT

The design of energy efficient and environmentally sound kitchen was approved by the Architects and house planners at Udaipur and many house owners in the nearby villages got their kitchens renovated. The finanical assistance for the renovated work of these kitchens was given by agencies like Department of Science and Technology, Indian Council of Agricultural Research, New Delhi and District Rural Development Agency, Udaipur. The authors are grateful to all these agencies, College of Technology and Engineering and College of Home Science, Udaipur. The feed back received from the owners show that they are very happy with their working conditions at home. Many more rural kitchens are being renovated.

## REFERENCES

1. S. A. R. Borse, *Women Empowerment in health through ergonomically designed kitchen,* National seminar on empowerment of women for better health and family life, Sardar Patel University, Gujarat, 2002.
2. K. Oberio and H. K. Gill, *Rural India*, **5** Jan-Feb 2003.
3. P. Rishi, *Kurukshetra*, **49**, 2001.
4. World Bank Report, *Draft, Energy and Poverty : Strategies for Assisting the Rural and Urban Poor,* Joint UNDP/ World Bank Energy Sector Management. Assistance Programme, Washington DC : 86-97, 2000.

## DO YOU KNOW ?

Q5. Do identical twins have similar body odour?

Q6. Can an animal do without normal sleeping i.e. when the entire brain rests ?

Q7. Where do the word pencil came ?

# THE ORIGIN OF LIFE ON MARS AND MARTIAN ASTROBIOLOGY

Archan Bhattacharya*

**In the present article, the astrobiology (Greek *astro*-related to star, *bios*-life and *logos*-knowledge; branch of biology dealing with the search of extraterrestrial life) of Mars and the probability of past and present existence or future establishment of life on the planet, origin and nature of that life etc. will be discussed.**

## INTRODUCTION

Mars is our sister planet. Her surface, due to presence of iron oxide or rust, appears blood red (the Red Planet) like the ground after war, so the planet is named 'Mars' after the God of war in Roman Mythology[1]. Her red surface reminds us of the iron-rich red soil of South India. May be that for this reason ancient Indians called the planet as 'Bhouma' or 'Kuja', both meaning the filial of Earth[2]. The planet has two moons–Phobos (meaning fear) and Deimos (terror).

From centuries, it was believed that there was life on Mars because of the appearance of branching channels on her surface, possibly formed due to past water flow. It has North and South Poles with ice-caps of frozen $CO_2$ and $H_2O$. The caps grow in size during winter (down to 55°–60° latitudes) and shrink almost completely during summer. In July, 1997, the Path Finder reached the Martian surface and did not find any sign of life. But still the possibility of life there can't be denied due to some biocompatible properties of the planet. The planet is in the ecospheric belt of solar system, has some atmosphere (although very thin), plenty of $H_2O$, $CO_2$ and $H_2$, other gases and possible volatile inventories **(Fig. 1)**, does not have great extremes of temperatures. (40°C to – 60°C) and has suitable astrophysical parameters like the specific rotation period (24 hr. 37 min., almost like the Earth), axial tilt (the angle between the equatorial plane and orbital plane of a planet) (25.2°, that of the Earth 23.5°), seasons (like the Earth), size (4224 miles, half of the Earth) and gravity. All show that the planet is still biocompatible (favourable to life) and in the past, the planet might be biogenerative (where life may originate spontaneously) like the Earth. Martian winter is longer and colder and summer is shorter in the Southern Hemisphere than her Northern Hemisphere, just like Earth. However, the Martian year contains 687 Earth days or 670 Martian days[3]. In the present article, the astrobiology (Greek *astro*-related to star, *bios*-life and *logos*-knowledge; branch of biology dealing with the search of extraterrestrial life) of Mars and the probability of past and present existence or future establishment of life on the planet, origin and nature of that life etc. will be discussed.

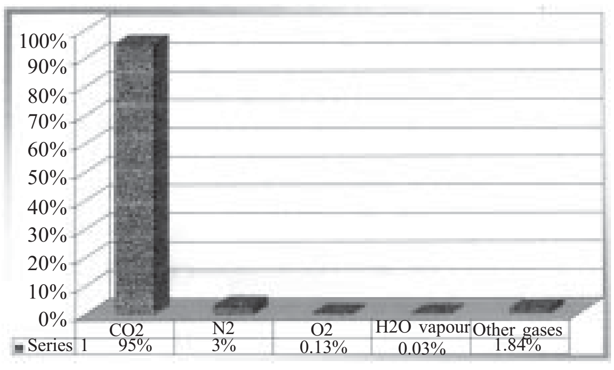


*Fig. 1 : Present atmospheric composition of Mars*

## MARTIAN CLIMATE AND GOLDILOCKS PROBLEM[4]

In the children's fable, Goldilocks is the little girl finding the porridge of father bear too hot, that of mother bear too cold, but baby bear's is just

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right. In climatology, the Goldilock's problem is to understand why Venus has become too hot for life (~ 460°C), Mars has become too cold (~ – 60°C) and Earth has remained just right (~ 15°C) while the starting points before 4.5 billions years were presumably the same. Possibly after an early warm period of one billion years after genesis, Mars cooled rapidly due to its high surface-to-volume ratio, lost initial internal heat and could no longer release interior $CO_2$ from carbonates due to lack of plate tectonics (the planet-wide movement of huge crustal plates together with the accompanying deformations and alteration of the crust, during the process the interior $CO_2$ from carbonates in the crust is released, as the Mars is a single plate planet). But her atmospheric $CO_2$ was being lost continuously as carbonic acid rainfall. Mars became cool and cooler due to decrease in green house effect. Perhaps, it became dry due to a change in its orbital characteristics[5]. On the other hand, on Venus the runaway green house effect has burnt the planet and on Earth the biota recycle carbon in such a way that green house effect always remains in a biofriendly mode.

## LIFE ON MARS

Biologists know that life is indomitable. Extremophiles (mainly archaebacteria) such as acidophiles (liking acid), alkaliphiles (liking alkali), halophiles (liking salt), hyperthermophiles (liking high temperature), psychrophiles (liking very low temperature) etc. thrive under extreme conditions with the help of their hardy extremozymes [enzymes present in extremophiles—organisms whose optimal growth and reproductive factors are extreme in our view) that continue to function at high temperatures, salinities, acidities or alkalinities at which other enzymes would fail]. *Pyrolobus fumarii* (an archaebacterium) grows at temperatures up to 113°C. Some extremozymes work beyond 140°C. In the Himalayan ridges, certain bacteria live at – 18°C. Bacterium *Deinococcus radiodurans* can survive high radiation doses that are fatal to all eukaryotes and can withstand repeated vacuum drying and dehydration. Some archaebacteria thrive in the hypersaline Dead Sea. In Yellowstone's Norris Geyser Basin, bacteria (Mycobacterium and Cyanidium) grow in rock-pores with 95°C temperature, high concentrations of metals and silicates and a pH value of 1, which is enough to dissolve our nails! These examples provoke astrobiologists to think about the probability of life on Mars as now the Martian environment is very hostile to tellurian (of Earth) life.

The nature of the possible life-form on Mars at present or in the past is totally unknown. Although different Mars vehicles sent could not discover any sort of life, it may be that there are some undiscovered cryptic Martian communities or their remains well-hidden in some special niche[6] (a position or role to which one is suited; Italian-nichia : a recess in a wall) underground or elsewhere. Possibly they were / are mainly carbon, hydrogen and nitrogen compounds like us as the past Martian and Earthen environments were very similar. The orthodox Haldane-Oparin view would be applicable to the evolution of such 'Earth-like Martian life' (if it ever took pace) also :

(i) safe voyage of organomolecules from intersellar cloud to the Mars-surface with meteorites and cometes or *de nouveau* (anew) synthesis of those organomolecules on Mars,

(ii) accumulation in some water body to form pre-biotic hot dilute soup,

(iii) polymerization with the help of cyanogens and cyanotetraacetylene and arrival of ribozyme (catalytic RNA molecule) and other bio-catalysts,

(iv) biopoiesis (Greek bios-life, *poiesis*-a making; formation of membrane-enclosed, self-replicating, information-storing and inheriting macromolecular organization through wedding of nucleic acid, protein and lipid-membrane in primordial cells).

(v) subsequent evolution and diversification of life.

The seed of life on Mars might reach through panspermia (migration from somewhere with some vector like meteorite or comete) also. For panspermia through space, there are two hurdles-high radiation and extraordinarily long time requirement. It is only possible for some long living or dormant and radioduran forms. However, if some comet of meteorite acts as the carrier of seed of life, the matter becomes something easy. This kind of panspermia may be the interplanetary route which according to Meyer, is a reasonable idea. For example, Mars and Earth exchanged materials which might carry life from one planet to other. According to Stephen P. Broker[7], the member of the emient Yale–New Haven Teachers Institute, borrowing analogy from the ecology of bees and flowering plants, asteriods and comets have acted, in effect, as flying penises.

The seven clues to the origin of life on Earth given by A. G. Cairns–Smith[8] should be equally applicable to the origin of hypothetical Martian life :

**First clue** : *from biology*–Only genetic information can be evolved through variation and natural selection, so naked gene or something close to it were the first life.

**Second clue** : *from biochemistry*–Both chemically and biochemically DNA (and also RNA) is a difficult molecule to make, so it arrived later.

**Third clue** : *from building trade*–The earlier designer organisms with different genetic make up, like scaffolding structure of a building, might be subtracted in evolution.

**Fourth clue** : *from nature of ropes*–Earlier gene fibers have been replaced by newer ones just like no fiber in a rope stretches from one end to other.

**Fifth clue** : *from history of technology*–The first unevolved, 'low–tech' ancestors have been replaced by 'high'–tech' newer ones like the replacement of primitive machinery by newer ones in technology.

**Sixth clue** : *from chemistry*–Crystals (e.g. kaolinite) helped in the formation of primitive, inorganic, 'low-tech' genes (primary organisms) which were replaced by advanced, organic 'high-tech' genes (secondary organisms) through 'genetic takeover' during evolution.

**Seventh clue** : *from geology*–For primitive genes, 'low-tech' catalysts and membranes, the crystal minerals of clay seemed to be appropriate which were later replaced.

Now scientists from the U. S. Dept. of Energy's Idaho National Laboratory, University of Idaho, and University of Montana are writing a chemical guide book to aid a NASA rover that would search for life on Mars. The rover would contain precise chemical imagers and human-like reasoning ability. The Laser and Optical Chemical imager (LOCI) and Fourier-transform mass spectrometer will be used to complete the chemical guide book. A fuzzy logic computer programme, viz, the Spectral Identification Inference Engine (SIDE) using an open-ended reasoning approach mimicking human's decision-making abilities and learning, would provide the Mars rover with artificial intelligence.

There are three possibilities regarding the life on Mars :

**(a) Once upon a time there was life on Mars and life is extinct now :** Possibly the Mars once possessed a much thick atmostphere and plenty of surface water. This condition lasted for at least 500 million years but ended because Mars lacks plate tectonics and so a long term geological cycle. Biological evolution might take place during this period and remnants may be discovered in future[9]. Studies in 1994 revealed that the meteorite ALH 84001 in Antarctica, most likely to be from Mars in past, is about 4 billion years old. It showed the tubular, bacteria-like forms and deposits of polycyclic aromatic hydrocarbons and $CaCO_3$ in and onto it. However, these may be the result of contamination from Earth[7]. When, and only when such a discovery would take place, the exploration of the origin of life would be meaningful.

**(b) Life is still present there :** Two NASA (National Aeronautics and Space Administration) scientists, Stocker and Lemake suspected the presence of subsurface life with unique metabolism on Mars from $CH_4$ signature and other signs of possible biological activity similar to those recently found in cave-ecosystems on Earth[10]. In the past, Martian surface oceans came and went, but underground ponds could have persisted long enough to give rise to extremophiles. Possible life on Mars, is bound to be microbial and could be very different from the Earth[5]. However, until the possible extant life-forms are discovered on Mars, it is not possible to explore how 'they' did originate there.

**(c) Mars is waiting for the anthropogenic introduction of life** : In a committee meeting of NASA in 1967, R. H. Haynes suggested that the feasibility of establishing life on Mars should be examined seriously. In 1998, an "organizational meeting " of scientists from universities and NASA staff was held to discuss about the terraformation on Mars.

## PRESENT CONDITION OF MARS

Presently Martian surface is extremely hostile to carbon-based life due to its highly oxidizing nature. Neither her atmospheric composition, nor her surface conditions are either biogenerative or bioprotective. Substantial amount of water is tied up in geological sinks, the surface is devoid of soil and made of regolith (sand and stones) which is highly desicated due to low atmostpheric pressure and temperature. Due to lack of ozone layer, solar U. V. ray floods the surface. Nevertheless, in future, the planet with some biocompatible features, may become an abode of life through planetary and biological engineering through the following steps.

**A. Ecopoiesis**

This means the process of establishing an ecosystem on a lifeless planet (Greek *oikos*-an abode and *poiesis*-a making, coined by Haynes, 1990[4]). This can be achieved through following steps.

**First Stage : Planetary Engineering**

**I. Warming of Mars by :**

(i) focusing solar energy on the polar regions with giant space mirrors,

(ii) lowering the reflectivity of ice caps by spreading suitable absorbing material over them,

(iii) introduction of some highly efficient broad-band infra red-active and photochemically stable green house gases into Martian environment.

**II. Positive Feedback :**

(i) after a small rise in temperature, the $CO_2$ absorbed in regolith would be released and would exert green house effect,

(ii) more increase in temperature would cause more release of $CO_2$,

(iii) start of positive feedback mechanism.

**III. Release of Water :**

(i) from ice caps and permafrost, water would be released and $H_2O$ vapour also would exert green house effect through positive feedback.

(ii) liquid $H_2O$ would run again through the dead and dried 'river beds',

(iii) rain water would once again fall on the Martian surface,

(iv) two scientists Sadoway and Debelak have described how respirable $O_2$ can be produced from common iron ores in Martian soil with the help of electrochemical cell and how to extract drinking water from Martian clays and minerals (probably Martian polar ice-caps would be salty) with the help of $CO_2$[5].

**IV. Formation of a thick Atmosphere :**

Due to temperature increase, gases would be released from regolith and some compounds would be gasified. Thus, a thick atmosphere would be developed.

Possibly in the Martian world nutrients would not be a limiting factor. The fertility of meteorites on Earth from Mars has been examined. Water soluble salts from the Martian Dar al Gani 476 (DAG 476) and EETA 79001 yielded extractable nutrients on levels similar to terrestrial basalts but with higher levels of $PO_4$ and $NO_3$. Tissue cultures of *Asparagus officinalis* in DAG 476 extracts yielded higher weight and greener colouration. The Murchison $CM_2$ meteorite showed the soil fertility parameters like that of the productive Earthen Earth. This meteorite also supports high levels of diverse algal populations, microbes like *Flavobacterium oryzihabitans, Nocardia asteroides, Pseudomonas fluorescence, Thermotoga maritima, Thermus aquaticus etc*. Recently, different Martian meteorites on Earth are found to contain diverse microbes from terrestrial contaminations. Martian minerals may have also supported indigenous microbes in the past[11].

**Second Stage : Biological Engineering**

After some degree of *ecopoiesis*, some kind of super hardy, extremophilic, acid-fast, anaerobic, chemolithotrophic, radioduran (withstanding very high radiation dosages) microbes might be introduced to Mars. We shall have to construct some special strains with broad range of atmospheric tolerance, versatility and phenotypic plasticity by gathering different novel genes and their combinations into some cosmid (plasmid attached with 'cos' site-a specific DNA sequence present in the genome of bacteriophage lambda) and bacterial artificial chromosome of large molecular size through gene-cloning, site-directed mutagenesis, cassette mutagensis, polymerase chain reaction (PCR), inverse PCR, induced crossing over, exon shuffling, transgenesis *etc*. We might have to borrow different photosensitive membrane-transporters like bacteriorhodopsin, halorhodopsin *etc*., supramolecules like thermosome (chaperonin folding partially heat denatured proteins in hyperthermophiles), extremozymes (enzymes capable of functioning under physical and chemical extremes) and organelles like peroxysome, hydrogenosome *etc*. from different microbes and the heat resistant lipid monolayer cell membrane from some hyperthermophilic archaea for the purpose. Possibly we have to make a suit of microbes forming consortia. Archaebacteria are the most potential candidate to be pioneer on Mars. Friedmann (NASA) believes that the designer organisms would be some genetically modified version of the present chroococcidiopsis (cyanophyceae) bacteria[12].

**B. Terraformation**

After complete ecopoiesis, the Mars would gain an average temperature of ~ 15°C, an anoxic wet environment, a thick $CO_2$ –atmosphere with a pressure of about 2 and a plenty of liquid water. The microbiota would cause pedogenesis from regolith through biological weathering, bioleching and addition of biomass. At this stage, the planet might be called *vitanova* (Latin *vita*–life, nova-new; a new abode of life in the sky[4]). Then the process by which the Martian surface and atmosphere might be transformed into an aerobic environment favourable to *Homo sapiens sapiens* is called *terraformation* (Latin *terra*-Earth). This may only be achieved with the help of microbiota whose excellencies have already been proved on earth before 2-1.5 billion years ago. After ecopoiesis, if we introduce some oxygen-generating phototrophs (photosynthesizing green agents), $O_2$ will be liberated and may form ozone through natural Chapman cycle with the help of U. V. ray and the $O_3$ layer would shield Martian surface from deadly U. V. ray. If Mars would become suitable for man, this new land in the sky would be called *terranova* (Latin *terra*-Earth, *nova*-new[4]). Ultimately the *terranovan* biota might evolve in an independent way of *tellurian* (Earthen) evolution.

Now scientists from the US Department of Energy's Idaho National Laboratory, University of Idaho and University of Montana are writing a chemical guidebook to aid a NASA rover that would search for life on Mars. The rover would contain precise chemical imagers and human-like reasoning ability. The LASER (Light Amplification by Stimulated Emission of Radiation) and optical Chemical Imager (LOCI) and Fourier-transform mass spectrometer will be used to complete the chemical guidebook. A fuzzy logic computer programme (the Spectral Identification Inference Engine, SIDE) using an open-ended reasoning approach mimicking human's decision-making abilities and learning, would provide the Mars rover with artificial intelligence.

## OBSTACLES TO TRANSFORM MARS

(i) Extremely high expenditure and time efforts

(ii) Problems related to global availability of $N_2$

(iii) Difficulty to release $CO_2$ from carbonates

(iv) Being a single-plate planet Mars lacks plate tectonics and so a long-term carbon cycle, so possibly it would not support a long-term stable environment

(v) Phobos will collide with Mars after about 50 million years from now[1]

(vi) On Earth, there are different environmental and ethical problems, starvation and other miseries of human which have to be solved just now.

## ARE WE FROM MARS ?

It may be that originally life was created on Mars and then came to Earth. Through interplanetary panspermia Mars and Earth have been exchanging materials (meteorites). The higher Earth's gravity (three times to that of Mars) and the less escape velocity of Mars (less than $\frac{1}{2}$ of that of Earth) make it more likely that past microbial life migrated from Mars to Earth with some meteorite[5] (however the opposite event also had some possibility; and Earth might have simply an indigenous biota also). If it indeed took place, ontogenically we are the Martians!!

## AN UNSUCCESSFUL ATTEMPT TO CONSTRUCT AN ARTIFICIAL 'BIOSPHERE' ON EARTH : 'BIOSPHERE II'

In 1991, 'Biosphere II'[13] was constructed in the Arizona desert. The building has a volume of $20 \times 10^4$ cubic meter and contained ~ 4000 species and was designed to be a self-contained ecosystem except for sunlight to drive the biogeochemical cycles. Eight scientists entered it and it was sealed off with intention that for two years they would live there, grow their own food and be a part of the 'ecosystem'. But the Biosphere II faced various problems and in January 1993, the managers had to inject $O_2$ into the system. This failure on Earth questions our ability to construct a 'biosphere' on Mars.

## ETHICAL GROUND OF VITALIZING MARS

Literature on ecosophy (ecological philosophy; Greek *oikos* : an abode and *sophia* : wisdom) and other on the rights of animals, plants and objects fail to provide specific guidelines when applied to the rationale of implantation of life on Mars. This is due to extremely complex nature of ecological ethics which is specific for the properties of Earthen life. According to Haynes and Mc Kay[14], a 'green planet' has much intrinsic value than that of a 'red planet'. However, we must be aware of the moral consideration to possible indigenous Martian biota[4]. If they are there, we have no right to pose any threat or harm to them.

## CONCLUSION

The study of Martian astrobiology is extremely complicated, expensive and should be extensive. This study and the implantation of life on the planet are related to and dependent on the socio-ecological, cultural, political, ethical and economic view of nations. It is still unclear whether ecopoiesis is scientifically possible or technologically achievable. However, the study of origin of life on Mars is important as it would help unveil the mystery of the origin of life on Earth. From comparative planetology of Earth and Mars we would be able to understand the origin and development of Earth's biosphere and to learn its proper management. The project may elicit a cooperative international effort beneficial for international relationships. It may be that in future Mars (and some other heavenly bodies also) will become another abode for us.

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## REFERENCES

1. The Amazing Facts–Universe, pp. 18-19, Pentagon Press, New Delhi, India, 2003.
2. K. D. Abhyankar, Astrophysics of the Solar System, Universities Press (India) Pvt. Ltd. (www.universitiespress.com), Hyderabad, 1999.
3. C. M. Michaux, Handbook of the Physical properties of the Planet Mars, SP–3030, NASA, 1967.
4. R. H. Haynes, In : Moral Expertise, D. Mac Niven (ed.), pp. 161-183, Routledge, London and New York, 1990.
5. C. Sivarajan and A. Sastry, Introduction to Astrobiology, Universities Press (India) Pvt. Ltd., Hyderabad, 2004.
6. C. P. Mc. Kay, In : Moral Expertise, D. Mac Niven (ed.), pp. 184-197, Routledge, London and New York, 1990.
7. S. P. Broker, Asteroids, comets and meteorites : their intimate relation with life on Earth, Curriculum Unit 96. 06. 03, Yale-New Haven Teachers Institute.
8. A. G. Cairns-Smith, Seven Clues to the Origin of Life, Canto, Cambridge University Press, 1998.
9. C. P. Mc. Kay and R. H. Haynes, *Scientific American,* 144, December 1990.
10. K. Sandeep, *Science Reporter*, 9-15 & 26-27, 2005.
11. Mc Kay *et al.*, 1996, in : M. N. Mautner, (mautnerm@lincoln.ac.nz, Planetary bioresources and astroecology, http://www.astroecology.com/Astrobiology_Paper.htm).
12. Anon. Mars may turn green, *Scitech, The Statesman,* p. 4, Monday, 30th April, 2001.
13. J. L. Chapman and M. J. Reiss, Ecology Principles and Application, pp. 202-203, Cambridge University Press, 2000.
14. H. Haynes and C. P. Mc. Kay, In : Chemical Evolution : Self – Organization of the Macromolecules of Life, J. Chela–Flores, M. Chandha, A. Negron–Mendoza and T. Oshima (ed.), Proceedings of The Trieste Conference on Chemical Evolution and the Origin of Life, 25-29th October, 1993, pp. 201-212, A. Deepak.

# NORTH EASTERN INDIA — A HOT SPOT FOR DEVELOPING CYMBIDIUM CUT FLOWERS INDUSTRY

Syamali Chakrabarti*

**Cymbidium hybrids are prized for their incredible sprays of long lasting large attractive flowers and play an important role in the orchid trade as cut flowers. In the past few years the orchid trade has increased both in volume and value throughout the world but in our country the current status of cymbidium orchid industry is not even in infant stage though India has all the potential for development of successful cymbidium cut flowers orchid industries in the hot spot north-eastern region.**

Cymbidium orchids are recognized as the king of orchids mainly for the hybrid's (originally bred from the wild orchids from the mountains of India and South East Asia) cut blooming spikes which are prized for their sprays of long lasting, large attractive flowers of beautiful colours and play an important role in the orchid trade as cut flowers.

Among orchids cymbidium cut flower ranks first. It occupies the seventh position out of top ten cut flowers of international trade. High humidity and low temperature accompanied by good rainfall make entire north eastern region of our country a hot spot for development of cymbidium cut flowers industries but at present growing of orchids in India commercially is not organized and is still in the hands of some hobbyists and few dealers. With the increasing demand in overseas market and also within the country particularly in big metropolitans, a very good prospect exists for cut flower trade of cymbidium. Though India has favourable climate, low labour incentives and progressive technology yet cymbidium orchid cultivation is not even popularized and attention not given for large scale commercial cultivation of cymbidiums. It is high time to take proper initiative to encourage the unemployed youths of the region for popularizing the cultivation of cymbidium orchids.

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## GREENHOUSE MANAGEMENT FOR GROWING CYMBIDIUMS

The success of a cut flowers industry depends on the production of quality flowers and the quality and vase life of cut stems is determined in the greenhouse where the plants are to be grown.

The cymbidiums appreciate a protected condition away from strong hot sun, heavy winds and direct frost .The perfect environment should be warm, airy and bright and preferably off the ground .The following important factors are to be taken into consideration for an ideal greenhouse management for developing a successful cymbidium cut flower industry.

## POTTING MEDIUM

The potting medium for growing cymbidiums should be free drained, capable to retain moisture to nourish the plant. The ideal potting mixtures are leaf moulds, broken bricks, charcoal, perlite, tree bark, coconut husk, coco peat and mosses in any combinations as per grower's choice and availability.

## NUTRIENT REGIME

All macro and micro nutrients must be supplied to the potting media for better growth and blooming. The amount of feeding depends on the plant concerned , time of the year and general health of the plant. An incomplete or weak feed will lead to the development of soft flowers which bruise easily with small flower size and low flower counts per stem. During the growth season high nitrogen fertilizer (30-10-10) is recommended; whereas in late summer a high phosphorous (10-30-20) blossom-booster should be applied to help plants to form bloom spikes.

## TEMPERATURE AND HUMIDITY

Temperature is another crucial factor in flowering cymbidiums. In summer season the maximum temperature of 30°C must be maintained inside the green house. During flower initiation a temperature drop of approximately 10°C at night is needed. Humidity inside the greenhouse is to be maintained around 40-70%, at both in summer and winter by watering and with overhead misting. In winter the minimum temperature requirement is 8°C and some heat is to be created as an emergency measure at night. If the temperature inside the house gets too warm in winter the flowers may become soft or bleed into the lip or if it is too cold i.e. less than 7°C the flowers of some hybrids will show lip burn. Low humidity will stress the plants in summer, high winter humidity will cause flower spotting usually caused by fungus.

## AIR MOVEMENT

Good air movement is another essential factor for the growth of cymbidiums. Proper ventilation in the green house depending on the weather condition is recommended.

## LIGHT

For flower field good light and less air pollution is needed. Cymbidiums grow best under partial shade and partial sun conditions. Adequate light is the most important factor to grow and flower well. The plants grow best with 3000-4500 foot candles of light intensity as measured with a light meter. Growers are advised not to use shade-net in summer. Too much light results in a brown or red stain called **sun stain** on the exposed part of the sepals, which may give the flower an undesirable muddy colour. Providing additional shade after the flowers open will hold the colour and increase the life of flower.

## WATERING

Cymbidiums like lots of water and prefer to be constantly moist but not wet. Plants left to dry for a long period will survive but will not flower well in the following years. Use of rain water or demineralized water will give the best results. Watering requirement is determined by the location, temperature, potting mix and water quality.

## PEST AND DISEASE MANAGEMENT

For healthy growth of plants a good management practice to control diseases and pests may be taken. Cymbidiums are subject to bacterial, fungal and viral diseases. Bacterial and fungal diseases are often associated with too wet and crowded condition. Adequate spacing of plants on the bench and watering early enough in the day so that the plants can dry out before dark is the best prevention. Viruses such as mosaic and ring spot will show up as black or brown spots in leaves. If it is suspected to be a virus attack the best measure is to destroy or isolate the plants.

The major pests are aphids, thrips, mites, caterpillar, slugs and snails. Regular spray with a systemic insecticide will help to remove the insects. Snails love to eat the flowers. They hide under the rim of the pots and come out. Use of snail bait or checking plants and pots thoroughly for snails helps to prevent the problem.

## POTTING AND DIVIDING

Cymbidiums generally need to be repotted about every three to four years under normal conditions otherwise the number of flowers will decrease. The ideal time for repotting is just after flowering. To do the repotting successfully, it is first necessary to understand that an orchid plant consists of three types of bulbs:

- Type-1: Old back bulbs without leaves. These hold an emergency reserve of food for the plants
- Type-2: Old bulbs with leaves. These bulbs support the growth and produce the flowers.
- Type-3: New leads or bulbs which form most of the new growth and flowers which are yet to come.

For dividing and repotting it is recommended to leave at least one of the back bulbs (type1), two of the bulbs (type2) attached to the new bulb (type3) in order for the plant to flower in the following year. Plants are to be removed from their existing pots and rinsed in water to remove all the dead and decayed materials as well as stale potting medium. Then plants are to be soaked in solutions of fungicide and insecticide as a preventative measure against pests and diseases. The divisions are to be kept aside until new root growth begins. After a week or so the divisions should be repotted in new pots which are large enough to allow three year's growth. After dividing and repotting, the plants should be placed in an area with heavier shade than normal and should be kept cool and slightly on the dry side for several weeks. This encourages the growth of new roots into the new medium. Water and fertilizers may be applied as usual without worrying for rotting.

## HARVESTING

Flowers should be harvested in the early morning when temperature is lower and plant water content is high. Care must be taken not to place flowers on the ground to protect from brushing and fungal infections.

Cut flowers should be cut before the bees can remove all the pollinia. If this happens, the flowers will begin to fade to almost white within less than a day. A good rule of thumb as to when to cut an orchid spike is to wait until the bottom flower is fully opened, the next flower is half open, the flower above that has just burst its bud, and there are lots of fat buds above this still to open.

## GRADING

There are no uniform standards laid down for flower grading in world trade, but cut flower stems must meet the following standards for trade :

- Minimum 8 standard bloom per stem.
- Flowers must be clean, unblemished and evenly coloured.
- Stems must have flowers evenly arranged along and around the stem.
- Stem must be 2/3 of flowers and 1/3 of clear stem or stalk.
- Flowers must have a firm texture and a luminescent sheen.
- Stems must be firm when held up and not bend from the vertical.
- The diameter of the base of the stem should be a minimum of 10 mm.

So the growers before starting the industry should give attention for selection of hybrids as planting materials considering the above standards.

## POST HARVEST CARE AND PACKING

The cymbidium stems after harvesting from the green house are to be kept in cardboard boxes and taken to the packing room where they are to be cleaned and graded on the basis of colour, size and quality. Individual stems are to be checked for any faults or pests before they are sleeved. The sleeve is perforated plastic. Tetoron is to be put on the back of the sleeve to form a cushion for the stem to protect the petals from transit shock. Vials containing a post harvest solution or water tubes are to be inserted to keep the flowers fresh for a long period. These are to be then transferred to plain printed cartons with each carton carrying around 5-10 flowering stems. The cartons are to be kept in a cold store where the temperature is maintained at around 8-12°C.before marketing.

Cymbidium hybrids, by virtue of their unique position in cut flowers trade, are expected to be in limelight with their demand growing more than that of other cut flowers. The State Governments, NGOs and other organizations of this region may take initiative in a well organized way to develop entrepreneurships using the favourable climate to grow cymbidiums This will help not only to strengthen the development of cymbidium industry in this region but also to improve the economical status of the local people.

## BIBLIOGRAPHY


1. Y. K. Aurora and A. Mukherji, *Ornamental Orchids of NorthEast India*. ICAR, Shillong, 1983.
2. A. S. Rao, *Orchids of India*, National Book Trust, New Delhi, 1979.
3. Y.Kumar and J Sharma, *J.Orch. Soc. Ind.*, **691**, 21-25,1984.

# CONDITION BASED MAINTENANCE SYSTEM

B. K. N. Rao

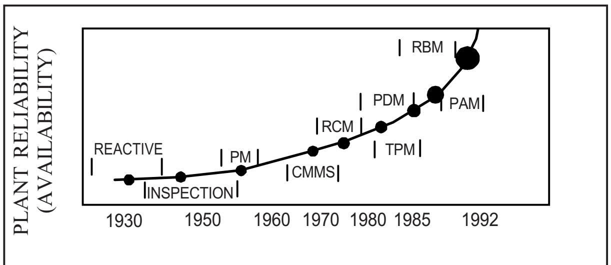
## BASIC TECHNOLOGY

Maintenance is now redefined as "a business function (and a profit centre) which manufactures capacity for production". In its new role, maintenance presents a great opportunity to improve productivity and quality and reduce cost of products.

The availability of equipment is very important for the production of quality products at low cost. A good maintenance system ensures the optimum availability of equipment. Conventionally, maintenance system are of three types :

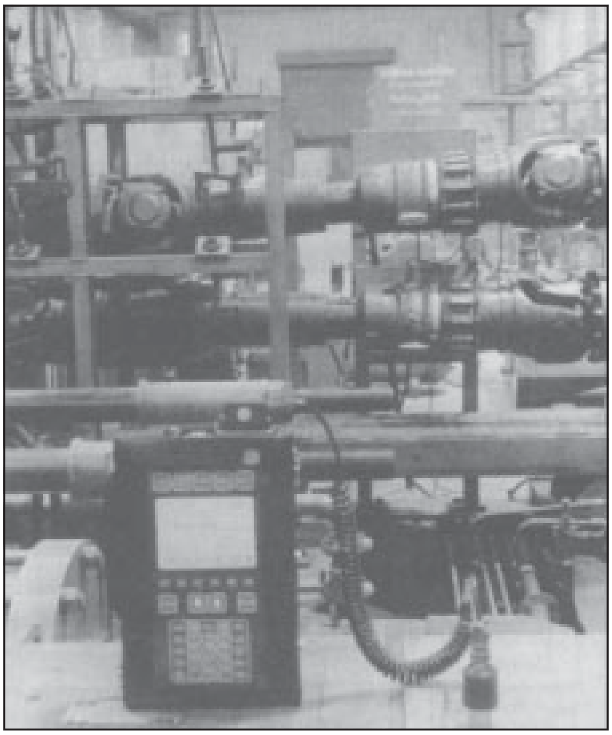
**Maintenance System**

Breakdown Maintenance (BDM) | Time Based Maintenance System (TBMS) | Condition Based Maintenance System (CBMS)




*PM : Preventive Maintenance : CMMS : Computerised Maintenance Management System; RCM : Reliability Centred Maintenance : TPM : Total Productive Maintenance : PDM : Predictive Maintenance : PAM : Pro-Active Maintenance. RBM : Reliability Based Maintenance*

*Fig. 1 : Maintenance practice Vs. reliability*



To meet the requirement of reliability and availability (Fig. 1), maintenance philosophy and practices have changed over last six decades. The need for containing the cost forced development of new strategies. Thus CBMS is increasingly being adopted for meeting the new objectives.

The Condition Based Maintenance System (CBMS) has been in vogue since 1951 in US Navy. Condition monitoring, among the SAIL plants, was first implemented in a systematic manner at BSL in the year 1989. Setting up an effective maintenance program using condition monitoring techniques boost the productivity of plant equipment by increasing its availability in two ways :

- avoiding unplanned shutdowns; and
- decreasing the time needed to make repairs.

'Condition Monitoring' is defined as the process

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of measuring, recording, trending and analysing specific machine parameters which are indicative of the machine-health. An effective condition monitoring programme is a systematic diagnostic approach consisting of :

- Detection
- Analysis
- Correction

The cycle chart for CBMS is shown in Fig. 2.

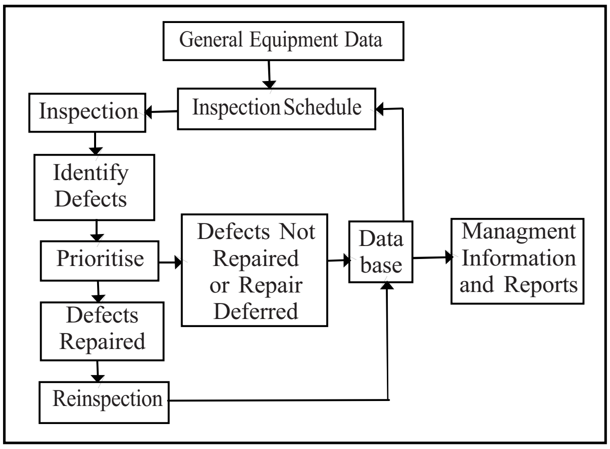


*Fig. 2 : Cycle chart for condition based monitoring system*

'Condition Based Maintenance', on its own or combined with TBMS, has been proved to minimise the cost of maintenance, improve operational safety and reduce the frequency and severity of in-service machine failures.

The basic purpose of condition monitoring is to know the deteriorating condition of a machine component well in advance of a breakdown for proactive maintenance. Common techniques used for condition monitoring are :

- Vibration Analysis
- Shock Pulse Measurement Analysis
- Wear Debris Analysis; and
- Thermography

## VIBRATION ANALYSIS

Each and every component of a rotating equipment emits vibration signals at distinct frequencies. The procedure for vibration analysis is to pick up the signals with the help of portable data collectors at site. The vibration data, analysed with the help of a dedicated software, indicate probable faults in machine components. Corrective actions are then taken to avoid failure.

## SHOCK PULSE MEASUREMENT ANALYSIS

'Shock Pulse Measurement (SPM)' are carried out in ball and roller bearings. Shock pulse are generated through mechanical impact due to irregularities in the surface of raceways and rolling element. The magnitude of shock pulse depends on impact velocity and are monitored to assess the condition prevalent in the bearing. Accordingly, maintenance work is undertaken at an appropriate time.

## WEAR DEBRIS ANALYSIS

In centralised lubrication and hydraulic systems, wear particles eroded out of the oil-wetted-machine-components normally exist as a separate phase and get dispersed in the fluid. Wear debris analysis is a diagnostic tool to study the oil-wetted-parts, without opening the machine, through the trending of size, shape, colour, texture and number of these wear particles. This is studied using ferrographic technique, spectrometric technique, rotary particle depositor and particle size analyser.

*Ferrography* is an analytical method to quantify and examine ferrous wear particles associated in lubricants and hydraulic fluids.

*Spectrometric Oil Analysis Procedure (SOAP)* is an analytical technique used for the determination of metallic contents present in lubricating oil.

In *Rotary Particle Depositor (RPD),* wear particles are deposited on a rotating glass substrate in presence of a powerful magnetic field and are observed in a microscope to characterise the wear mechanism.

*Particle Size Analyser* is based on laser diffraction principle. It measures the size and number of particles in lubricating oils and hydraulic fluids in centralised systems.

*Oil View Analyser Instrument* shows the condition of the lubricating oil in service in terms of wear, contaminant and change in chemistry by measuring the change in dielectric constant. This instrument also gives the presence of moisture level in ppm.

## THERMOGRAPHY

Thermography is a non-contact temperature measuring technique of producing pictures from infrared electromagnetic radiation emitted by objects.

The magnitude and distribution of temperatures as compared to its normal or acceptable range are often indicators of the plant's operational performance. The pictures (called thermograms) pinpoint the trouble spot and give an indication of areas of impending failure of mechanical/electrical components and refractory/insulating materials. The benefits of the technology include saving energy, protecting capital equipment investment, quick inspection and diagnosis and checking repair work. This technique is very good for monitoring high risk processes.

Potential application of thermography in steel plants include monitoring of refractory lining of BOF converter, mixer, ladle, blast furnace wall etc. The condition of boiler, heat treatment furnace, gear, shaft, motor connector, transformer, thyristor panel, circuit breaker etc. are also monitored through thermography.

## DEVELOPMENTAL TRENDS

### NEW INSTRUMENTS

- New instrument have been developed to diagnose faults in slow and variable speed, variable load machines and electrical equipment like motors, transformers, cable joints etc.
- On-line vibration monitoring systems have been developed to monitor very large number of points from a central station.
- Automatic oil analysing system can analyse eleven oil samples simultaneously for their contaminant levels. Other physical parameter assessment is used as a tool for conserving lubricant and prevent mechanical failures in oil-wetted-components.

### NEW COMPUTER AIDED TECHNIQUES

- Single condition monitoring technique is normally not adequate to identify the fault by itself in high speed rotating machines. Several CBMS techniques need to be adopted for reaching to the root cause of failure in any system. This task is simplified with the use of computer application software developed for expert systems through neural network.
- Computer image analysis is adopted for trending wear particles' shape, size, colour, texture and numbers for fault diagnosis.
- The new generation laser scanning systems based on advanced semi-conductor laser technology are being widely used for ultra-fast and accurate measurement of wear in the lining of BOF converters, ladles and tuyere bricks.
- Detection of beaks in centralised hydraulic systems and defects in large gear-boxes can be identified with the adoption of ultrasonic acoustic monitoring.

**STATUS OF CBMS IN INTEGRATED SAIL PLANTS**

| Plants | Techniques | Diagnostic Instruments | Applications |
|---|---|---|---|
| BSI, BSP, DSP & RSP | Vibration analysis | Vibration data collectors, Vibration analysers cum balancers, Strobe light, Motormonitor | Rotary machines, Induction motors |
| BSL, BSP & DSP | Shock pulse monitoring | Shock pulse meter, Analyser for polling element bearings | Ball and roller bearings, Lubrication starvation |
| BSP, RSP & DSP | Motor monitoring | Motor current monitor and related software | Motor cages, Bars, Insulation, Improper Alignment |
| BSL, BSP, RSP & DSP | Wear debris analysis | Analytical ferrograph unit, SOAP, Particle size analyser, Rotary particle depositor, Oil view analyser | Lubricants and hydraulic fluids in centralised systems, Transformer oil, Insulating oil, Transmission oil, hydraulic oil |
| BSP & BSL | Thermography | Thermovision camera, Thermal image analyser, Thermocouples, Infrared Pyrometer | Refractory lining, Furnace frames, Gas pipelines, Boiler tubes, High tension electrical joints |

## GLOSSARY

***Proactive Maintenance*** **:** A condition based maintenance technique emphasising the routine detection and correlation of root cause conditions that would otherwise lead to failure. Root cause such as high contaminants in lubricant, misalignment and imbalance of mechanical system are among the most critical ones.

***Contaminant*** **:** Any foreign or unwanted substance present in lubricant in a centralised lubrication system that can have an adverse effect on system operation, life and reliability.

***Strobe Light*** : Instrument used for balancing rotating machines.

***Saponification Value*** : Fat content in oil.

## SUGGESTED READINGS


1. Handbook of Condition Monitoring, edited by B. K. N. Rao, Elsevier Science Ltd., 1996.
2. NKk Technical Review–Special Issue on Diagnostic Technology, Issue No. 55, April 1989.
3. Mechanical Fault Diagnosis and Condition Monitoring by R. A. Collacott, Chapman & Hall, London, 1977.


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## SHORT COMMUNICATION

# WHAT SIZE SHOULD A BACTERIUM BE ?

D. Balasubramanian*

The sizes and shapes of animals, plants, and other life-forms have always been the subject of great interest and fascination. A dinosaur in the museum or an elephant in the zoo evoke awe in us; and humming-birds and ladybugs are cute to behold. Who is not pleasantly affected by a smiling infant ? This subject interested to Italian thinker, Galileo Galilei, who is better known for his telescope and his declaration that the earth moves around the sun. Galileo was intrigued about what would happen if an animal becomes bigger and bigger. The larger it gets, the more should be the gravitational pull on the animal. Beyond a particular size, an animal could become immobile. He reasoned that there could be no animal on earth weighing more than 100 tonnes. Anything beyond that and the animal would simply be crushed by the gravitational force of the earth. Of course, it could happily live in water thanks to the buoyancy that water offers. This is how whales can weigh 100 tons or more.

Galileo was essentially right in his argument. This problem has since been revisited by Dr D'Arcy Thompson, Dr J B S Haldane, Dr R Alexander and Dr K Schmidt-Nielsen. The most recent attempt was a few years ago by the Finnish physicist, J E I Hokkanens who analyzed the matter using the laws of elementary physics and the data available on land mammals and dinosaurs. His conclusion was essentially the same as that of Galileo.

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**HOW BIG CAN YOU BE ?**

A land animal needs to take care of a lot of mechanical problems with respect to its build, anatomy and motion. It needs to be supported on land by its legs. The load on the legs is essentially a function of the diameter of the supporting leg bones. In fact, the stress or the load increases as a square of the bone radius or diameter. On the other hand, the animal grows and becomes bigger in volume. The increase here will go as a cube of the body radius or the bone radius. These two factors– constant load and constant shape–conflict and impose a limit to the weight of the animal on land.

There is a whole branch of science connected with body sizes and shapes and the manner in which these increase or grow with age. These relationships are called allometry, that is, the proportional growth of body part with respect to the growth of the whole body itself. Allometry tells us about the bone strength, muscle strength and the ability of the body to handle gravitational pull. Hokkanen concludes that if an animal gets heavier than one thousand tons, it simply cannot move–if it attempts to move, it will break its bones and tear its muscles.

Of course, if it does not move and stay at one place, it is no longer an animal but more like a vegetable or a tree; we do know of trees of massive size. The world's largest living tree is a sequoioa tree, called the General Sherman at the Sequoioa National Park at California, USA. Sherman is 83 m tall, 25 m in girth and weighs a massive 6100 tons.

**HOW SMALL CAN YOU BE ?**

We could go to the other extreme and ask : how small can an organism be? That is equally fascinating because just as we are overawed by big sizes we are also tickled by miniatures; the smaller it is, the cuter. This is the age of microminiaturization and one is constantly fascinated and challenged by trying to make robots and self-contained systems that can be as small as possible.

As you shrink the size, we could probably go even lower than animals and ask how small can a bacterium be? A bacterium, with its single cell, has life just as an animal or a plant does. Is there a size limit that one can talk about for germs and cells? This question has caught the attention of Prof Arthur L Koch of the Department of Biology, Indiana University, Bloomington, Indiana, USA, who has written a fascinating review entitled "What size should a bacterium be? A question of scale" in the 1996 issue of the *Annual Review of Microbiology*. Prof Koch has been studying the general problem of the sizes, shape limitations, evolution and selection of bacteria for quite some time and has been a lonely sentinel in this area, publishing single-author papers in the area since 1959. His question carries new relevance these days when molecular biology can actually ask the question : if you were to create life *de novo*, what size should you make a cell?

One can right away dismiss a variety of considerations. What we are looking for is a completely self-sufficient living entity. A virus is not to be considered here, because it is not free living. It has to infect a "host" and use the machinery and resources of the latter in order to survive, pro-create and multiply. It can thus afford to be very small indeed; in fact, it can be as small as a nucleic acid molecule covered in a protein coat; this takes us down to a couple of hundred nanometers (a nanometer is a billionth of a meter or a millionth of a millimeter). People talk about yet another kind of particles called the prion which also has to infect, subvert and exploit its host for its business. (Prions became, notorious recently with the mad cow disease, Alzheimer's and Kuru.) Here too, the size is essentially molecular. Thus, a prion too is not really free living. Some even ask the question whether a virus or a prion is living at all!

In a sense one is reminded of what the poets Kabir and Subramanaya Bharati asked. How much land does a man need? Kabir said : "Six feet by three by three", since that is all one needs when he leaves the world. Bharatiyar took a more materialistic attitude when he said "*Kaani Nilam Vendum Parasakti......*" Not only did he want this bit of land but he also wanted other living beings around him—flowers, trees, birds and a wife. He did not want to be independent of others.

There is a point in this. As Koch says, no organisms in the world today exist as self-reproducing, free-living cells, completely independent of other organisms for help and resources. Self-sufficiency goes against compactness. The less you need from others, the bigger you have to be.

There are essential constraints to the size of a bacterium and these are physical, chemical, generational and other biological factors in nature. There are factors that would give a lower limit to the size. Some are advantageous and argue for a smaller size. A cell with a very high surface-to-volume ratio would be able to effectively take in material from outside and transport substances in and out efficiently (see why the lungs and intestines are so rich in alveoli and microvilli). Of all shapes, the one that offers the best surface area-to-volume ratio is the sphere or a ball. The surface area is proportional to the square of the radius while the volume is proportional to the cube of the radius. The area-to-volume ratio thus goes as the inverse of the radius. What this means is : as the size decreases or the radius becomes smaller, the area-to-volume ratio becomes better and better. It is also better to be very small since you will then be ignored and not eaten up by predators. Indeed, there are many cells that reduce their size when they switch over to resting stages, such as bacterial spores or what are called shut-down cells. In this state of limbo, the cell is alive but not growing; it is just dormant. There are other factors too that would argue against a large size; the diffusion of nutrients up to the cell, and of waste products to the outside of a cell are better facilitated with a smaller size.

**HOUSEKEEPING**

But there are other factors that would argue against shrinking the size indefinitely. Many of these have to do with housekeeping functions. A cell must have a sufficient set of information and instructions to get on with its life. There is thus a minimum size to its genome. Genes are needed to make the protein machinery–the proteins that make up the structural matter of which the cell is made, proteins that help in digesting food and to store the energy obtained thereby, proteins that aid in transporting materials across, and so on. If it has to be free-living and not virus-like, it needs to have the machinery that translates the genetic message into these proteins, namely the ribosomes.

A minimalist cell can cut down its genome and protein requirements to a spartan limit; yet, it would still need some mechanisms to protect itself from any outside danger that mutates or kills its genetic message. Error correction and repair machinery are vital if a cell were to live and leave descendants. That would add to its size. The proteins and enzymes can be more efficient, they could digest and turn over food faster. But that would add a new problem. The cell will be ever hungry and will have to keep on eating, to keep pace with its speed of digestion and energy consumption. (This is readily seen with small birds like a hummingbird or a sparrow. Their alimentary canal, stomach and intestines are rather small, but their digestive enzymes are just as efficient as ours. While the size of the morsel is small, its clearance is rapid. As a result, a humming-bird has to keep feeding every eight minutes. And it needs the energy in order to keep flying and not to be blown away by the wind, and to dart around at lightning speeds towards food and away from danger). Optimum is better than maximum; or the golden mean is the best policy.

How small a free-living organism can get is thus determined by several parameters. One is the amount of information that it should contain in its genes for housekeeping and free living. This is reflected in the size of the genome or the DNA that it should have. The catalytic efficiency of enzymes and the necessity for protein synthetic machinery are other factors. In addition, it must have machinery to cope with danger or catastrophe. This machinery would involve repair kits, the power to move quickly and, in extreme cases such as starvation, to possess the minimum shut-down set-up. All these would put a lower size limit to cells. The smallest single cell, free-living organisms that are known are roughly globular, no bigger than one-third of a micrometer in size.

On the other hand, there are limits on how large a cell become. It cannot becomes too large because the diffusion of nutrients up to the cell and within the cell should not become a problem. Likewise, the diffusion of waste products to the outside of the cell should also happen optimally. In addition, temperature could pose a limit in size. As the temperature increases, diffusion becomes faster, and as it decreases the movement of the molecules becomes slower. The viscosity inside the cell would also increase at low temperatures. But then, as the temperature decreases, the rates of metabolism and enzymatic reactions also decrease. Generally, as the temperature drops by 10°, the reactions slow down 2-3-fold. As a consequence and in balance, as Koch says, all other things being equal, an organism can be larger if it grows in a lower temperature environment, such as in Antarctica or on icy mountains. The largest free-living, single cellular organism known are almost 8 microns in size, with a volume of 400 cubic microns. In anthropological terms, these would be the Sumo wrestlers in the prokaryotic world, while the mini cells on the other extreme would be the dwarfs with whom Snow White was friendly.

# KNOW THY INSTITUTIONS


## CENTRE FOR APPLIED RESEARCH & DEVELOPMENT, NEYVELI LIGNITE CORPORATION LIMITED, NEYVELI, TAMIL NADU

**Centre for Applied Research & Development (CARD)** is the in-house R&D Centre of Neyveli Lignite Corporation Limited, a Miniratna Government of India enterprise involved in lignite mining (24 MT per annum) and power generation (2490 MW) situated at Neyveli, Tamil Nadu, 200 kms southwest of Chennai. This R&D Centre has been recognized by the Department of Science & Technology since 1975.

The testing facilities were upgraded under a project funded by United Nations Industrial Development Organization (UNIDO), Vienna during 1995 - 2000. The main objective was to strengthen CARD to improve its capability to provide analytical, monitoring, R&D and technology information services to industry and the Government. Under the project, services of national and international experts were utilized, sophisticated procured equipments were procured and combustion and gasification testing were established facilities.

The major functions of CARD are carrying out Science & Technology Projects (Ministry of Coal), In-house S&T Plan Projects, Pollution level measurements, Quality control Testing & Consultancy services, Pilot Plant studies based on R&D, Coordination of S&T projects taken by other NLC Units, Institutional services for students, Special studies for operation & new schemes etc.

CARD has a well-established analytical facility and is rendering analytical services towards quality control of various products/materials used in mines, power stations and other service units as well as outside agencies. The analytical testing facility includes lignite analytical, microbiology, material testing, metal testing, paint testing, general analytical, petrography etc. CARD is also having a full fledged environmental testing facility for monitoring air, water and soil. The sophisticated instruments available include ED-X-RAY Fluorescence Spectrometer, Elemental Analyzer, TGA/DTA, ICP, AAS, HPLIC, Anaerobic chamber, Fluorescence Microscope, Electrolytic respirometer, Trinocular Polarized microscope, Metallurgical Microscope etc. CARD facilities are utilized by other agencies like SAIL, BHEL, MECL, GSI, STCMS etc.

**RESEARCH & DEVELOPMENT**

CARD is carrying out various R&D works on lignite utilization, diversification, product development, by-product utilization, solid waste management, wasteland reclamation etc. For implementing these projects, CARD is associating with outside agencies like, IIT-Delhi, IITM-Chennai, CFRI-Dhanbad, TNAU-Coimbatore, BHEL-Trichy, Anna University, Madras University, Annamalai University, NIST-Thiruvananthapuram etc. Based on the R&D works, some of the processes have been scaled up to pilot plant scale. The projects taken up include Ministry of Coal funded R&D projects as well as in-House S&T funded projects.

*The major completed Ministry of Coal funded R&D projects are*

- Soil enrichment and reclamation of backfilled areas of Neyveli open cast mines
- Production of bio-fertilizer using lignite as a carrier material.
- Biological methods of employing VAM fungi and Nitrogen fixing bacteria in the restoration of Neyveli lignite mine spoils
- Utilization of fly ash in agriculture
- Bio technological conversion of Lignite to humic acid.
- Pond ash reclamation and possibilities of utilization of Industrial wastes for developing green cover.
- Field studies on the application of lignite humic acid and crop response in various agro climatic conditions.
- Bio processing of lignite and bioremediation of its sulphur rich wastes for development of environment-friendly value added products.
- Separation of marcasite from pulverized lignite using fluidized bed.
- Development of high performance high ways using fly ash composites.
- Development of a process for the production of activated carbon from Neyveli lignite.

*The major ongoing projects under Ministry of Coal / In-house funding are*

- Studies on the use of Bottom Slag in crop production
- Transforming NLC mine spoil into productive agricultural land through Eco-friendly integrated farming system
- Pilot study on environmental management and rehabilitation of mine spoil slopes of NLC
- Studies on renewable source of energy and utilization for environment friendly application
- Pilot plant feasibility studies for continuous production of various forms of potassium humate

- Development and use of fly ash based pesticides
- Survey and ecological conservation of NLC environment through bioremediation with tree species

**NEW PRODUCTS DEVELOPED**

CARD has developed a process for the production of humic acid from lignite. Humic acid helps to build up organic matter status in soil and is a plant growth stimulant. This process has been patented. By commercialization of this product, lignite will have a diversified utility in producing a value added product and thereby promoting agricultural growth in the country. Recently, CARD successfully completed a joint R&D project with National Institute of Interdisciplinary Science & Technology (NIST), Thiruvananthapuram, for development of a process for the production of activated carbon from Neyveli lignite. This is a novel method for production of activated carbon from lignite as it is generally prepared from coconut shell, palm kernel shell, wood chips and coal.

CARD is a member of Bureau of Indian Standards (BIS) for sampling of lignite/coal testing and utilization procedures and a member of Industrial Associateship Scheme - IITM, Chennai.

*For further information, please write to:*

Deputy General Manager

Centre for Applied Research & Development (CARD)

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# Conferences / Meetings / Symposia / Seminars

**National Symposium on Problems of Anaemia in India : Genetics and Environment, November 30-December 2, 2007, Ramkrishna Mission Seva Pratisthan, Vivekananda Institute of Medical Sciences, Kolkata.**

The Symposium will cover diverse topics like Epedemiology of inherited and deficiency anaemia, Role of environment and diet in causation, Methods of Study including molecular and genetic methodology, Recent advances in management and Treatments. Eminent scientists and medical teachers of national and international fame will address the issues. There will be workshop covering recent methodology of study. The Proceedings will be published in the Nucleus. The 3-day symposium is open to scientists, research workers, medical and paramedical workers. Contact : **Dr. Geeta Talukder,** Convener, E-mail geetatalukdar@hotmail.com,Dr. Madhusnata De, Organising Secretary, E-mail : madhusnata de@yahoo.com., Dr. Shila Chakraborty, Joint Secretary, E-mail : shilashila@rediffmail.com

**77th Annual Session of the National Academy of Sciences, India and Symposium on Novel Approaches for Food and Nutritional Security, December 6-8, 2007, Central Food Technological Research Institute, Mysore**

Presentation of papers in the symposium would only be through invitation. Papers would be accepted both for oral and poster presentation. Authors will be informed about the mode of presentation for which their papers have been selected. The decision of the Academy would be final for mode of presentation. Contact : **Prof. P. K. Seth,** General Secretary, The National Academy of Sciences, 5, Lajpatrai Road, Allahabad-211002. Phone : 91 532 2640224 ; Fax : 91532 2641183 ; E-mail : allahabad.nasi@gmail.com

**12th Carbohydrate Conference and Association of Carbohydrate Chemists and Technologies (India), December 13-15, 2007, National Institute of Pharmaceutical Education & Research (NIPER), Mohali (Punjab).**

The theme of the CARBO XXII will be "Carbohydrates : Chemistry, Biology and Industrial Applications". Contact **: Professor K. P. Ravindranathan Kartha,** Organizing Secretary, Dept. of Medicinal Chemistry, National Insitute of Pharmaceutical Education & Research (NIPER), Phase X, Sector 67, Mohali-1606062, Punjab ; Phone : 0172-2214682-87 ; Fax : 0172-2214692 ; E-mail : rkartha@nipper.ac.in

**3rd International Conference on "Fermented Foods, Health Status and Social Well-being" December 14-15, 2007, Anand Agricultural University, Anand, Gujrat State.**

The programme will include lead papers from experts on the technological, microbiological, nutritional and clinical aspects of various fermented foods in addition to the presentation (oral/poster) of a number of original research papers in the subject. There will be technical session on fermented (1) Probiotics in Dairy Foods, (2) Blended functional Foods, (4) Fermented Foods of North East India, Nepal and Bhutan, (5) Fermented Foods of SriLanka and Maldives (6) Fermented Foods : Clinical and nutritional aspects. An important part of the meeting will be devoted to group and panel discussions on clinical, sociological, safety, regulatory and marketing aspects of fermented foods. There will be a special forum for Food Industry involved in Functional Food business. Scientists, teachers & research scholars of food science and technology, practitioners from medical colleges, professionals concerned with community nutrition and social medicine, R & D Workers from food processing, dairy and allied industries and any body who is interested in application of fermented foods. Contact : **Dr. J. B. Prajapati,** (Coordinator), Dept. of Dairy Microbiology, SMC College of Dairy Science, Anand Agricultural University, Anand-388110, Gujrat, Phone : 91 2692 264170 ; Fax : 91 2692 261314; E-mail : prajapatijashbhai@yahoo.com or **Prof. Baboo M. Nair,** Dept. of Applied Nutrition, Land University, Sweden. Phone 46 462229634

E-mail ; Baboo_M.Nair@appliednutrition.lth.se

# S & T ACROSS THE WORLD

## DEVICE TO PREDIET HEART FAILURE

Melbourne based biotechnology company HD Medical Group Ltd. is progressing rapidly towards developing the first non-invasive heart failure prediction device, based on core technology licensed from the CSIRO's ICT Centre.

It is claimed that the device, known as the Viscope® has the potential to revolutionize the early detection and management of heart disease.

The technology is based on mechanical heart sound analysis for early detection of cardiac diseases. It is a method which, it is said, overcomes many of the limitations of current approaches which rely on echocardiography and stethoscopes.

In the US, clinical trials have already been held with favourable initial results while clinical results in Australia are expected to commence shortly.

Another step towards adoption of the technology is a proposal by HD Medical and Media Lab Asia to the government of India for use of this device as part of the initiative in rural telemedicine.

*(CSIRO Media Release, Jun. 19, 2007)*

## PSORIASIS DRUG

Bangalore based Sami Laboratories is conducting clinical trials for a plant based psoriasis drug on 300 human volunteers in leading Indian hospitals and will soon start trials in the USA and Australia.

Sami Labs plans to launch the drug in the domestic market in the next few months as soon as the regulatory clearances from the Drug Controller General of India (DGCI) are received. Single durg treatment options are not available at present to cure psoriasis, a non-contagious disease, affecting 120 million people worldwide.

Apart from psoriasis, Sami Labs is developing drugs of plant origin to cure cancer and lifestyle diseases. The company hopes to take at least two drug leads—on cancer and anti-obesity into the clinical trial stage very soon.

The R&D division of Sami Labs, with 100 scientists, is currently focusing on drug development for lifestyle diseases, and anti-inflammatory segment. An anti-obesity drug is under preclinical development stage. Probiotics and cosmeceuticals are also thrust areas of research.

The company has received 21 patents and another 18 are in the pipeline. Its products are mainly marketed in USA, Australia and Japan.

*(Chemical Weekly, Mar. 27, 2007)*

## THERAPY TO BLOCK CELL DEATH

Researchers at the Universities of Chicago and Cornell in USA report that compounds, which inhibit a group of enzymes called histone deacetylases (HDAC), can modulate gene expression, and in some cases produce cellular proteins that are actually neuro protective ; they are able to block the death of cells.

According to the researchers, the use of histone deacetylase inhibitors hold tremendous promise, but to be clinically useful, drugs will have to be designed that are able to distinguish between different types of histone deacetylase which can cause a variety of disorders, including Parkinson's disease, and even stroke.

*(Journal of Medicinal Chemistry, Jun. 13, 2007)*

## FUSION ENERGY

Researchers in Wisconsis University, USA, have come one step closer to harnessing fusion energy, by proving that the Helically Symmetric experiment (HSX), a curiously shaped magnetic plasma chamber called a stellarator, can overcome a major barrier in plasma research, by losing less energy.

Plasma is very hot, ionized gas, that can conduct electricity and essentially it is what stars are made of. If heated to the point of ignition, hydrogen ions could fuse into helium, the same reaction that powers the sun. This fusion could be clean, sustainable and provide a limitless source of energy.

Current plasma research builds on two types of magnetic plasma confinement devices, tokamaks and stellarators. The HSX aims to merge the best properties of both by giving a more stable stellarator the confinement of a more energy efficient tokamak.

Tokamaks, the current leader in the fusion race, are powered by plasma currents, which provide the magnetic field that confines the plasma, but they are prone to disruptions, which might even blow the reactor sized machine apart. Stellarators do not have currents and therefore they are not liable to disruptions, but they tend to lose energy at a high rate because of the external magnetic coils. The HSX is the first stellarator to use a quasi-symmetric magnetic field, and the energy loss is much less.

*(Chemical Weekly, Mar 27, 2007)*

# Recommendations of the 94th Indian Science Congress

- Energy conservation and efficient resource utilization are important for energy security.
- Cleaner technologies need to be developed.
- Coal meets 70% of our energy requirements today, and the scenario is not likely to change over the next two or three decades. Necessary resources are available in the country. To meet the demands, the coal industry needs to be deregulated.
- Management of water resources and promoting their sustainable use is the most challenging problem.
- A note is taken of the successful operation of the 1,00,000 liters/day Low Temperature Thermal Desalination (LTTD) plant at Kavaratti, Laksh Dweep since May 2005. This is the first plant of its kind anywhere in the world. LTTD can solve the potable water problem in the coastal areas of tropical regions. The concept can also be applied to make use of hot industrial waste water. Public-private partnership should be encouraged in this exciting new development.
- There is an urgent need to upgrade our weather forecasting systems with emphasis on monsoons, as it is the key for our food security.
- Dryland and rain fed agriculture deserve a special focus.
- Second green revolution needs to be more holistic and should extend application of Science & Technology to forest conservation & management
- Sustainable protection of environment should be emphasised.
- Links between green house gas emissions and climate change should be explored and its impact on monsoon patterns examined.
- Environment concerns must be integrated into the mainstream of all our economic policies and activity.
- Natural calamities like earthquakes, tsunamis, droughts, floods, cyclones etc. deserve special attention.
- Every time a damaging earthquake occurs, we are clueless. Study of earthquakes should be institutionalized. Recommendations to this effect have been made for past several decades, but some how this has not happened. Suitable micro zoning needs to be carried out and building codes need to be implemented, initially covering all major cities and gradually expanded to cover the entire country.
- Steel production should be stepped up. Present practice of exporting large quantities of iron ore should be discouraged.
- Over thousands of years, mining has been carried out at the surface in India. In spite of very powerful geophysical tools available for sub-surface investigations, these have not been properly implemented. As a matter of fact, India remains basically unexplored. Integration of appropriate geophysical techniques in our exploration for atomic minerals, metals, and fossil fuels is highly desirable.
- A three pronged strategy to improve the S&T scenario in India needs - (i) to raise the quality and number of trained individuals; (ii) to deepen

and widen the valorization of our science outputs; and (iii) to improve the quality of our environment.

- Geological Survey of India is one of the oldest and very important departments of country. It needs to be liberalized from bureaucracy and given a place of pride, and should rightfully become a part of the newly created Ministry of Earth Sciences.
- A center for Himalayan Glaciology and Ecology needs to be set up.
- Geology should be taught at the school level. Outreach programs to educate the common man about the steps to be taken to safe guard our Planet Earth need to be strengthened.
- Public education and understanding the environmental challenges we face are to be strengthened.
- Upgradation of universities for improving the standards of research has become an urgent need.
- In this Science Congress, several Institutions/ Organizations have been brought together as Knowledge Partners. This effort should continue and be strengthened to address Planet Earth related issues nationally and globally.

## ANSWERS TO "DO YOU KNOW ?"

A1. Maximum of 8 mm. diameter. Beyond this it must split up.

A2. Perhaps just about a teacup full of water.

A3. It moves rather flies about 250 times its body length per second.

A4. A few special kinds seem to like colourful flowers (eg. hibiscus) and leaves.

A5. Yes. Even dogs have problems distinguishing one from the other.

A6. Yes the Dolphin does. Its brain goes to rest one half at a time.

A7. From the Latin word 'Pencilium' which means a small tail.

भारतीय विज्ञान कांग्रेस संस्था
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## Terms of Membership and Privileges of Members :

Membership of the Association is open to persons with *Graduate or equivalent academic qualification* and interested in the advancement of science in India.

1. **Member :** A person willing to be enrolled as new Member has to pay an annual subscription of Rs. 200/- **along with an admission fee of Rs. 50/-** (for foreign* U.S. $70) only. The annual subscription of a Member shall become due on the 1st April of each year. Anyone who fails to pay the subscription on or before the *15th July* in any year shall lose the right of voting and / or holding any office of the Association for that year. A Member failing to pay the annual subscription by the end of March of the following year shall cease to be a Member.

   Members may contribute papers for presentation at the Science Congress. They will receive, free of cost, reprint of the Proceedings to Session of any one section of their interest and also the bi-monthly journal of the Association "Everyman's Science".

2. **Sessional Member :** Sessional members are those who join the Association for the Session only. A Sessional Member has to pay a subscription of Rs. 250/- (for foreign U.S. $60) only.

3. **Student Member :** A person studying at the under-graduate level may be enrolled as a Student Member provided his/her application be duly certified by the Principal/Head of the Department. A Student Member shall have the right to submit papers for presentation at the Session of the Congress of which he/she is a member, provided such papers be communicated through a Member, or an Honorary Member of the Association. He/she shall not have the right to vote or to hold any office. A Student Member shall not be eligible to participate in the Business meetings of the Sections and the General Body.

4. **Life Member :** A Member may compound all future annual subscriptions by paying a single sum of Rs. 2000/- (for foreign U.S. $ 500) only. Any person who has been continuously a member for 10 years or more, shall be allowed a reduction in the compounding fee of Rs. 50/- for every year of such membership, provided that the compounding fee shall not be less than Rs. 1,200/- (for foreign U.S. $ 12.50 and U.S $ 300 respectively). A Life Member shall have all the privileges of a member during his/her lifetime.

**Admission fee of Rs. 50/- is needed only for becoming a new annual member and not for sessional member / life member / Institutional member / student member / donor.*

5. **Institutional Member :** An Institution paying a subscription of Rs. 5,000/- (for foreign U.S. $ 2,500) only, can become an Institutional Member of the Association. It shall be eligible to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional Member shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also a copy of the Association's journal "Everyman's Science".

6. **Donor :** Any person paying a lump sum of Rs. 10,000/- (for foreign U.S. $5000) only, can become a Donor of the Assocaiation. An ***INDIVIDUAL DONOR*** shall have all the rights and privileges of a member during his/her lifetime. An Institution paying a lump of Rs. 50,000/- (for foreign U.S. $25,000) only, can become ***INSTITUTIONAL DONOR*** of the Association, which shall have the right to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional / Individual Donor shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress as also the Association's journal "Everyman's Science".

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A) **Presentation of Papers :** A copy of complete paper accompanied by an abstract in triplicate not exceeding one hundred words and not containing any diagram or formula, must reach the Sectional President General Secretary (Hqrs) Latest by *September 15*, each year.

B) Members of all categories are entitled to railway Concession of return ticket by the same route with such conditions as may be laid down by the Railway Board for travel to attend the Science Congress Session provided that their travelling expenses are not borne, even partly, by the Government (Central or State), Statutory Authority or an University or a City Corporation.

C) Members of all categories are entitled to reading facilities between 10.00 a.m. to 5.30 p.m. on all weekdays (except Saturdays & Sundays) in the library of the Association.

D) Members of all categories may use Guest House facilities, Lecture Hall hiring at the rates fixed by the Association from time to time.

Note : All Money Orders, Bank Drafts etc. should be drawn in favour of "*Treasurer, The Indian Science Congress Association*". Members are requested to mention their Card No. while making any correspondence to ISCA office.

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* (A Foreign Member means one who is normally resident outside India.)

# भारतीय विज्ञान कांग्रेस संस्था

14, ड० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

# THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

| | | | | | |
|---|---|---|---|---|---|
| Telegram | : | SCICONG : CALCUTTA | Fax | : | 91-33-2287-2551 |
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## APPLICATION FORM FOR MEMBERSHIP

To
The General Secretary
The Indian Science Congress Association
14, Dr. Biresh Guha Street,
Kolkata-700 017

Stamp
Size
Photograph

Dear Sir,

I like to be enrolled as a Member / Life Member / Donor / Sessional Member / Student Member / of The Indian Science Congress Association.

I am sending herewith an amount of Rs. ............... in payment of my subscription by Bank Draft / Money Order / Cash for Membership / Life Membership Subscription / from the year 1st April 200 ...... to 31st March 200 ......

I am interested in the following section (Please tick any one).

## SECTIONS

1. Agriculture and Forestry Sciences
2. Animal, Veterinary and Fishery Sciences
3. Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)
4. Chemical Sciences
5. Earth System Sciences
6. Engineering Sciences
7. Environmental Sciences
8. Information and Communication Science & Technology (including Computer Sciences)
9. Materials Science.
10. Mathematical Sciences (including Statistics)
11. Medical Sciences (including Physiology)
12. New Biology (including Bio-Chemistry, Biophysics & Molecular Biology and Biotechnology)
13. Physical Sciences
14. Plant Sciences

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(Please type or fillup in Block Letters)

Name (in block letters) : ____________ ____________ ____________
SURNAME FIRST NAME MIDDLE NAME

Academic Qualifications :
(Evidence to be submitted)

Designation :

Address for Communication :
(including State, City/Town and Pin code)

Phone No. & e-mail

Permanent Address :

Yours faithfully

Date : Signature

- *As per resolution of Executive Committee in its meeting held on October 10, 2004 application for membership of ISCA in 'Care of' of some other person is generally discouraged. However, if in the application form "care of" address is given then there should be also signature of the person in whose name "care of" is given.*
- *Admission fee of Rs. 50/- is needed only for becoming a new annual member and not for sessional member / life member / Institutional member / student member / donor.*

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