



Science Horizon

ODISHA BIGYAN ACADEMY

4TH YEAR

2ND ISSUE

FEBRUARY 2014



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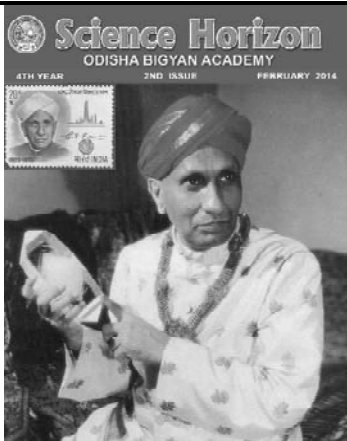
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The Cover Page depicts : Sir Chandrasekhara Venkata Raman

Cover Design : Sanatan Rout

EDITORIAL

SCIENCE AND FRONTIERS OF REASON

When the country is awake in paying tribute to the legacy of Sir C. V. Raman for his nobel prize winning discovery of Raman effect on 28th February 1928 and Celebrating National Science Day on 28th February every year since 1987, for reminding its younger generation to draw inspiration from this spectacular scientific achievement; it is an appropriate occasion to reflect upon Science; its scope and its limits. This is because; vast majority of people do not understand scientific principles, even though science has invaded our lives, our language and our religion in a major way. Science remains a sort of magic or miracle for many, since it impinges on our lives, not at the intellectual level but practically through the many marvels of technology only.

Science represents one of the great systems of human thought; which is based on human reasoning. Careful experimentations, systematic observations, thorough analysis, leading to formulations of theoretical models to connect observations and experiences centering on certain ideas or events pertaining to the physical world; constitute the hallmarks of scientific methodology. By this process; possible regularities, subtle order or hidden patterns in the observed set of data are sought, which hopefully reveal the fundamental laws according to which matter and forces in nature behave.

Language of mathematics and logic provide the pathway not only to enforce human reason and rationality in such scientific enquiry; but also to provide quantitative exactitude and reliability to the arrived inferences. Any scientific theory, model or inference; however successful it may be in certain domain of observation and experiences; if found unsuitable and inadequate in the face of new evidences or in an extended domain of investigation; it becomes imperative on the part of scientific culture to rectify this inadequacy by improving or generalizing the theoretical formulation. Similarly any idea pertaining to physical world imagined or borrowed from any other traditional systems of thought is unbiasedly pursued and examined but never suo-moto rejected outright in science, until unless its falsity is established by rigorous mathematical logic. Therefore a true scientific culture calls for not only the spirit of enquiry with childlike curiosity, but also an open mindedness with strict honesty and integrity in character; an attitude of preparedness to

adopt self-corrective measures for continuous upgradation of ideas and explanations. In this process science has developed its capability of creating an exact and reliable knowledge base that has empowered the human society to gain control over many physical systems in our environment.

Scientific quest is a continuous journey into the unknown; an ever unfinished intellectual enterprise which, at each step of its advance; brings new and unexpected discoveries to challenge the mind and intellect with very difficult and unusual concepts. However underlying all these challenges runs the familiar thread of rationality and order which science so far has been successful to exploit. Science, at its formative stages upto 19th century, was mostly guided by rigid classical logic based on common-sense. This so-called classical science, with a mechanical world-view, helped us to make sense of the world in an objective and methodical manner. It generated the technology that brought industrial revolution. Twentieth century found new evidences in atomic realms contradicting our common-sense logic in a major way. In the face of this challenge; science grew up to be young and spirited by crossing the rigid boundary of classical logic and by broadening the horizon of human reason with subtle intuitive thinking to accommodate these new phenomena in atomic realms. This gave rise to the so called modern science centering around 'Quantum Theory' and 'Relativity' that ushered in many marvels of modern high technology.

In course of its advancements with dazzling success, science has also realized through (i) Heisenberg's uncertainty, (ii) Einstein's Relativity and (iii) Kurt Godel's undecidability; some fundamental limits, which may forbid it to arrive at all the truths that exist in nature. Therefore in the process of pursuing science it is very likely that uncertainty and mystery would be encountered. In all probability at some stage, reasoning may fail; which may require other routes to knowledge, such as mysticism or revelation. This would bypass or transcend human reason. But till then human reasoning should be pursued through science as far as possible in exploring the frontiers of reason and rationality. Science should continue its march on its way to maturity to attain not only enough knowledge but also wisdom, if possible.

Prof. Niranjan Barik

THE MYSTERY OF BLUE SEA AND THE RAMAN EFFECT

Dr. Abhay Kumar Mahanta

The Blue Mystery

It was early Sept., 1921. The British ship named S.S. Narkunda was sailing through the Mediterranean Sea towards Bombay (Now Mumbai) harbour. Onboard a young professor of Calcutta University, sitting calm and quiet, was curiously looking at the deep blue water of the sea. He was very much excited by the optical illusion of the blue sea. Several questions were perplexing in his mind. Why does the sea look blue? Water doesn't have any colour but the sea with huge quantity of water appears blue. Is it because of the reflection of the blue sky as Professor Rayleigh, explained? or Is there any interaction between sunlight and the water molecules? Could something else be the reason? The other day, weather changed. The sky got cloudy but the colour of the sea didn't change. It still remained blue. He confronted Professor Rayleigh's explanation that says: the dark blue of deep sea has nothing to do with the colour of the water but simply the reflection of the blue sky. No, something else is



Fig.1: The blue sky and the sea (the insert is the ship S.S.Narkunda sailing in Mediterranean Sea).

happening here. He guessed, the colour of the sea could have some analogy with the Rayleigh scattering which explained why the sky is blue.

According to Rayleigh, the sky is blue because of elastic scattering of sunlight by the molecules present in air, wherein scattered light intensity is inversely proportional to the fourth power of the wavelength of the incident light. The blue colour having lower wavelength scattered in all directions with greater intensity as compared to other colours (green, yellow, red, etc) making the sky blue. Inspired with Rayleigh scattering concept, he went to the deck of the ship, took out a small Nicol prism and a pocket telescope he had with him. With these optical gadgets, he conducted a series of experiments to explore the blue mystery of the Mediterranean sea during his fifteen-day long sea voyage and convinced himself in no time that the blue colour of the sea was independent of reflection of the blue sky as originally thought by Professor Rayleigh. He discovered that water molecules could also scatter the sunlight just like air molecules. He noted down all the observations made out of his experiments and soon after the ship docked in Mumbai port on Sept. 26, 1921, he telegraphed a letter to the editor of the journal "Nature" entitled "The colour of the sea" explaining the light scattering of the water molecules could be the probable reason for the blue colour of the sea rather than the

refection of the blue sky as previously thought by Rayleigh. The young professor was none other than the brilliant Indian physicist Chandrasekhar Venkata Raman popularly known as Sir C.V.Raman.

The Raman Effect

The simple observations during the maiden sea voyage inspired the young Raman to pursue more detailed studies on light scattering. On returning to Indian Association for Cultivation of Science (IACC), Calcutta, Raman started serious research on this subject. He passed the light beam in a number of liquids and studied its effects. In 1922, he wrote a brilliant essay entitled "The Molecular Diffraction of Light". It was during 1923, Professor Compton discovered that when X-ray was passed through graphite, a small fraction of emergent beam had wavelengths different from the incident one due to inelastic scattering of X-rays by the electrons. This discovery known as Compton Effect earned Nobel Prize in physics in 1927. This was the turning point for Professor Raman. He intuited, if Compton inelastic scattering was true, then it could be true for light beam as well. Taking inspiration from Compton Effect, Raman started research to find out similar effect of light beams as that of X-rays. After a series of experimentations and detailed deliberations, on Feb.28, 1928, he and his colleague, K.S.Krishnan, established that when a monochromatic light (single colour, say wavelength λ) passed through a liquid, a small fraction (1×10^{-7}) of scattered light had different

colours (i.e. $\lambda \pm \lambda_1$) than the incident light. It was shifted to both higher and lower wavelengths. The higher wavelength line ($\lambda + \lambda_1$) is called Raman-Stokes line and the lower one ($\lambda - \lambda_1$) is called Raman anti-Stokes line. This discovery, widely known as Raman Effect, had a great impact on the scientist fraternity and created a sensation around the world. Many scientists world over including the most famous scientists like Neils Bohr, Louis de Broglie, and Lord Rutherford sensed the importance of Raman Effect and recommended it for prestigious Nobel Prize. In 1930, C.V.Raman became the first person from Asia to be awarded the Nobel Prize in physics. In 1954, Govt. of India bestowed on him, Bharat Ratna, the highest honour of the land. In 1986, it was decided by the Govt. of India that Feb. 28, the day on which Raman discovered this effect, be celebrated as "National Science Day" all over the country to commemorate the discovery of Raman Effect, one of the greatest discoveries of nineteenth century.

The Applications of Raman Effect

Soon after the discovery, Raman Effect had a catalytic effect in research worldwide. During the period between 1930 to 1942, approximately 2500 chemical compounds were studied and around 1800 research papers were published on various aspects of Raman Effect. It became a technique of choice for studying the structure and composition of materials. However, after World War-II, it lost its flavour mainly due to its weak excitation light source which gives feeble Raman signals and replaced by simple complementary

Infrared (IR) technique. Coincidentally, in 1942, the British ship S.S. Narkunda, which led to the discovery of Raman Effect, was sunk by German's bombers. Raman technique got back its wings only after the discovery of LASER (Light Amplification by Stimulated Emission of Radiation) in 1960. Subsequently, many advanced versions of Raman Spectroscopy like Resonance Raman Spectroscopy (Raman peak intensity 10^6X), Surface Enhanced Raman Spectroscopy (Raman peak intensity 10^{14} - $10^{15}X$), Tip-Enhanced Raman Spectroscopy, Spatially-offset Raman Spectroscopy (SORS), etc. were developed. Surface Enhanced Raman Spectroscopy (SERS) was developed in 1974 by Fleischmann, Hendra, and Mcquillan of the University of Southampton (UK). Thereafter, Raman technique became a powerful and indispensable analytical tool for many scientific researches. It has been successfully used in many areas of science like biology, medicine, pharmaceuticals, cosmetics, polymers, explosives, forensic, mining, mineralogy, and many more. Off late, Raman imaging is evolving as a potentially more safer and sensitive cancer diagnostic tool with extraordinary precision to detect even a microscopic cancer tumors. Recently, scientists have developed a device called Raman Scanner. It can be pointed at a substance to tell what it is. Police have started using this scanner to find out if people are carrying any banned substances.

Conclusion

To achieve the highest international honour for the work entirely carried out in India was indeed incredible. Raman was a genius, a

determined, and single-minded scientist who never deviated from his goal in any adversity. He had the courage and conviction to sail through the stormy weather. Raman's life and work is an excellent example of passion, determination, devotion, and audacity to pursue science. It has been inspiring and will continue to inspire the young scientists worldwide throughout the age. A tree was planted in the lawn of Raman Research Institute in memory of Sir C.V. Raman (known as Raman tree) and coincidentally, it blooms in the month of February as India celebrates the "National Science Day" to pay tribute to this great legendary scientist.



Fig.2: Raman tree in bloom at Raman Research Institute, Bangalore

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HOW SAFE IS NUCLEAR POWER

Dr. Brundaban Chandra Padhi

India has targeted production of 700000 Mega watts of electric power by 2030. Out of this 592000 M.W will be thermal power and 84000 M.W. Hydro power. After the Nuclear agreement with U.S.A., India expects to produce 63000 M.W. of Nuclear power in the next 20 years.

At present there are 432 Nuclear power plants in 29 countries, America has 104, Canada 18, Mexico 2, France 58, Britain 19, Germany 17, Sweden 10, Russia 32, Spain 8, Romania 1, Ukraine 15, Pakistan 3, Japan 54, South Korea 20, and India 20. By 2030 the target is another 90 plants.

India proposes to have 40 Nuclear plants by 2030. 17 projects are working. (15 with indigenous technology and two with Russian assistance) 16 new projects under 12th five year plan will be constructed at a cost of Rs23000/- crores. Out of this 8 will be 700 M.W. Heavy water plants and another 8 Light water plants.

As per clause 123 of Indo-US agreement India will import Light water reactors from USA. As a result the Nuclear plants lying idle in USA will find their way to India. As per the agreement India has to purchase Uranium also from USA. But there is no guarantee for continuous fuel supply. There is no permission for disposal of by-product Plutonium. India has no power to withdraw from the agreement and in case of accident there is no assurance of full compensation.

India has developed its own technology for installation of 270 M.W. and 500 M.W.

Nuclear plants and management of emergency measures in these small project is easier.

Nuclear power is certainly a viably unlimited and alternative source of energy; which was believed to be safe till the 1st accident occurred at Chernobyl in Russia on 2nd July 1984. All the four reactors of the plant exploded and radiation spread over 30 kms area, 32 died and more than 200 fell sick. After Chernobyl; there were ten more nuclear accidents with loss of life and property. But no serious attention was paid till the Fukusima accident on 11th March 2011, when a 8.9 intensity earth quake hit the Japan coast and subsequent Tsunami destroying Sendai city inhabited by 10 lakh people. 33 ft high waves swept over Sendai city and destroyed Fukusima Daichii nuclear plant. 15846 died, 10000 went missing and more than 5 lakhs rendered homeless. Many Ships and four trains disappeared and 21 kms of the sea shore destroyed. The intensity of the quake was equivalent to 8000 Hiroshima Bombs. The ground developed 448 Kms long crack and Japan island was pushed 8ft to the east. Even with four stage control measures; the plant was totally destroyed spreading radiation over 60 kms area. The total loss is estimated at 15900 crore dollars. Reconstruction may take more than 40 years.

After the Fukushima Daichii accident most nations changed their nuclear policy. Japan decided to close all the Nuclear power plants by 2030, Germany by 2020 and Switzerland by 2034. France who gets 70% of power from its nuclear power plants decided

to reduce it to 50%. USA decided to reduce dependence on nuclear power from 65% to 4%. The USA has not constructed any new plants after three mile island accident in 1979.

When most of the nations are closing down their nuclear plants; India, China and Pakistan are contemplating setting up new Nuclear power plants, China is constructing 43 new nuclear power plants in 16 provinces. Pakistan has established two reactors with Chinese assistance. Survey has been completed for constructing six more reactors and has earmarked 350 billion dollars. India is going to setup 16 reactors eight heavy water and eight light water reactors. On completion, nuclear power production will go upto 10080 M.Ws.

With assistance of Rosotam of Russia, India is building five reactors at Kudankulam in Tamil Nadu to produce 4000 M.W of power. The project was expected to be completed by 2008, then it was extended upto 2010 and lastly by April 2013 but it was still incomplete. It has been learnt that the valves supplied by Geo Podolask of Russia were found to be defective due to nepotism by the Chief of Geo. Due to fitting of defective Valves, plants constructed in India, China, Bulgaria and Iran are still non-functional. The Kudankulam plant is also not Tsunami proof. Experts opined that international Atomic Energy experts should examine the details of construction work before the plant is made functional.

The nuclear power plant constructed at Jaitapur in Maharashtra by French firm Ariva consists of 6 units of 1650 M.W. each. The power plant complex will be setup at a cost of two lakh crore and will destroy vast tracts of fertile land. The famous Alphanso Mango

orchards will be totally destroyed. The hot water generated will heat the river and lake water destroying aquatic life resulting in climate change and more heat. Bio-diversity of the Konkan Bay will be destroyed. Besides Arivas's Evolutionary Pressurised reactors are new technology never tried elsewhere making it a highly risky proposition. This area has power plants producing more than 15680 M.W. In addition there are three Bauxite mining plants in operation. According to Dr. E. L. Prasanna, former power Secretary, Jaitapur is situated in the west-east fault line and prone to earth quakes.

Famous Nuclear Scientist V.K. Krishna Iyar has cautioned our Prime Minister about the disastrous consequences of nuclear agreement with U.S.A. Dr Iyer went to Moscow to discuss about establishment of nuclear reactors, he vehemently opposed purchase of reactors and even asked to supply large graveyards along with nuclear plants. The Supreme Court of India has warned Govt. that if there is any lapse in safety of nuclear plants they will order their closure. Dr. A.S. Prasad past Director of Bhava nuclear project has warned that by the 123 agreement America is contemplating to stop our dependence on our own resources and self-sufficiency. According to Dr. P. K. Aiyangar, Chief of nuclear energy commission of India, our leaders are giving Importance to import of Uranium fuel instead of establishing our own nuclear plants and utilising our own resources. According to former Director of Nuclear Power corporation of India Dr. A. Gopalkrishna India has committed a great blunder and consequences may be very grave. Gopal Krishnan has written

several letters to our Prime Minister about the grave consequences of the nuclear agreement.

Our Prime Minister on his recent visit to U.S.A. in Sept. 2013 has finalised new agreement for setting up nuclear plants at Kovada in Andhra Pradesh and Mitthi Viridi in Gujrat without calling for tender with General Electric and Westing House. GE9 Economic Simplified Boiling water reactor and Westing House's AP1000 Pressurised light water reactors are also new technology and never tested anywhere. It seems India has become a testing ground for new and dangerous technology by the West.

Nuclear power plants need vast tracts of land about 30000 acres per 1000M.Ws. As such more than 221akh acres of fertile land will go waste for production of 63800 M.Ws of nuclear energy even though the production cost is very high. In case of Heavy water plants it is about 12 to 13 crores per MW (per Watt 60 to 80 rupees). In case of Light water reactors the cost will be Rs.50 per watt of power produced. The cost of producing 63860 M.W. nuclear power will be about Rs.819000 crores. Further the life span of a Nuclear power plant is about 60 years. In USA, license is given for 40 years and after full assessment license is renewed for another 20 years. So for production of 63000 MWs of nuclear power in 60 years India has to spend a colossal sum of Rs.819000 crores. Thus the nuclear power plants are very costly needing vast tracts of fertile land and thereby destroying agriculture. In case of accident, radiation will spread to hundreds of kms lasting more than half a century and affecting our future generation also.

India has more land than necessary to meet the energy needs of the country as per Australian scientists. For Solar projects, land requirement, much less than thermal, hydro-electric and nuclear projects. For every river valley project; 31340 persons are displaced and 8748 Hectres of land gets submerged. For every MW of thermal power, the land requirement is 4 to 5 acres and for nuclear projects 35 acres per MW. Similarly land is needed for coal mines, dumping yards, Ash ponds, waste water ponds, housing projects, market complex etc. But for Photo Voltic projects much less land is needed. For conventional Solar projects 500 sq ft of land is needed for every 2 KW of power produced. But in case of Solar trees for every 2 KWs, only 5 sq ft of land is needed. Further the vacant land in between can be utilised for grazing and vegetables cultivation. As per solar scientist Atul Chaksi if solar pannels are installed on 425 million house tops, the energy produced will be equivalent to 1900 MWs. As per Hira Mitavachan and Jayaram Srinivas of Indian Institute of Science, Bangalore, 4.1% of our uncultivated land can be utilised for production of 3400 MW of solar power by 2070. But installation of Roof top solar project, and Solar tree can reduce our land requirement to 3.1%.

It is high time our leaders and administrators realize the grave consequences of American diplomacy in subverting India's Independent nuclear power programme and making us totally dependant on USA. We should oppose the heinous conspiracy of the United States and strive for nuclear free world.

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SOLAR PHOTOVOLTAIC PUMPS

Prof. Bishnu Prasad Behera
Prof. Manoj Kumar Ghosal

Solar energy, with its virtually infinite potential and free availability, represents a non-polluting and inexhaustible energy source which can be harnessed to meet the energy needs of mankind in a major way. The high cost and reduced availability of fossil fuels and the public concern about the safety of nuclear reactors as a potential power source have led to a surge of interest in the utilization of solar energy. The sun gives an average energy input of 6kW-h/day for each square meter of the surface of the earth it shines upon. It depends upon solar intensity, spectrum, incident angle and cloudiness as a function of time. Water pumping by solar power is a concept which has won widespread interest since the early seventies. Solar energy can be utilized to operate pumps, utilizing either the thermal or light part of the solar radiation. The operation of solar powered pumps is more economical and has less environmental impact than pumps powered by an internal combustion engine and electricity. Solar pumps are useful where grid electricity is unavailable in remote areas. Solar pump system is comparatively cost effective because of the free availability of solar energy.

Photovoltaic Power Generation

Photovoltaic cells frequently referred to as solar cells, convert the light part of the

solar spectrum (sunlight) into electricity. They are the most rapidly expanding energy sources in the world. Cost reduction has been the main concern in solar cell manufacturing in recent years. Large scale manufacturer of photovoltaic are expected to make photovoltaic cells within the affordability limits of the rural people, where electricity is not available in the remote areas.

Solar Cells

The solar cells are made of various materials and with different structures in order to reduce the cost and achieve maximum efficiency. There are various types of solar cell materials like the single crystal, poly crystalline and amorphous silicon, compound thin film material, and other semi conductor absorbing layer which give highly efficient cells for specialized application. The solar cell operates on the principle of the photovoltaic effect by the creation of charge carrier within a material by the absorption of energy from the incident solar radiation. The solar cell is made of two thin layers of a semi-conductor material appropriately doped with impurity atoms so as to give one layer a negative electrical bias (n-bias) and the other a positive bias (p-bias). Sunlight falling on the cell reaches the junction between the two layers in the form of photons of energy, and

knocks the electrons across the junction. This results in the development of a potential difference across the two layers. Direct current (DC) electricity can be drawn across the two layers through an external circuit. Silicon is the most commonly used material for making solar cells. Other materials include Cadmium Sulphide and Gallium Arsenide. Crystalline silicon cells are most popular, though they are expensive. The amorphous silicon thin film solar cells are less expensive. The fabrication of the solar cell involves starting from the growth and characterization of basic silicon material in water form, followed by junction formation, contact fabrication and anti-reflection coating on the active surface of the cell. The outer surface of the panel is protected by a special tempered glass which provides high transmittance of sunlight. The efficiency of solar cells in converting incident solar energy into electrical energy depends on the illumination spectrum intensity, materials of construction and design of the cell, atmospheric temperature and dustiness of the sky. Dust free atmosphere and low day temperature lead to higher efficiency of solar cells.

A solar cell behaves like a low voltage (0.5 volt) battery whose charge is continuously replenished at a rate proportional to the incident solar radiation. By connecting such cells into series/parallel configuration results in photovoltaic modules or solar arrays with high current and voltages. The power developed by a solar array ranges

from 80 to 120 watts per square meter of panel. The photovoltaic power can be utilized to operate conventional electrical appliances, including DC electric motors. The solar array is mounted on a simple frame which has provision for adjusting the array manually against the position of the sun. The angle of the array may be changed, if required.

Photovoltaic pumps

The solar pump unit consists of a solar array, a direct current electric motor and a pumping unit (Fig.1). The other components are the electrical control and some mechanism for tracking the array against the sun. Two types of pumping sets are used with

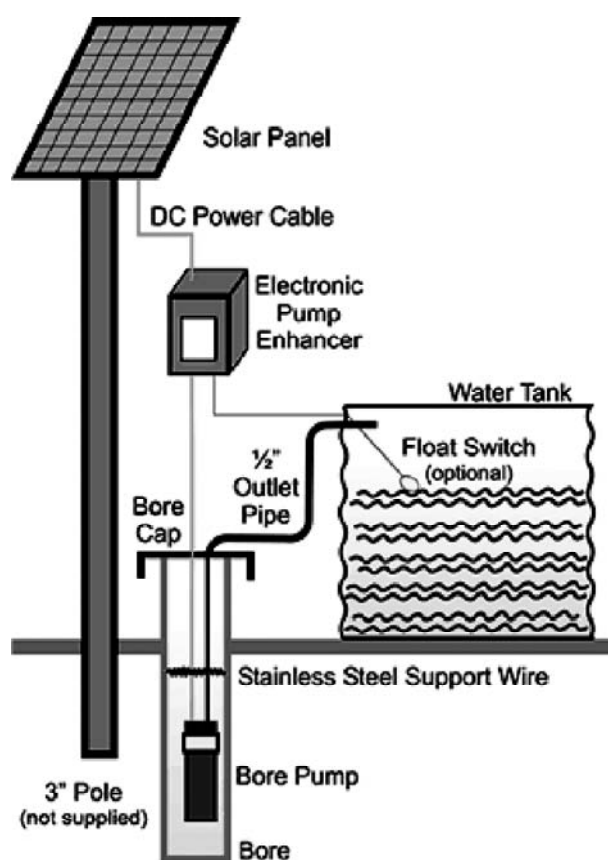


Fig.1. Line sketch of SPV pumps

photovoltaic systems, a vertical centrifugal pump coupled to a submersible DC electric motor, or an ordinary volute centrifugal pump close coupled to a horizontal DC electric motor. However, the submersible pump unit is more suitable for the photovoltaic system. The submersible pump is made leak proof by a silicon carbide mechanical seal. In case a volute pump is used, care is taken to limit the pump suction within about 4.5m, to maintain a high level of pump efficiency.

The output of the solar array varies with the intensity of the incoming radiation and other factors. Hence, it is necessary to match a variable speed DC motor with the panel output. There is considerable commercial interest in manufacturing photovoltaic powered pumping sets. The power output of the system is directly proportional to the number of solar cells and the surface area of the panel exposed to the sun. The array has to be tracked 3 or 4 times daily to orient it to the sun. It requires shadow free area for installation of solar panel. The discharge of a solar pump from 1800 watts DC centrifugal pump varies from 6 to 8 liters per second at a head of 5m. This could irrigate about 1.5 to 2ha of land with crops having moderate irrigation requirements. The system can be used for agriculture and livestock. Solar water pumps may be especially useful in small scale or community based irrigation, as large scale irrigation requires large volumes of water.

Solar PV water pumping systems (Fig.2) are used for irrigation and drinking water in India. The majority of the pumps are fitted with a 200-3000 watt motor, powered with 1800 Wp PV array which can deliver about 140,000 liters of water/day from a total head of 10 meters.



Fig.2. Photovoltaic pumps with solar array

Advantages of SPV pumping systems

- i) It is cost effective, more reliable as compared to the conventional systems.
- ii) SPV systems depend upon solar energy, which is free gift of nature.
- iii) The operation and maintenance is very low, popular for remote rural areas.
- iv) This provides greater energy security by using local resource-sunlight.
- v) SPV systems are modular in nature and can be easily transported and easily expandable to enhance the capacity.
- vi) It is most energy efficient and one of the energy conservation programs.
- vii) This system can be coupled with drip irrigation for water conservation.

viii) The use of sunlight as a source of fuel leads to clean, eco-friendly and decentralized generation of energy, which saves the fossil fuel, controls deforestation and prevents environmental pollution.

Maintenance of Photovoltaic Systems

The solar panel is expected to provide about 20 years of satisfactory service under normal conditions, even though the cell itself may last much longer. The only maintenance requirement is occasional washing of the surface to maintain maximum optical transmission through the glass. If an individual cell of an array is damaged, the same can be replaced without disturbing the array. The panel has to be protected from breakage by external agencies. Some manufacturers cover the cell/array with unbreakable glass. The motor and the pump require the usual periodic maintenance like cleaning, lubrication and replacement of worn parts.

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NUCLEAR MEDICINES

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Radio Pharmaceuticals

A Radiopharmaceutical product is a Special Radiochemical formulation of adequate purity and Pharmaceutical safty, suitable for oral or intravenous administration to humans for performing a diagnostic test or treatment. This branch of medicine is known as "NUCLEAR MEDICINE". Radiopharmaceuticals are "Open Source" Radio-Isotope products in the form of solutions, capsules or injections.

Radio-Isotopes used in Radiopharmaceuticals

Diagnostic radiopharmaceuticals employ radio-nucleides emitting photons, preferably of 100-200 Kev energy and minimal or no high LET (Linear Energy Transfer) particulate radiations. Positron emitters form a separate class of radio Isotopes used in positron emission tomography. Some immensely used diagnostic radionucleides are ^{51}Cr , $^{52/59}\text{Fe}$, ^{67}Ga , $^{81\text{m}}\text{Kr}$, ^{82}Rb , $^{99\text{m}}\text{Tc}$, ^{111}In , ^{133}Xe , ^{169}Yb , ^{195}M , ^{198}Au & ^{201}Tl . The Radio Isotopes used in therapy are mostly β -emitters such as ^{32}P , ^{89}Sr , ^{90}Y , ^{131}I , ^{153}Sm , ^{166}Ho , ^{177}Lu & ^{198}Au .

Radiopharmaceuticals are classified basing on the nature of formulation.

A landmark in the Nuclear medicine occurred in the year 1946, when a thyroid cancer patient's treatment with radioactive iodine (^{131}I) resulted in complete cure of the

disease. In the year 1950's wide spread clinical use of Nuclear medicine took place for measuring the function of the thyroid & diagnosis of the disease for the treatment of patient with hyper-thyroidism.

The advances in counting & computing systems, availability of variety of radionuclides have aided the phenomenal growth of Nuclear Medicine. A major break through in this area has been the advent of computed Tomography (CT) & positron emission Tomography (PET) which are presently the effective tool for diagnosis of the disease. Today there are approximately 100 nuclear medicine imaging procedures which provide informations about almost every organ system.

Radio-Isotopes are tagged to vast variety of chemicals, which can be selected so that it is targeted to the body organ to be studied. Since the chemical is localized in the targeted organ; it depends upon the localization and on the special function of the organ as well as or the amount of blood flowing to it. By this means, not only the anatomy or structure of the organ, but also the function & physiology of the system is evaluated. If there is any anatomical defect this will be detected by Radio Pharmaceuticals (Radio Isotopes tagged on special chemicals).

Hence Nuclear medicine works as a double edged knife. Now a days it is an integral part of the patient's care and extremely valuable for early diagnosis, treatment & prevention of numerous medical conditions.

Uses of Radio Isotopes (half life indicated)

Molybdenum - 99 (^{99}Mo , 66h) is used as the 'parent' in a generator to produce Technetium-99(m) in a metastable state. Technetium-99(m) with half life of 6 hours ($^{99\text{m}}\text{Tc}$, 6h) is used for imaging the skeleton & heart muscle, as well as for brain, thyroid, lungs (perfusion & ventilation), liver, spleen, kidney, gall bladder, bone marrow, salivary, heart blood pool, infection & numerous specialized medical studies.

Chromium - 51 (^{51}Cr , 23d) is used to label red blood cells & quantify gastro - intestinal protein loss.

Cobalt - 60 (^{60}Co , 10.5 mth) was formerly used for external beam radiotherapy.

Copper - 64 (^{64}Cu , 13h) is used to study genetic diseases affecting copper metabolism, such as Wilson's & Menke's diseases.

Iodine - 125 (^{125}I , 60d) is used in Cancer brachytherapy (prostate & brain), also to diagnostically evaluate the filtration rate of kidneys & to diagnose deep vein thrombosis in the leg. It is also widely used in radioimmuno-assays to show the presence of hormones in tiny quantities.

Iodine - 131 (^{131}I , 8d) is widely used in treating thyroid cancer & in imaging the thyroid. It is also used for diagnosis of abnormal liver function, renal (kidney) blood flow & urinary tract obstruction.

Selenium - 75 (^{75}Se , 120d) is used in the form of seleno-methionine to study the production of digestive enzymes.

Sodium - 24 (^{24}Na , 15h) is used for studies of electrolytes within the body.

Strontium - 89 (50d) is very effective in reducing the pain of prostate & bone cancer. It is a beta emitter.

Xenon - 133 (5d) is used for pulmonary (lung) ventilation studies.

Radio isotopes of calcium, gold & ruthenium are also used in brachytherapy. These are known as Reactor Radio Isotopes.

Isotopes such as Carbon - 11 (^{11}C), Nitrogen - 13 (^{13}N), Oxygen - 15 (^{15}O), Fluorine - 18 (^{18}F). are positron emitters which are used in PET for studying brain physiology & pathology, in particular for localising epileptic studies. They also have a significant role in cardiology. F-18 (^{18}F) in FDG has become very important in detection of cancers and the monitoring of progress in their treatment, using PET. Cobalt - ^{57}Co , 272d). is used as a marker to estimate organ size. It is also used for in-vitro diagnostic kits.

Iodine - 123 (^{123}I , 13h) is being increasingly used for diagnosis of thyroid function. It is a gamma emitter .

Strontium - 92 (^{92}Sr , 25d) is used as a parent in a generator to produce Rb-82.

Thallium - 201 (^{201}Tl , 73h) is used for diagnosis of coronary artery disease, other heart conditions such as heart muscle death & for location of low-grade lymphomas.

These are known as cyclotron Radio Isotopes.



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THE UNSEEN INTERIOR OF THE GLOBE

Dr. R. N. Mishra

Our Globe as we know of

It is a common knowledge that our globe, i.e. the planet Earth, has been taken reverentially as the plinth of our standing on and as such, classically has been treated as the first database of all the wisdom from time immemorial. The visible surface was traditionally thought as a habitable flat ground, centre of the revolving Sun in the 'Geocentric Concept' of the yore enunciated by Plato (429 - 347 B.C.) and others. It was later accepted as a spheroid revolving round the Sun as propounded by Copernicus (1473-1543 A.D.) in his famous 'Heliocentric Concept'. The surface features of Earth studied as a subject of Geography [Geo=Earth+ graphics= Visuals] had to remain confined to the uppermost hard shell of the Globe.

Today of course, the very clear satellite pictures of the planet do no longer warrant any further proof for its recognised globular outfit. The exterior having been established with unmistakable identity, the probable interior of the Earth being an inaccessible region, has yet remained dependant upon scientific evidences to be gathered from the science of Geology [Geo = Earth + logos = Study] and its allied sciences combined with their perfect understandings and interpretations. Scientific appreciation of the Earth's internal structure

is based upon observations of topography and bathymetry, observations of rock in outcrop, samples brought to the surface from greater depths by volcanic activity, analysis of the seismic waves that pass through the Earth, measurements of the gravity field of the Earth, and experiments with crystalline solids at pressures and temperatures characteristic of the Earth's deep interior.

The important clues are :

- The overall density of the Earth is much higher than the density of the rocks we find in the crust. This tells us that the inside must be made of something much denser than rock.
- Meteorites (created at the same time as the Earth, 4.6 billion years ago) have been analysed. The most common type is called chondrite which contain iron, silicon, magnesium and oxygen where as others contain iron and nickel. A meteorite has roughly the same density as the whole earth. A meteorite minus its iron has a density roughly the same as Mantle rock (e.g. the mineral called olivine).
- Iron and Nickel are both dense and magnetic. Scientists can follow the path of seismic waves from earthquakes as they travel through the Earth. The inner core of the Earth appears to be solid whilst the outer core is liquid (S-Waves or Transverse Waves do not travel through liquids). The mantle is mainly solid as it is under extreme pressure. It is known that the mantle rocks are under extreme pressure, so much so that diamond

is formed from carbon deposits and is created in rocks of kimberlite type that come from depths of 150-300 Km, squeezed under massive pressures.

The Earth is a sphere (as is the scotch egg!) with a diameter of about 12,700 Km. As one goes deeper and deeper into the earth, the temperature and pressure rise. The core temperature is believed to be an incredible 5,000-6,000°C.

The crust is very thin, (average thickness being 20 Km). This does not sound very thin but if one were to imagine the Earth as a football, the crust would be about 0.5 millimetre thick. The thinnest parts are under the oceans (Oceanic Crust) and extends to a depth of roughly 10 Km. The thickest parts are the continents (Continental Crust), which extend down to 35 Km on average. The continental crust in The Himalayas is estimated to be some 75 Km deep.

The mantle is the layer beneath the crust which extends about half way to the centre. It is made up of solid rock which behaves like an extremely viscous liquid, possibly due to the confined and heavy supra-incumbent pressure due to the solidified crust of the periphery. The convection of heat from the centre of the Earth is what ultimately drives the movement of the tectonic plates and cause mountains to rise and subterranean troughs to get structured out on the crust.

The outer core is the layer beneath the mantle. It is made of liquid iron and nickel

eutectic melt, commonly known as the NiFe. Complex convection currents within this fused NiFe zone, give rise to a dynamo effect with the differential angular velocity of Earth's diurnal rotation between the core and the crust (core much faster than the crust); which is ultimately responsible for the Earth's permanent magnetic field.

The inner core is the final bit in the middle. It is made of solid iron and nickel and many indirect inferences in the present day, points finger to this ultimate core as a hyper-massive and possibly unitary super-gigantic crystal of NiFe. Temperatures in the core are thought to be in the region of 5,000-6,000°C and its solidity is comprehended as due to a mixed combination of pressure-temperature parameters, non-comparable to any other thing yet in the Solar System.

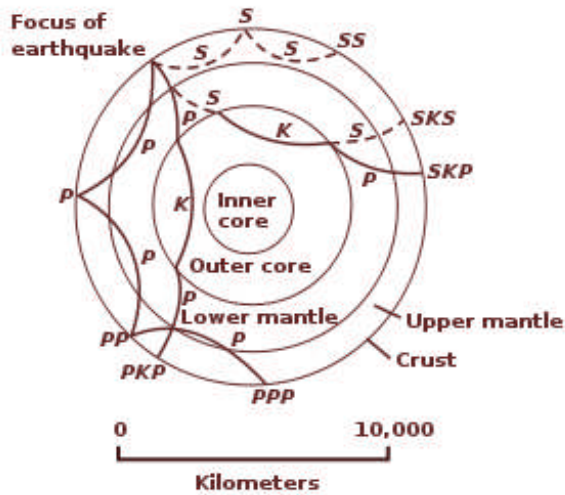
Internal Structure of the Earth

The structure of Earth can be defined in two ways; by physical & mechanical properties such as rheology, or the overall chemical characteristics. Mechanically, it can be divided into lithosphere, asthenosphere, mesospheric mantle, outer core, and the inner core. The interior of the earth is divided into 5 important layers. Chemically, Earth can be divided into the crust, upper mantle, lower mantle, outer core, and inner core. The geological component layers of Earth are at the following depths below the surface; vide Table-1.

Table 1: Structural Pattern

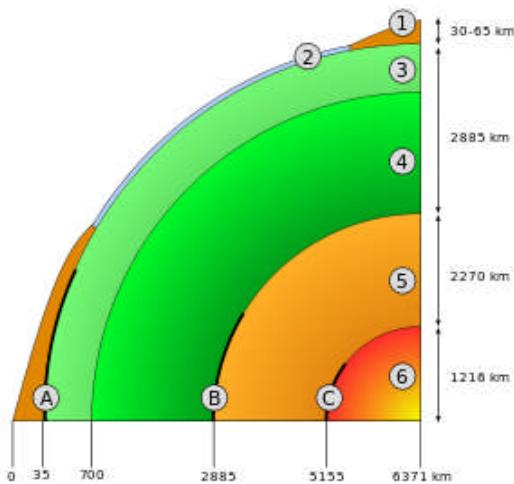
Depth in Kilometres	Overall Details of the Layers
0-60	Lithosphere (locally varies between 5 and 200 km)
0-35	Crust (locally varies between 5 and 70 km)
35-60	Uppermost part of mantle
35-2,890	Mantle
100-200	Asthenosphere
35-660	Upper Mesosphere (upper mantle)
660-2,890	Lower Mesosphere (lower mantle)
2,890-5,150	Outer Core
5,150-6,360	Inner Core

The layering of Earth has been inferred indirectly using the time of travel of refracted and reflected seismic waves created by earthquakes. The core does not allow Shear waves (S- and SS-Waves) to pass through it, while the speed of travel (seismic velocity) is different in different layers. The change in seismic velocity between different layers causes refraction obeying Snell's law. Reflections are also caused by a large increase in seismic velocity and are similar to light reflecting from a mirror. It is worthy of mention that, of the more Penetrating waves (P-, K- and SKP-Waves), K-Waves, which are waves of Mixed Characteristics (though in Simple Harmonic Motion) do penetrate into the Outer Core, keeping the apprehended solid Inner Core completely unpenetrated.



Mapping the interior of the Earth with earthquake

Geological specialities of Earth's Internal Layers



Schematic view of the interior of Earth. 1. continental crust, 2. oceanic crust, 3. upper mantle, 4. lower mantle, 5. outer core, 6. inner core

A: Mohorovicic discontinuity, B: Gutenberg Discontinuity & C: Lehmann-Bullen discontinuity

Core

The average density of Earth is 5.515 Kg/m^3 . Since the average density of surface material is only around $3,000 \text{ Kg/m}^3$, we must conclude that denser materials exist within Earth's core. Further evidence for the high density core comes from the study of seismology.

Seismic measurements show that the core is divided into two parts, a solid inner core with a radius of $\sim 1,220 \text{ Km}$ and a liquid outer core extending beyond it to a radius of $\sim 3,400 \text{ Km}$. The solid inner core was discovered in 1936 by Inge Lehmann and is generally believed to be composed primarily of iron and some nickel. In early stages of Earth's formation about 4.5 billion (4.5×10^9) years ago, melting would have caused denser substances to sink toward the center in a process called planetary differentiation while less-dense materials would have migrated to the crust. The core is thus believed to be largely composed of iron (80%), along with nickel and one or more light elements, whereas other dense elements, such as lead and uranium, either are too rare to be significant or tend to bind to lighter elements and thus remain in the crust (see felsic materials). Some have argued that the inner core may be in the form of a single iron crystal.

Under laboratory conditions a sample of iron nickel alloy was subjected to the core-like pressures by gripping it in a vice between 2 diamond tips, and then heating to approximately $4,000 \text{ K}$. The sample was observed with X-rays, and strongly supported the theory that the earth's inner core was made of giant crystals running north to south. The boundary with the Outer Core is called as the Lehman-Bullen Discontinuity.

The liquid outer core surrounds the inner core and is believed to be composed of iron mixed with nickel and trace amounts of lighter elements. Recent speculation suggests that the innermost part of the core is enriched in gold, platinum and other siderophile elements.

The matter that comprises Earth is connected in fundamental ways to matter of certain chondrite meteorites, and to matter of outer portion of the Sun. There is good reason to believe that Earth is, very much like a chondrite meteorite. Beginning as early as 1940, scientists, including Francis Birch, built geophysics upon the premise that Earth is like ordinary chondrites, the most common type of meteorite observed impacting Earth, while totally ignoring another, albeit less abundant type, called enstatite chondrites. The principal difference between the two meteorite types is that enstatite chondrites formed under circumstances of extremely limited available oxygen, leading to certain normally oxyphile elements existing either partially or wholly in the alloy portion that corresponds to the core of Earth.

Dynamo theory suggests that convection in the outer core, combined with the Coriolis effect, gives rise to Earth's magnetic field. The solid inner core is too hot to hold a permanent magnetic field (see Curie temperature) but probably acts to stabilize the magnetic field generated by the liquid outer core. The average magnetic field strength in the Earth's outer core is estimated to be 25 Gauss, 50 times stronger than the magnetic field at the surface.

Recent evidence has suggested that the inner core of Earth may rotate slightly faster than the rest of the planet. In August 2005 a team of geophysicists announced in the journal *Science* that, according to their estimates, Earth's inner core rotates approximately 0.3 to 0.5 degrees per year relative to the rotation of the surface.

The current scientific explanation for the Earth's temperature gradient is a combination of heat left over from the planet's initial formation, decay of radioactive elements, and freezing of the inner core.

Mantle

The core-Mantle Boundary is known as Gutenberg Discontinuity. Earth's mantle extends to a depth of 2,890 km, making it the thickest layer of the Earth. The pressure, at the bottom of the mantle, is ~140 GPa (1.4 Matm). The mantle is composed of silicate rocks that are rich in iron and magnesium relative to the overlying crust. Although solid, the high temperatures within the mantle cause the silicate material to be sufficiently ductile that it can flow on very long timescales. Convection of the mantle is expressed at the surface through the motions of tectonic plates. The melting point and viscosity of a substance depends on the pressure it is under. As there is intense and increasing pressure as one travels deeper into the mantle, the lower part of the mantle flows less easily than does the upper mantle (chemical changes within the mantle may also be important). The viscosity of the mantle ranges between 10^{21} and 10^{24} Poise, depending on depth. In comparison, the viscosity of water is approximately 10^{-3} Poise and that of pitch is 10^7 Poise.

Crust

The crust ranges from 5-70 km in depth and is the outermost layer. The thin parts are the oceanic crust, which underlie the ocean basins (5-10 km) and are composed of dense (mafic) iron magnesium silicate igneous

rocks, like basalt. The thicker crust is continental crust, which is less dense and composed of (felsic) sodium potassium aluminium silicate rocks, like granite. The rocks of the crust fall into two major categories - Sial and Sima (Suess, 1831-1914). It is estimated that Sima starts about 11 Km below the Conrad discontinuity (a second order discontinuity). The uppermost mantle together with the crust constitutes the lithosphere. The crust-mantle boundary occurs as two physically different events. First, there is a discontinuity in the seismic velocity, which is known as the Mohorovicic discontinuity or Moho. The cause of the Moho is thought to be a change in rock composition from rocks containing plagioclase feldspar (above) to rocks that contain no feldspars (below). Second, in oceanic crust, there is a chemical discontinuity between ultramafic cumulates and tectonized harzburgites, which has been observed from deep parts of the oceanic crust that have been obducted onto the continental crust and preserved as ophiolite sequences.

Many rocks now making up Earth's crust formed less than 100 million (1×10^8) years ago; however, the oldest known mineral grains are 4.4 billion (4.4×10^9) years old, indicating that Earth has had a solid crust for at least that long.

Physical Layering [Rheological]

Because of variations in temperature and in pressure, the materials inside the earth vary in their physical properties with depth.

Inner Core is the central part of the iron-nickel core. It is a solid iron sphere. The reason is that the pressure at the center of the

earth is significantly higher than the pressure above, while the temperature is only slightly higher. While higher temperature would tend to melt materials, higher pressures tend to create solids.

Outer Core constitutes the remainder of the iron-nickel core and is liquid. It is comprehended to be in a liquid state because the overall pressure is lower.

Mesosphere : The majority of the mantle matter from the core-mantle boundary is solid and is called the mesosphere.

Asthenosphere : Nearer to the surface of the earth the temperature is still relatively high but the pressure is greatly reduced. This creates a situation where the mantle is partially melted. The asthenosphere is a plastic solid in that it flows over time.

Lithosphere: Above the asthenosphere, the temperature begins to drop more rapidly. This creates a layer of cool, rigid rock called the lithosphere. The lithosphere includes the uppermost part of the mantle and it also includes all of the crust. That is, the crust is the upper part of the lithosphere, and the upper mantle is the lower part of the lithosphere. The lithosphere can be deemed as the "float" on the plastic solid state of the asthenosphere.

Compositional Layering [Chemical]

The chemical layering of the earth formed as part of the earth's differentiation - resulting from the heat generated during the process of planetary accretion. As a general rule, denser materials settled to the center of the earth, leaving lighter materials on top.

Thus, the earth consists of successive layers of material getting less dense as you approach the surface. The major compositional layers are:

Core is made of iron with minor amounts of nickel, and lies at the center of the earth, while Mantle is made of iron-magnesium silicates and surrounds the core. The mantle, critically appreciating, makes up the bulk of the global body, viz. the planet Earth. Crust occurs as two distinct types, oceanic crust and continental crust. Both types of crust are lighter (less dense) and contain more silica than the mantle. Oceanic crust is the crust that underlies most of the areas we call "oceans". It is thinner, more dense, and contains less silica and aluminum and more magnesium and iron than continental crust. The lack of silica makes it darker than continental crust. Because Continental crust is thicker and made of less dense material than the oceanic crust, it "floats" higher on the earth.

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CONQUEST OF PHAILIN

Sri Nikunja Bihari Sahu

Phailin, the strongest cyclone to hit India in the last 14 years since the Super-cyclone of 1999, was one of the finest tropical storms like a Sapphire (true to its original meaning in Thai) that rocked the coastal belts of Odisha with Ganjam district bearing the brunt of aggression. The storm had a very interesting course of development ever since its origin in the far sea that acquired immense popularity amongst people like never before as it unfolded over the Odisha coast.

The system was first noticed as a tropical depression on October 4 within the Gulf of Thailand. Over the next few days, it moved westwards and passed over the Malay Peninsula before moving out of the Western Pacific Basin on October 6. It emerged into the Andaman Sea during the next day and moved West of the North-West direction into a favourable environment for further development. The Indian Meteorological Department (IMD) on October 9 reported that the system had been consolidated further to become a Deep Depression. The system subsequently passed over the Andaman islands into the Bay of Bengal to be rapidly reorganized into a Cyclonic Storm named as Phailin. Phailin intensified further to be recognised as a category-1 Hurricane on the Saffir-Simpson Hurricane Wind Scale (SSHWS) early on

October 10 with a clear Eye feature developing which the IMD termed as a Very Severe Cyclonic storm. The system continues to grow at brisk pace and acquired category-5 Hurricane rank with wind speeds reaching upto 260 km/h. It continued its journey towards the Indian coast and subsequently made landfall on October 12 near Gopalpur on Odisha coast between 8.30 P.M. to 9.30 P.M. as a very severe Cyclonic Storm. As the storm moved inland, wind speeds picked up from 100 km/h to 200 km/h within 30 minutes and ravaged the city of Berhampur, (the closest place to the point of landfall) with gale winds and heavy rainfall. It moved North-West and caused large scale destruction to human habitats all along its path. Eventually, it got weakened over the land before being last observed over Jharkhand on October 14 as a well marked area of low pressure. In spite of all its awesome strength Phailin fell short of the situation of the Super-cyclone of 1999 when the storm laid stationary over the coastal region for nearly 24 hours causing a much higher scale of devastation with a sea surge of nearly 30 feet.

The destruction caused by Phailin was immense affecting lives and livelihoods of millions of people. The cyclone has devastated homes in coastal villages uprooting trees and tearing down power and communication lines and knocking out road and rail links. A storm surge of nearly 10 ft high had inundated coastal

areas. In coastal towns, shop signs and other debris were pitched high in the air by storm gusts and elaborate decorations for Durga Puja were strewn away with the Puja fervour completely lost. The cyclone has prompted India's biggest ever evacuation drive with more than 3 lakhs people moving up from the coastal villages of Odisha to safer places. A cargo ship with 20 crew on board sank during the storm off the coast of West Bengal. The cyclone continues its assault and left its footprints in the neighbouring state of Jharkhand too during its dying hours. Heavy rainfall in the upper tracts of many rivers caused flash flood marooning people in the coastal districts of Odisha. The storm has indeed left people in the coastal districts scared and scarred.

Given the vast devastation as described above, the huge strength of the storm can be easily understood. The secret to its enormous prowess lies on a basic property of Water. Water, unlike all other liquids, has a high Latent Heat of vaporisation which is essentially the heat released when water in gaseous state changes its form to liquid state as a result of condensation. This value for water is 2.5×10^6 J/kg in contrast to other liquids like Ammonia: 1.2×10^6 J/kg, Propane: 4.2×10^5 J/kg, Ether: 3.9×10^5 J/kg, Carbon tetrachloride: 2.2×10^5 J/kg.

The storm has its humble beginning as a small twister over the far seas as the sunrays heat up water producing mass of warm and moist air. Sometimes, the moist air mass lay

stationary as a huge cloud over the sea surface without dispersing out which is highly unstable in nature that eventually becomes the cradle for the storm. Further heating causes streams of air rising up within the moist air cloud creating a low pressure region there. Surrounding mass of moist air rushes into the region that curves around due to the Earth's spin. On reaching the low pressure centre, the mass of moist air rises upward and expands suddenly into the higher atmosphere getting cooled. The cooling triggers condensation of millions of water vapour present in the moist air releasing a huge quantity of heat to the surrounding due to the high Latent heat of water. This evaporates more amount of moist air from the sea surface that feeds and fuels the storm and keeps it raging for weeks with wind speeds reaching as high as 300 km/h. Although the common name for such storms is Hurricanes, these are named as Typhoons in the Pacific and Cyclones in the Bay of Bengal. The word Cyclone is actually a Greek word that means coil of a Snake which was first used by a British meteorologist to refer to small depressions created over the Bay of Bengal. Eventually, the storm heads towards the land and appears as a killer to be reckoned with. But on reaching the land, it quickly subsides as no moist air is available to keep its cyclic process going. Before that, it had caused widespread damage to life and property.

Like many other natural calamities, a Cyclone cannot be prevented with the present day technology. But early warning of the impending disaster with accurate meteorological inputs can bolster the preparedness of the people to face the challenge, thus lessening the scale of devastation. The pre and post management of Phailin by the Govt. of Odisha is a good example and should be a torch bearer in this direction. We need to learn many lessons from our Phailin experience. Firstly, as the storm hits hard the power sector in particular which is the key to all other spheres of development, electric transmission cables should be laid underground to ensure minimal damage to the network during the disaster and early restoration of the power supply. Secondly, the storm is generally fed by a huge mass of moist air collected from the vast expanse of the sea (which in case of Phailin was half the size of India) and this water is abruptly released on land creating flood. Hence, we should be fully prepared to deal with the flood situation in the aftermath of the storm. Lastly, stringent action should be taken against unscrupulous traders and hoarders to ensure availability of essential commodities to people at reasonable prices before and after the storm.



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IRON AND STEEL MAKING PROCESS

Er Mayadhar Swain

Iron and steel are important infrastructure materials for the growth and development of a nation. India ranks fifth in the world in production of iron and steel. Iron was even used in prehistoric times. It was produced by melting iron ore in hearths. Not only iron was hugely used in India, but its metallurgy was also praiseworthy. Some of its finest examples are Delhi's "Iron Pillar" and the so called "Damascus Sword".

Production Process

Iron and steel are produced in a number of processes starting from iron ore and ending at finished steel products. The different stages are: (1) Iron ore preparation, (2) Coke making, (3) Iron making, (4) Steel making, (5) Casting (ingot or continuous) and (6) Rolling and finishing.

1. Iron Ore Preparation

Pure iron is not readily available since it easily oxidizes in the presence of air and moisture. It is available in the form of oxides. These are reduced in blast furnace to make iron. Iron oxides can come to the blast furnace plant in the form of raw ore, pellets or sinter.

The raw ore is removed from the earth and sized into pieces that range from 0.5 to 1.5 inches. This ore is either Hematite (Fe_2O_3) or Magnetite (Fe_3O_4) and the iron content ranges from 50% to 70%. This iron rich ore can be charged directly into a blast furnace without any further processing.

Iron ore that contains lower iron content must be processed to increase its iron content. Pellets are produced from this lower iron content ore. The ore is crushed and ground into powder so the waste material called gangue can be removed. The remaining iron-rich powder is rolled into balls and fired in a furnace to produce strong, marble-sized pellets that contain 60% to 65% iron. Pellet plants are generally established near iron ore mine.

Sinter is produced from fine raw ore, small coke, sand-sized limestone and numerous other steel plant waste materials (mostly iron dust from the blast furnace and iron oxide scales from the rolling mills) that contain some iron. These fine materials are proportioned to obtain desired product chemistry and then mixed together. The raw material mix is then heated (1300°C to 1400°C) to form larger size pieces that are from 0.5 to 2.0 inches. Before charging to blast furnace, these are cooled to below 200°C .

2. Coke Making

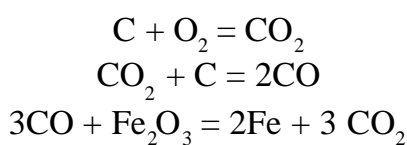
The coke is produced from a mixture of coals. The coal is crushed and ground into powder and then charged into an oven called "Coke oven battery". As the oven is heated, the coal is cooked and most of the volatile matters such as oil and tar are removed. The cooked coal, called coke, is removed from the oven after 18 to 24 hours of reaction time. The coke is cooled and screened into pieces ranging from one inch to four inches. The

coke contains 90% to 93% carbon, some ash and sulphur. 1000 kg of coal usually yields 750 - 800 kg of coke.

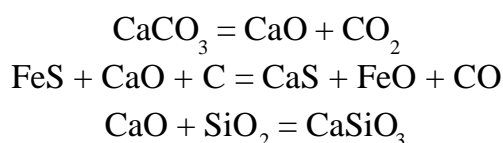
Coke is used in the blast furnace as a fuel and as the reducing agent. Therefore, coke manufacturing is done as part of an integrated steel works activities.

3. Iron making

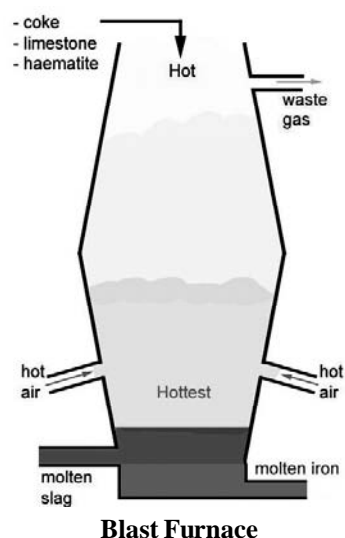
Iron is produced in blast furnace. Iron ore, pellets, sinters, coke and limestone are charged into the blast furnace and coke is ignited by hot blast and immediately reacts to generate heat. Iron is produced from iron oxide by reduction. The chemical reactions are



Carbon monoxide formed from the reaction of carbon and oxygen is a reducing agent, because it is more reactive than iron. Limestone (Calcium Carbonate) decomposes forming calcium oxide. This is a fluxing agent and combined with impurities to make slag.



The CaSiO_3 and CaS become part of the slag (waste). Other impurities such as Alumina (Al_2O_3), Magnesia (MgO) or Calcia (CaO) also form part of slag. The liquid slag floats on top of the liquid iron since it is less dense. The liquid iron and slag are tapped off through tap holes at the base of the furnace. This iron is called pig iron. The slag is cooled and processed as a saleable product.



Another product of the iron making process is hot dirty gases. These gases exit at the top of the blast furnace. This gas has a considerable energy value and so is burned as a fuel to preheat the air entering the blast furnace. This gas is also sent to the boiler and is used to generate steam which turns a turbo blower that generates the compressed air or the steam can be used to rotate a steam turbine to produce electrical power.

4. Steel Making

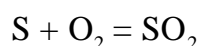
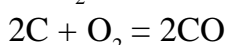
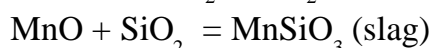
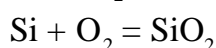
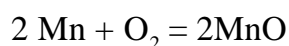
Steel is an alloy of iron, carbon (less than 2%) and manganese (less than 1%), although other alloy metals are used to produce specific properties. Mechanical properties can be varied by changes in composition (for example mild steel contains less than 0.15% carbon, hard steel more than 0.3% carbon) or by heat treatment. Stainless steel also contains 8-25% of chromium.

Either the hot metal from the blast furnace or iron / steel scrap, or a mixture of both, is the main raw material for any steel

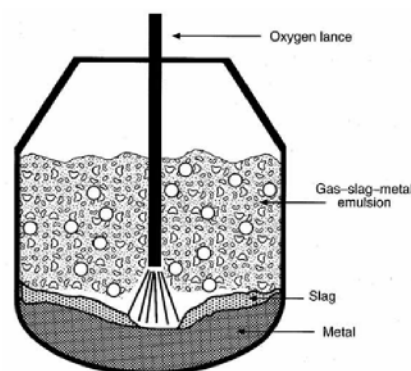
furnace. The respective amounts used vary according to the process and the type of steel required. During the first half of last century, basic Open Hearth Furnaces (OHF) accounted for about 80% of steel production. Since then the electric arc and basic oxygen processes have replaced OHF, and Basic Oxygen Furnaces (BOF) now account for 75% of the world steel production, with Electric Arc Furnaces (EAF) responsible for the remainder.

4.1. Basic Oxygen Furnace (BOF)

Hot metal is the principal material used in a BOF. The furnace is charged first with scrap and then with molten iron; typically 70-85% of the charge is hot metal and the remainder is scrap. High purity oxygen is blown into the metal through a lance. The oxygen combines with carbon and other unwanted elements, thus eliminating them from the molten metal as the slag. The reactions are:



During the 'blow', lime is also added as a flux which removes the oxidized impurities and forms a floating layer of slag. When the desired quality is achieved, the steel is poured into a ladle for casting. The slag is poured into a separate ladle for removal to a slag pit where metal reclamation takes place. Modern BOFs can make up to 400 tonnes of steel in about 40 minutes.



Basic Oxygen Steel Making furnace

4.2. Electric Arc Furnace (EAF)

EAFs were originally used solely for making steel of special high qualities because of the close control they gave over the composition of the metal. Nowadays they are also widely used for making large quantities of the more common steels. An EAF consists of a refractory-lined circular bath with a swiveling roof through which carbon electrode is lowered to a position above the scrap in the furnace.

EAF is charged with clean scrap, limestone and possibly anthracite or broken electrodes as a source of carbon and melted as quickly as possible. If alloy steels are being made, the scrap is selected to ensure that the furnace charge contains some of the elements required, for example nickel, molybdenum, chromium, etc. The larger EAFs can produce up to 150 tonnes of steel in 1-2 hours, depending on the steel type.

5. Casting Process

After the molten steel has been tapped from the steel furnace, it is cast into ingots or special castings or directly into slabs, blooms or billets by the continuous casting process. Prior to the mid-1960s, most molten metal

was released through the base of the ladle into moulds in which the metal was allowed to solidify. Continuous casting processes were subsequently developed and are now used for most steel making. Molten steel is channeled down through a water-cooled mould.

6. Rolling and Finishing Operations

Semi-finished cast steel from the steel making plant is formed in rolling mills into products for the market place. A wide range of mills exists, varying in size, profile, complexity and output. Some form part of large integrated steelworks and may be almost 2 kilometers long. Others, more numerous, produce a limited range and size of products and occupy a site of a few hundred square meters. However, they can be considered in two categories i.e. hot rolling and cold rolling plants.

Steel is subjected to a variety of "finishing" processes to meet market demands, including acid picking, painting, galvanizing, tinning and plastic coating. The processes are complex and the detailed procedures vary from plant to plant.

Conclusion

India is the 4th largest crude producer of steel in the world after China, Japan and USA. In 2012-13, production of total finished steel was 78 million ton (MT). The production of pig iron in 2011-12 was 5.78 MT. India is the largest producer of sponge iron in the world (20.37 MT in 2011-12). The steel production in India is expected to reach 200 MT by 2020.

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FAIRCOSMETIC IS FOUL

Dr. Dwijesh Kumar Panda

Your make up may be leaving you with a touch of toxic heavy metals, with potential health implications over long term use. Toxicity...the term is defined as the severity of damage; any substance can do to a living organism. Physical toxicity is caused due to physical presence of element which has the tendency to interfere with the biological activity of the body. The entire concept of toxicity is based on the amount of exposure of the toxic substance and its time span. The perils under the name of metal exposure which are unseen, slowly accumulating in body, causes everlasting effects on physical and mental abilities. Cosmetics can be a fun way to change or enhance your look. What is not so fun is that many cosmetics contain toxic chemicals. A study by Centre for Science and Environment (CSE) claims to have found high levels of mercury in several well-known national and international brands of skin whitening creams and chromium in several brands of lipsticks. The perils under the name of metal exposure which are unseen, slowly accumulating in the body, causing everlasting effects on physical and mental abilities.

High levels of mercury are associated with kidney damage, skin discoloration and scarring, while chromium is carcinogenic. Despite use of mercury being banned in cosmetics under the Drugs and Cosmetics Act, 44% of the 32 fairness creams that CSE

tested reported contained mercury. It found chromium in 50% of 30 lipstick samples tested; and nickel in 43%. All the samples were purchased from a market in Delhi and tested at CSE's pollution monitoring lab. The samples also included some popular herbal products. The results showed that whitening creams can contribute up to 71% of the acceptable daily intake (ADA) for mercury. Lipstick users could be worse off. Among the brands that tested positive for nickel and chromium, that worst could expose a heavy user to over 15 times the safety limit for chromium, according to the study.

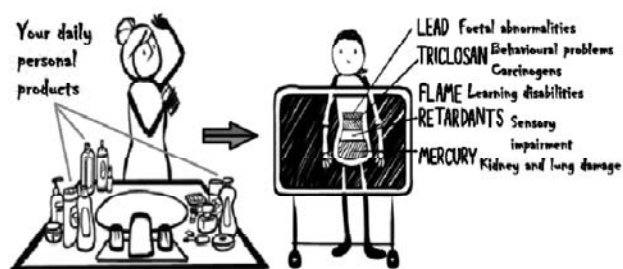
Heavy metals are generally termed as toxic elements as our body is unable to metabolize these elements and they get accumulated in soft tissues causing neurodegenerative effect on the body. Elemental toxicity due to mercury, chromium, and nickel are dangerous as it impairs the functions of liver, kidneys, and lungs. Long term exposure of these elements can result in slow precipitation of mental disorders like Parkinson's disease and other neurodegenerative diseases. Hypersensitive reactions are common upon contact with a particular metal exposure and repeated exposure can cause cancer. Some of the elements in trace quantities are tolerated by and are essential for the human body. But when these levels are above tolerance limit, they cause diseases.

Diagnosis of metal toxicity depends on laboratory testing for blood, urine analysis,

liver and kidney function tests, analysis of fingernails, chest X-rays etc. Arsenic estimation is done from urine sample. Arsenic gets cleared from the blood quickly; hence urine sample testing can give a fair estimate for over a few days of exposure. If the exposure is longer i.e., several months, examination of finger nails and hair is done. For mercury, urine sample (24 hrs. old) is preferably tested. Accumulation of mercury in the chest can be seen by an X-ray. As mercury exposure has adverse effects on liver and renal system; respective function tests are recommended by the doctors.

Cosmetics can be a fun way to change or enhance your look. What is not so fun is that many cosmetics contain toxic chemicals. David Suzuki Foundation has released a report showing the dangers of 12 toxic chemicals commonly found in wide range of cosmetic products in Canada. The "Dirty Dozen" are found not just in make-up, but in everything from shampoo to hand moisturizers. These ingredients include endocrine disruptors, potential cancer causing agents and even some that are often contaminated with neurotoxins heavy metals.

The "Dirty Dozen Ingredients"



Toxins you put on your body go into your body.

1. **BHA AND BHT** : Used mainly in moisturizers and make-up as preservatives. These are suspected endocrine disruptors and may cause cancers.
2. **COAL TAR DYES** : Used in some hair dyes and in a variety of cosmetics. These heavy metals are toxic to the brain.
3. **DEA, COCAMIDE DEA AND LAURAMIDE DEA** : Used in some creamy and foaming products, such as moisturizers and shampoos. These react to form nitrosamines, which may cause cancer.
4. **DIBUTYL PHTHALATE** : Used as a plasticizer in some nail care products. This is suspected endocrine disruptor and reproductive toxicant.
5. **FORMALDEHYDE-RELEASING PRESERVATIVES: DMDM HYDANTOIN, DIAZODINYL, UREA etc.** : Used in a variety of cosmetics. These slowly release small amounts of formaldehyde, which causes cancer.
6. **PARABEN, METHYLPARABEN, BUTYLPARABEN, AND PROPYLPARABEN**: Used in a variety of cosmetics as preservatives. They are suspected endocrine disruptors and may interfere with male reproductive functions.
7. **PARFUM** : Used in a variety of cosmetics as mixture of fragrance ingredients which can trigger allergies and asthma.
8. **PEGS** : Used in some cosmetic cream bases. This can be contaminated with 1, 4-dioxane, which may cause cancer.

9. **PETROLATUM** : Used in some hair products for shine and as a moisture barrier in some lip balms, lip sticks and moisturizers. It is a petroleum product that can be contaminated with polycyclic aromatic hydrocarbons, which may cause cancer.

10. **SILOXANES** : Used in a variety of cosmetics to soften, smooth and moisten. These are suspected endocrine disruptor and reproductive toxicant.

11. **SODIUM LAURETH SULFATE** : Used in some foaming cosmetics, such as shampoos, cleaners and bubble bath. This can be contaminated with 1, 4-dioxane, which may cause cancer.

12. **TRICLOSAN**: Used in some antibacterial cosmetics, such as toothpastes, cleaners and antiperspirants. This is a suspected endocrine disruptor and may contribute to antibiotic resistance in bacteria.

FAIR IS FOUL. Cosmetics giants deny charges. The government and industry should follow the recommendations of David Suzuki Foundation and take measures to protect people from the toxic ingredients contained in cosmetics.

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CENTRIFUGATION : A TECHNIQUE USED IN BIOTECHNOLOGY

Dr. Anoop Kumar

Dr. K. K. Anand

During last three decades Biotechnology has emerged as a useful branch in biology. It is a field of applied biology that involves the use of living organisms and bioprocesses in engineering, technology, medicine and other fields requiring bioproducts. Biotechnology also utilizes these products for manufacturing purpose. Modern use of similar terms includes genetic engineering as well as cell and tissue culture technologies. The concept encompasses a wide range of procedures (and history) for modifying living organisms according to human purposes going back to domestication of animals, cultivation of plants, and 'improvements' on these through breeding programs that employ artificial selection and hybridization.

Biotechnology depends on pure biological sciences (genetics, microbiology, animal cell culture, molecular biology, biochemistry, embryology, cell biology) and in many instances is also dependent on knowledge and methods from outside the sphere of biology (chemical engineering, bioprocess engineering, information technology, biorobotics). Conversely, modern biological sciences (including even concepts such as molecular ecology) are intimately entwined and dependent on the methods developed through biotechnology and what is commonly thought of as the life sciences industry.

Centrifugation is one of the most important and widely applied research techniques in biochemistry, cellular and molecular biology, and in medicine. A centrifuge is an instrument which uses centrifugal force to isolate suspended particles from their surrounding medium according to their size, shape, density, viscosity of the medium and rotor speed. Applications for centrifugation are many and may include sedimentation of cells and viruses, separation of cellular and subcellular organelles, and isolation of macromolecules such as DNA, RNA, proteins, or lipids. A centrifuge, generally driven by an electric motor (some older models were spun by hand), that puts an object in rotation around a fixed axis, applying a force perpendicular to the axis. Due to this, lighter objects will tend to move to the top and heavier at the bottom of the tube.

In centrifuge, the rotating unit called the rotor, has fixed holes drilled at an angle (to the vertical). Test tubes are placed in these slots and the motor is spun. As the centrifugal force is in the horizontal plane and the tubes are fixed at an angle, the particles have to travel only a little distance before they hit the wall and drop down to the bottom. Among different types of rotors, angle rotors are very common

in the laboratories. There are five types of rotors viz. Swinging-bucket rotor; Fixed angle rotor; Vertical tube rotor; Zonal rotor; Elutriator rotor.

Types of Centrifuge

1. Small Bench top or Desktop Centrifuge (With or without refrigeration): This type of centrifuge is generally of slow speed (up to 4000 rpm). These are commonly use in clinical labs (for blood/plasma/serum separation). Depending on diameter, desk top centrifuge can take approximately (up to) 100 tubes (Fig. 1).



Fig. 1 : A Desk top Centrifuge

2. Microcentrifuge: This type of centrifugation is very common in biochemistry/ molecular biology/ biological labs. In this, small volumes eppendorff tubes (up to 2 ml) are used. This may be with or without refrigeration. Such type of centrifuge can generate force up to ca. 15,000 x g.

3. High speed centrifuge: High speed centrifuge is normally refrigerated. Depending on the rotor, this has large sample capacity. Its speed is generally 15,000 - 20,000 rpm. This is normally used in research applications.

4. Ultracentrifuge: Ultra centrifuge is very expensive and its life time is very short. It requires special rotors. Its speed is 65,000 rpm (100,000's x g). In this balance is very critical. These are generally used in research applications (Fig. 2).



Fig. 2 : Ultracentrifuge

Operation

Increasing the effective centrifugal force it will cause the precipitate to gather more rapidly and completed at the bottom of the tube as a 'pellet'. The remaining solution is called the 'supernate' or 'supernatant'. The supernatant liquid is then either quickly decanted from the tube without disturbing the pellet, or withdrawn with a Pasteur pipette.

The rate of centrifugation is specified by the acceleration applied to the sample, typically measured in revolutions per minute (RPM) or relative centrifugal force (RCF). The particles settling velocity in centrifugation is a function of their size and shape, centrifugal acceleration, the volume fraction of solids present, the density difference between the particle and the liquid, and the viscosity.

Types of Centrifugal Separations

1. Differential centrifugation
2. Density gradient centrifugation

1. Differential centrifugation (Differential Pelleting)

This is the most common method to separate the particles on the basis of their size. This method is commonly used in simple pelleting, for separation of subcellular organelles and macromolecules. In this method, when homogenized sample spined by ultra centrifugation, the particles moved with varying velocities down in tubes. The supernatant can be further centrifuged to pellet subcellular organelles of intermediate velocities such as mitochondria, lysosomes, and microbodies. Some of these sedimenting organelles can be obtained in partial purity which are typically contaminated with other particles. After spin, pellet contains larger to smaller particles (usually mixture). Supernatant contains liquid and most slowly sedimenting component. Repeated washing of the pellets by resuspending in isotonic solvents and repelleting may result in removal of contaminants that are smaller in size.

2. Density gradient centrifugation :

Density gradient centrifugation is the preferred method to purify subcellular organelles and macromolecules. Density gradients can be generated by placing layer after layer of gradient media such as sucrose in a tube with the heaviest layer at the bottom and the lightest at the top in either a discontinuous or continuous mode. The cell fraction to be separated is placed on top of the layer and centrifuged.

Conclusion

Since biotechnology has emerged as a useful branch in biology; centrifugation is one of the most important and widely applied step in research applicable in biochemistry, cellular and molecular biology, medicine, genetic engineering and breeding science.

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A JOURNEY OF TRANSLATIONAL RESEARCH IN ENGINEERING PHYSICS

(Talk delivered by the author at Indian National Association of Engineers (INAE)
on the occasion of Life-time Contribution Award in Engineering-2013)

Prof. K L Chopra

I was born in 1933 in Chahal Kalan - a small village near Gujranwala in Pakistan. I used to walk about 4 km to my school, and read in the light of an oil lamp. My favorite sports were kabadi, wrestling and playing free-for-all hockey on a dirt road, and I learned to swim in the village pond. My dream was to become an Aeronautical Engineer. The partition of India brought our family to Delhi where I completed my tenth grade in DAV school in a camp near the Golemarket. With a few career options open even to a topper in those days, Physics was the most preferred choice which is what I did to graduate with BSc(Hons) and MSc (1954) in Physics from Delhi University. We were taught a lot of physics by some of the best known teachers in India in those days. But, sadly, I neither learned much nor I was inspired partly because Physics as taught to us was never related to anything around us which I could appreciate, and partly because the physics laboratory experiments we had to perform as a part of the curriculum were neither exciting nor innovative. This led me to look for opportunities elsewhere.

Inspirational Experience

When I arrived in the University of British Columbia, Canada in September 1954 to pursue my PhD programme on a World

University Fellowship, I suggested to my proposed supervisor that I wanted to learn physics by doing things with my own hands and that I enjoyed doing so and thus I would like to start with learning workshop skills. Shocked to see me in a brand new suit and tie asking to be first trained in workshop practice, he took me to the Workshop and asked someone to put me through the drill of learning the use of various tools, lathes, glass blowing, etc. Subsequently, I designed my own glass vacuum system with a mercury diffusion pump (which is what vacuum technology was at that time), silvered large glass dewars for storing liquid nitrogen and liquid helium, and wired electronic circuits to measure and maintain very low temperatures of a fraction of a degree Kelvin obtained by adiabatic demagnetisation. We had to learn how to liquify the gas, and recycle it after the evaporation of liquid. Observing the superfluid liquid helium (a macroscale quantum fluid) getting out of its container against gravity (a quantum phenomenon) was akin to a spiritual experience for me. Sometimes, such experiments lasted upto 48 hours. My supervisor stayed with me all the time and brought packed food for both of us. This experience of conducting exciting experiments in collaboration with a supervisor as a coworker and mentor left a deep impact on me. Then and there, I made up my mind

that, given an opportunity, I would like to set up a laboratory where students and faculty would work together like colleagues, learn to work with their own hands, learn to learn from experiences, and above all appreciate the need to translate the knowledge so obtained into an asset for society at large. Little did I know at that time that my dream would be fulfilled eventually in the form of an Institution came to be known as "Thin Film Laboratory" (TFL) at IIT Delhi.

Thin Film Research : A New Frontier

As a postdoctoral Research Fellow of the Defence Research Board of Canada at the Royal Military College, I set up facilities to verify the latest BCS theory of superconductivity by measuring ultrasonic absorption in superconductors. This was followed by a stint as a Max Planck Fellow in Fritz Haber Institute, Berlin where I established a low temperature XRD facility from scratch to determine any asymmetry in electron density distribution in hexagonal metals.

In the early 60's, a dramatic change took place in my scientific career. Based on remarkable electronic and optical properties of thin-films, vacuum deposited ultrathin films of several materials showed great promise of emerging as a new frontier of science and technology. Unfortunately, the properties of such films were not reproducible which led some to call it "5th state of matter" (besides solid, liquid, gas and plasma). I chose to work with two leading industry research laboratories in USA which provided me with a challenging

opportunity to establish what thin-films really were and why they showed anomalous properties. Of course, this gave me an opportunity to work in a new, exciting and evolving field of Thin Film Research for microelectronic and photonic applications. As a senior scientist, I was given a free hand to conduct research in any direction which could be of interest to the industry. First of all, many workers set out to find out why thin-film properties were so temperamental. After numerous studies, we all came to the conclusion that properties of thin-films (and similarly nanomaterials created abinitio) depended strongly on the way atomic species were created, transported and assembled to create nanomaterials of different dimensions. That is, the birth stages of nucleation and growth of a thin-film or nanomatter determined the nanostructure and thus the properties. This meant that controlled and reproducible deposition parameters were essential for obtaining reproducible properties of thin-films.

I published my research findings extensively and was granted 4 US patents. As early as 1962, I published a paper, the first of its kind, on Thin Film Photocell (solar cell as it is now called) in IEEE Journal. I discovered current controlled negative resistance switching in thin oxide films (a topic which is being revived for commercial applications). Our pioneering work on structural, electrical and optical changes in GeTe thin films at elevated temperatures led private companies

(such as Moser Baer) to develop writable CDs. I developed and patented a duoplasmatron ion beam source for vacuum sputter-deposition of hard optical films/coatings. Two decades later, this patent came to the rescue of a US based multinational who was dragged to court with an over one billion dollar legal suit by a rival company for violating their patent for depositing durable laser mirrors used in laser guided weapons for defence. By citing my patent as an evidence of an existing knowledge in the field, the company won the court battle. The news attracted headlines in New York newspapers.

The exciting ecosystem of research in industry oriented research laboratories in US pushed me further to challenge myself to author the very first book in the field. At the age of 32, I spent the next three years in my spare time to write a Treatise "Thin Film Phenomena". Published in 1969, the book was a grand success. The book is globally respected as the "Bible" for newcomers to the field even today. Learning about my work in the new area of Thin-Films, the Director, IIT Delhi inquired if I would be interested in joining IITD. Before long, the Institute offered me a very attractive position of a Senior Professor of Solid State Physics and also offered to pay all my relocation expenses by air for the family. Such a generous offer by a premier institution in India was unthinkable in those days. I could hardly refuse this golden opportunity to fulfill my dream of setting up a research laboratory in India with a paradigmatic difference. We arrived in Delhi on August 23, 1970. My wife

and I met the director of IITD on the 24th morning. Warmly welcoming me to IIT Delhi, the Director handed over personally the keys of the bungalow at 10, West Avenue, IIT Campus bungalow which became our future residence for 17 years. This warm welcome and reception led me to resolve to burn the bridge to my attractive US position (from which I had taken leave) and, come what may, justify the trust posed in me by IITD.

The Birth of the Thin Film Laboratory (TFL)

I was shown around the Physics department and, in particular, two large empty rooms where I was supposed to set up my research laboratory. A PhD student, who had decided to join me even before I joined IIT, was keenly waiting to talk with me. I told him that if he was prepared to accept the rough and tough role of a pioneering scientist, he was welcome as my student. Thus, both of us started together to clean the floors of what would become the globally famous Thin Film Laboratory (TFL). I had mentioned in my recently published book that growing polymer films epitaxially and doping them appropriately would be a fruitful area for R&D in developing new materials. We devised a very simple solution growth technique with very little equipment to deposit thin-films of well known polymers such as PVC, PVB, etc. By doping and incorporating different metals in the polymer films, we created what came to be known as semiconducting "Metallopolymers". We received our very first grant of Rs 30,000

as a DST sponsored project to synthesize conducting polymer films which boosted our spirits and our credibility. We were well ahead of time in creating semiconducting polymers but were not good chemists. The discovery of conjugated polymers some 8 years later led to the Nobel Prize discovery of conducting polymers by a Japanese and two American chemists. No, we were not disappointed. Our simple Solution Growth Technique became a popular technique for synthesizing and studying polymer thin-films by numerous workers globally and our original papers were cited widely.

The number of students keen to join TFL for PhD and MTech projects started increasing rapidly. We needed to build all purpose vacuum systems for thin-film research. A workshop was created in TFL out of whatever old tools were available within the institute. All students, male or female, had to learn to use the workshop for building equipment with whatever was available anywhere in junk, waste or scrap form. The students built several vacuum systems for evaporation, and for sputtering. Since large metal vacuum chambers were not available anywhere in the market, our students bent stainless sheet into a cylindrical chamber by sheer muscle power and welded it. Improved diffusion pumps, crude pressure gauges, electron beam gun, sputtering modules, quartz crystal and optical monitor, ellipsometer, DLTS, EBIC, spray pyrolysis system rapid quenching set-up, among others, for thin film deposition by different techniques were created by jugaad (an Indian version of innovation).

After his visit to TFL during 1976, Dr Arcot Ramachandran, the then Secretary of the DST, asked me what DST can do for TFL. I asked for a Nanoanalytical Facility. Dr Ramachandran lost no time in sanctioning Rs. 15 lakhs. I persuaded a US company which, at that time, was developing a Scanning Auger Microprobe-cum-Electron Spectroscopic Chemical Analysis, to give us the instrument for experimentation and evaluation at a nominal cost of Rs. 15 lakhs. The SAM-ESCA was the first such instrument anywhere in India. We maintained and used this instrument extensively for almost two decades. We received some more analytical equipment such as an electron microscope and spectrophotometers under the Indo-UK aid agreement. With further development of facilities, TFL became a foundry to develop a large number of home made physical, chemical and electrochemical thin-film deposition techniques and a range of micro and nano-analytical tools. At one time, TFL was considered globally as one of the few best Thin-Film R&D facilities under one roof.

Our research contributions were appreciated globally. TFL attracted lots of visitors- foreign dignitaries, academics from all over the world and several Nobel Laureates. The TFL was open and functioned 24X7. The Nobel Laureate Dr Abdul Salam visited TFL in the late evening. A theoretical physicist, himself, he was so impressed to see our work that he asked me if we could set up a similar facility in the International Centre for Theoretical Physics, Trieste, Italy of which he

was the Director at that time. Two prominent Japanese scientists came all the way only to verify our claim of having created transparent conducting ZnO films for the first time. German scientists visited at night to look at our work on thin-film CdS/Cu₂S solar cells. The vice President of IBM Research Centre at Yorktown Heights, USA spent six months of his Sabbatical leave in TFL. The list of prominent visitors is endless.

Invitations to me for lectures came from all over the world. Requests for engaging my students for postdoctoral fellowships came on telephone from many scientists abroad. The CEO of ULVAC- a leading Japanese Vacuum and Thin Film Company - requested me to send three of my students as PDFs on a 5-year contract. During my visits abroad, I spent some time to consult at the Research Centres of IBM, Westinghouse, and ARCO in USA. The pinnacle of our global recognition came when TFL was asked to hold the 7th International conference on Thin Films in 1987. With 700 participants, including three recent Nobelists, from all over the world, the conference held in Vigyan Bhavan is still remembered by the world community for the high quality of presentations, superb arrangements and hospitality- all taken care of by the TFLians.

Significant R& D Contributions of TFL

Some of the original and most prominent scientific contributions from TFL during my time are listed as follows:

- Developed Semiconducting Metallo-Polymers.
- Developed graded refractive index multilayer coating- the first "photonic crystal " (as it would be called today) of its kind for nearly perfect reflection mirrors.
- Established rigorously electron transport processes in thin metal and amorphous semiconducting films.
- Developed ZnO based bulk and thin-film varistors. The technology was transferred to WS Insulators, Chennai.
- Developed scientifically a Chemical Bath Deposition process for CdS Films- which some call it a Chopra process- used globally by all Thin Film Solar Cell industries today.
- Developed, for the first time, Transparent and Conducting Thin Films of ZnO which in its bulk form is a well-known insulator. Such ZO -TCO films are now used extensively by thin film solar cells and other optoelectronic industries- without, unfortunately, giving credit to us.
- Discovered structural and optoelectronic changes in various Ge-chalcogenide films which has led to the manufacturing of CDs.
- Discovered Giant Photocontraction Effect in Ge-chalcogenide films and demonstrated its lithographic and reprographic applications.

- Detailed study of the Physics of ThinFilm CdS/Cu₂S solar cells.
- Developed nanostructured aluminium oxide template for synthesizing nanostructured optically selective coatings for solar -thermal applications. Creation of templates of various materials is now an established industry.
- Developed hard metal carbide and nitride coatings for surface engineering and machine tools.

Since patenting of innovations was not encouraged in educational institutions at that time, we missed an opportunity to patent several significant innovations which were adopted in due course by global industries. However, TFL attracted industrial consultancy assignments and thus interacted strongly with the industry in India. Various consultancy jobs, and technology development and transfer assignments were executed by our students under the supervision of the faculty. The first consultancy assignment in IITD was offered to TFL by the then well known razor blade company manufacturing 7-O'Clock shaving blades. We were required to improve the smoothness, sharpness and life of blades by coating nanometric Cr films by a sputter-deposition process. The project was successfully executed to the satisfaction of the razor blade company by our students who also tested the performance of the blades by regular shaves in the morning inside TFL.

Some of the interesting consultancy and translational research projects undertaken by us were:

- Sputter deposition of Cr on 7 O'Clock razor blades (Malhotra Razor Blade Co)
- Study of nanostructure of imported silica powder for rubber tyres (Good Year, Delhi)
- Thin Film CdS Photo-cells (manufactured by Patel Enterprises, Bangalore)
- Thin Film Colour Coatings on Ophthalmic Glasses (Laxmi Opticians, New Delhi)
- Manufacturing of Electron Microscope grids (Montek Industries, Chandigarh)
- ZnO Varistors (manufactured by W S Insulators, Chennai)
- Moire Gratings for Lathe Machines (HMT, Bangalore)
- Thin Film Strain Gauge for Roorkee University
- Thin Film IR Detector for DRDO
- High power Electron Gun (manufactured by VICO, Delhi)
- Magnetron Sputtering module (manufactured by VICO, Delhi);
- Optical Monitor for Thin Film deposition (Hind High Vacuum, Bangalau)
- Optically Selective Copper Black Coatings for solar- thermal applications (Jyoti Ltd and BHEL)

(to be continued).

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GLOBAL WARMING AND CLIMATE CHANGE : THE SCIENCE BEHIND AND SOLUTIONS

Sachala Bala Mishra

Introduction

We have discussed earlier that the reasons behind Global Warming and climate change is two fold: - natural and man-made.

Natural causes may have devastating effect. But nature has devised its own check and balance system. It counter balances its positive and negative actions. Human capacity is limited. Vast forest went underground with all its flora and fauna due to earth quake, volcanic eruptions etc., in turn nature gave us coal, mineral and natural gases. Man is destroying forest, can he produce fossil fuel? So let's leave nature and think of what human being is doing. What we should do and what not to.

Negative impact of global warming and climate change has to be tackled urgently to save everything on earth. Life requires pure water, air and healthy food for its sustenance. In previous article we have discussed about how industry, mindless use of natural resources and mismanagement in garbage handling, pollution etc. do cause Global Warming and bring changes in climate. We have also discussed how to avoid GHG emission, make earth free from shackles of pollution and save our planet.

Now we will discuss about developing a greener earth, achieving food security, tackling the challenges of climate change. Food is the primary requirement for life to continue. Agriculture is main thing that gives us food. Industry, space crunch, pollution, climate

change are the main factors that effects agriculture. So we have to look deep in to, how to arrange healthy food for every mouth.

Atmosphere acts as a shield around the globe and protects life on it from the harmful effects of solar radiations. Man has evolved some similar technique to deal with such situation, which we will discuss here:

"Green House Technology" (GHT) - a controlled environmental agricultural method.

Green House Technology is the art of growing plants, in a planned way, in temporary or permanent infrastructures equipped with several means of controlled environmental conditions. If managed technically and efficiently, GHT will go a long way in providing food and nourishing life of plants (and animals) on earth. In comparison to the past we are now at a higher risk of environmental hazards. But at the same time human beings are now more aware of the danger facing the world. Plant and animal life and natural resources on earth, are facing multifaceted difficulties and challenges due to over population, pollution of air, water and soil, hazards of mass scale industrialization, deforestation, damage and destruction of ecosystem. Man is at present worried about it and trying to find solutions that can reverse the scenario and undo the damage done.

Constructing a Green House

A Green House structure is a permanent or temporary, small or big shade or building

made of transparent or translucent materials. This can be constructed on terrace, on roof top, in backyard and also in open field. Iron frame, glass, fiber glass and plastics are used to build the infrastructure, pipe channels are fitted for water supply. Electric supply, heating - cooling systems are needed for internal environment control. The roof and walls of this structure allow visible solar radiation to enter in. Hot air is retained keeping inside warm to optimum level. Plants, soil and other things inside the green house absorb solar radiation. Nutrients and pesticides required are supplied with water. Designing and constructing a Green House needs a team of experts, like scientists, engineers, agriculturists, masons, electricians, plumbers and those persons who are trained in construction of this structure. Air, water, soil, warmth, sunlight, nutrients, disease control, protection from insects and rodents specific for a plant, is provided to the plants in scientific and controlled way. Plants grown in GH are more adaptable.

Advantages of Green House technology

In Green Houses advantages are in many folds. Due to better seed, optimum water and nutrients, healthy germination and plant growth, quantity of produce per unit area is 10 -12 times more than outdoor cultivation. Products are of enhanced quality as nutrients supplied are specific to the crop, disease infection is controlled. Green house cultivation requires less water since drip irrigation is used. Around 40% less water is needed in comparison with open field cultivation. Farmers get maximum yield using less space as internal space is designed to achieve this. Off season plants can

be grown making grains, flowers, fruits available through out the year. Off season produce fetches more market value. GHT provides better scope of experimentation and innovation. GHT is very advantageous in extreme climatic conditions. For example in deserts, excessive cold places, drought prone areas, it protects plants from extreme cold, high wind, precipitation (acid rain), excess radiation (UV rays), high temperature, insect attack and diseases. Using this technique any plant can be grown at any time in any place.

Disadvantages of Green House Technology

Cost of construction and maintenance cost is high. There is a shortage of High tech manpower in India to apply this precision farming method. GHT requires trained manpower and expert technique. Knowledge and implementation of effective control of climate inside the house is not an easy task. But all these can be addressed through research and training and by using better technology.

Urgent Requirement

The report submitted by The Environment Ministry, Govt. of India, to the United Nations Convention to combat desertification says; over one fourth of India's land area, covering almost all states is under Desertification, Land Degradation and Drought (DLDD). This is a concern for sustainable development.

India has to be very serious about it and take firm action urgently to save its air, water resources and soil, arrest pollution, save environment through massive reforestation and afforestation and other means.

About one billion people all over the world go hungry. World has a limited space. Day by day more space is lost due to industries and construction of buildings, less and less space is left for agricultural land. Climate change has proved a constant threat to farming. Forests are destroyed decreasing the green cover on earth and resulting in scarcity of food, medicine and timber. In India food for all is a dream with reality far ahead. How to address malnutrition and achieve food security when population is multiplying very fast? The simple answer is, "grow more food and increase nutrient value of food, reduce loss through proper storage and distribution, organise better supply system". Farmers and farming need proper transportation (road and automobiles), communication (telephone and internet), electricity and water supply, farming tools, machinery and fuel at minimum cost, training institutions nearby for training. Using fossil fuel is too costly for poor farmers. Tapping alternate sources of energy (Solar, wind, bio-gas etc) will be highly beneficial. This will also help keep villages free from pollution.

Usefulness of GHT

Farming concept is shifting from large farmlands to small Green Houses. Once new agricultural techniques and practices are applied, environmental requirements of a plant are understood and fulfilled, harm due to negative environmental factors etc. are addressed in-house, in small scale, the same can be transferred to larger fields. This will cost less time, energy and manpower with less risk of crop failure.

GHT is being used for researches on - application of farmhouse equipment and new agricultural techniques, effective irrigation and water management, improving and using pesticides and insecticides that are environment friendly, grafting and genetic engineering, evolving newer and more adaptable healthier and higher yielding plants.

Very old and big trees are being cut everyday for road construction. It will take 50-100 years to grow such trees again. The fast pace of Global Warming will not allow us so long time. Growing healthy, fast growing plants that can replace the cut ones are the present day requirement. Good timber plants, plants having canopy for shade, fast growing plants are being grown inside Green House and being transplanted along the highways and roads and on barren land for quick reforestation and afforestation.

Tomatoes grow best in Green Houses. Traditionally winter vegetables, are now available throughout the year. A controlled temperature of 20 - 25 degree during day and 15-17 degree during night is the best for plant growth. Drip irrigation is advantageous. Tomatoes are fed with carbon dioxide easily, giving more yield of better quality. Other plants that yield best in Green house are : capsicum, cucumber, onion, garlic, brinjal, some spices. Garbera flowers, used for decoration in social events, have higher market value. They are now commercially grown in Green House. They need minimum wet and dry conditions. Open fields are either more wet or more dry for them.

Commercial use of Green House technology

More than 50 countries around the globe are using GHT for large scale commercial farming. Japan, China, US, Gulf Countries, Canada, Philippines, Egypt, Spain, Netherlands are a few to mention.

India is at start point and recently taking up to Green House Cultivation.

Government of India is subsidizing for setting up a Green House and providing technical support. Foundation for Organic Agriculture and Rural Development is organizing various levels of training programmes for this.

Research and findings

Extensive research was taken up all over the world after 1990, when Earth's temperature climbed sharply. Scientists under the leadership of Terje Berntsen at Center for International Climate and Environmental Research (CICERO) at Oslo, made a project.

A giant Laboratory was used which had all the factors - earth, its natural climate, man-made disruptions like emission of GHG, deforestation and natural disruptions like volcano, solar activity etc. This climate model was repeated millions of times and effects recorded. Scientists are now of opinion that containing global warming at less than 2 degree celsius is attainable. Ocean warming seems to have stabilized to some extent. But if we continue to emit GHG this trend may reverse in any time. Policy makers are framing policies to achieve and maintain this.

India has established Precision Farming Development Centers in states to promote high-tech precision farming. It is organizing seminars, using media for awareness, and providing training to stake holders. It is publishing information on climate zones and climate. NCPAH, National Committee on Plasticulture Agriculture in Horticulture is another effort in this direction.

Organic Agriculture and Rural Development is promoting Organic Farming. Organic farming works in harmony with nature and not against it. Using organic compost and manure and avoidance of artificially made manure and fertilizer, using biodegradable things in farming, maintaining optimum PH level helps maintain good soil and soil fertility. It helps growth of environment friendly worms and insects.

GHT improves the productivity, profitability and sustainability of major farming systems. It may be an answer to hunger, malnutrition and food security. A modern high-tech green house with Controlled Environment Agriculture (CEA) is made from knowhow in various fields - agriculture, horticulture, engineering, energy, construction infrastructure, electrical and electronics, computer for controlling heat, light, ventilation, humidity.

This is the place where traditional farming meets modern scientific practice. Here theory and practical go hand in hand. Green house farming is an answer to rampage of agriculture by global warming. It seems that future farming is protected farming.

Conclusion-Natural climate changes and fluctuation is not new to earth. It existed in past and will exist. Fortunately it is very slow. But human activities are pushing it fast. Climate change has thrown a great challenge to life. Effective action has to be taken very fast unless it will spread like a wild fire and the damage can never be undone.

To contain global warming and its impact we have to be more aware and make others aware, understand nature and its fury, know about preparedness for disaster management, undertake social responsibility seriously, help continue and enrich research work by providing support and feedback, promote scientists, farmers and ground workers, contain population and pollution with a firm hand, manage space crunch through modern architecture making more space available for greenery, make best use of garbage. "Reduce, reuse, recycle" is to be remembered and acted upon GHT is one of the many ways. International bodies are in favour of - Carbon Taxing-the more CFCs you spew, the more tax you pay, and in favour of using more and more biodegradable objects Using Solar and other renewable sources of energy replacing carbon fuel will greatly reduce GHG emission; lesson the cost of production as resources are free India being on equator has great advantage of plenty of Solar Power. Solar heater, solar cooker, solar streetlight system, solar water pumps are finding newer markets everyday. About 45% of rural housing who have no electricity can now be lighted by solar energy. Agricultural wastes, house hold wastes, both

in solid and liquid form in rural and urban areas can be converted and reused to our advantage.

Industries must take social responsibility, as it is the society from which they are getting raw material, manpower and getting all their earnings. Taking social responsibility should be a pre-condition for setting up any industry. Big corporate houses should take charge of research and training and developing infrastructure.

What I Should Do

I shall grow trees near my house and surrounding and take care of them, use my garbage for making compost and for recycling, use bio-degradable articles, like paper bags, baskets etc. made of jute, bamboo and such other things, avoid unnecessary wastage of water, preserve water, avoid causing any pollution, undergo training, so that what ever I do, it be a perfect and useful work. I shall be aware and make others aware.

Let us help nature in keeping our earth livable for us for our own requirement and benefit.

Man has provided "fast pace" to climate change, Solution to arrest it lies with MAN.

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PHYTOREMEDIATION: PLANTS TO CLEAN SOIL

Mihir Kumar Das

On the morning of April 26, 1986, a small town in the former Soviet Union was the site of a nuclear explosion that literally shook the earth. The historic accident at Chernobyl Nuclear Plant Reactor 4 in the Ukraine caused severe radioactive contamination. Families within a 30-km zone of the power plant were evacuated, and in the months that followed, extensive contamination was discovered in areas up to 100 km from the site. Scientists are hopeful that plants may play a key role in cleaning up some of the contamination.

In 1989, three years after the explosion, the Soviet government asked the International Atomic Energy Agency (IAEA) to assess the radiological and health situation in the area surrounding the power plant. Among the most significant findings were radioactive emissions and toxic metals--including iodine, cesium-137, strontium, and plutonium--concentrated in the soil, plants, and animals. Such substances are potentially harmful to human health. For example, although iodine tends to disappear within a few weeks of exposure, it can be inhaled or ingested and then accumulated in the thyroid gland, where it delivers high doses of radiation as it decays. Since 1991, the Canadian Nuclear Association has noted a marked increase in the incidence of thyroid cancer in the area surrounding the nuclear accident. Cesium-137, radioactive cesium with a mass number of 137, can enter the food chain and deliver an internal dose of radiation before it is eliminated metabolically.

Apparently these toxic substances entered the food chain via grazers, such as cows and

other livestock, that fed on plants grown in contaminated soils. The toxins then accumulated and concentrated in the meat and milk products eventually consumed by humans. Additionally, wild foods, such as berries and mushrooms, are expected to continue showing elevated cesium levels over the next few decades.

To prevent further spread of these toxins, it was determined that livestock should be allowed to feed only on uncontaminated plants and on plants not tending to accumulate toxic metals within their tissues. Then a soil cleanup method was employed using green plants to remove toxins from the soil. This technique is phytoremediation, a term coined by Dr. Ilya Raskin of Rutgers University's Biotechnology Center for Agriculture and the Environment, who was a member of the original task force sent by the IAEA to examine food safety at the Chernobyl site. Phytoremediation is a process that takes advantage of the fact that green plants can extract and concentrate certain elements within their ecosystem. For example, some plants can grow in metal-laden soils, extract certain metals through their root systems, and accumulate them in their tissues without being damaged. In this way, pollutants are either removed from the soil and groundwater or rendered harmless.

Today, many researchers, institutes, and companies are funding scientific efforts to test different plants' effectiveness at removing a wide range of contaminants. Raskin favors *Brassica juncea* and *Brassica carinata*, two members of the mustard family, for phytoremediation. In laboratory tests with

metals loaded onto artificial soil (a mix of sand and vermiculite), these plants appeared to be the best at removing large quantities of chromium, lead, copper, and nickel. Several members of this family are edible and yield additional products such as birdseed, mustard oil, and erucic acid, which is used in margarine and cooking oil. Researchers at the DuPont Company have found that corn, *Zea mays*, can take up incredibly high levels of lead.

Z. mays, a monocot of the Poaceae or grass family, is the most important cultivated cereal next to wheat and rice, yielding such products as corn meal, corn flour, cornflakes, cooking oil, beer, and animal feed. Phytokinetics, a company in Logan, Utah, is testing plants for their ability to remove organic contaminants such as gasoline from soil and water. Applied Natural Sciences in Hamilton, Ohio, is taking a slightly different route by using trees to clean up deeper soils, a process they call "treemediation." University researchers from the UK reported in the May 1999 issue of Nature Biotechnology that transgenic tobacco plants can play a role in cleaning up explosives.

In February 1996, Phytotech, Inc., a Princeton, NJ-based company, reported that it had developed transgenic strains of sunflowers, *Helianthus* sp., that could remove as much as 95% of toxic contaminants in as little as 24 hours. Subsequently, *Helianthus* was planted on a styrofoam raft at one end of a contaminated pond near Chernobyl, and in twelve days the cesium concentrations within its roots were reportedly 8,000 times that of the water, while the strontium concentrations were 2,000 times that of the water. *Helianthus* is in the composite, or Asteraceae, family and has edible seeds. It

also produces an oil that is used for cooking, in margarine, and as a paint additive. *H. tuberosus* was used by Native Americans as a carbohydrate source for diabetics.

In 1998, Phytotech, along with Consolidated Growers and Processors (CGP) and the Ukraine's Institute of Bast Crops, planted industrial hemp, *Cannabis* sp., for the purpose of removing contaminants near the Chernobyl site. *Cannabis* is in the Cannabidaceae family and is valuable for its fiber, which is used in making ropes and other products. This industrial variety of hemp, incidentally, has only trace amounts of THC (Tetrahydrocannabinol), the chemical that produces the "high" in a plant of the same genus commonly known as marijuana.

Overall, phytoremediation has great potential for cleaning up toxic metals, pesticides, solvents, gasoline, and explosives. The U.S. Environmental Protection Agency (EPA) estimates that more than 30,000 sites in the United States alone require hazardous waste treatment. Restoring these areas and their soil, as well as disposing of the wastes, are costly projects, but the costs are expected to be reduced drastically if plants provide the phytoremediation results everyone is hoping for. Meanwhile, of the original four reactors at Chernobyl, Reactors 1 and 3 are still operating today, providing 6,000 jobs and about 6% of the Ukraine's electricity. Reactor 2 was closed after a fire in 1991; the construction of Reactors 5 and 6 came to a grinding halt after the explosion.

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QUIZ ON FISHES

Prof. Prafulla Kumar Mohanty

- Which of the following fishes is colourful, curious and conspicuous ?
a) Electric cat fish b) Angel fish
c) Climbing perch d) Dolphin fish
- The branch of science which deals with the study of fishes is known as :
a) Herpetology b) Saurology
c) Pedology d) Ichthyology
- Which of the following is one of the most popular delicious fishes ?
a) Pomfret b) Pamphret
c) Pamplet d) Pamphlet
- In Zodiac signs, fish is one of the symbols which occupies the position.
a) First b) Fifth
c) Seventh d) Last
- Migration of fishes from river to sea is known as
a) Anadromous b) Catadromous
c) Potamodromous d) Oceanadromous
- Cat fishes are called so because of the
a) Catlike dark body
b) Absence of scales on the body
c) Presence of whiskers like structure called barbels on face
d) Production of sound like cat
- Flying fish, which is found in Atlantic and Indian Ocean, is coined with such a name because it
a) Flies
b) Possesses large dorsal fin
c) Actually cannot fly but simply glides
d) Hops
- Which of the following fins are paired in fishes ?
a) Pectoral
b) Pelvic
c) Both pectoral and pelvic
d) Dorsal
- The copulatory organ of fish is known as
a) Penis b) Hemipenis
c) Clasper d) Holopenis
- Which of the following is a true fish ?
a) Silver fish b) Cray fish
c) Jelly fish d) Parrot fish
- Which of the following fishes produce electric current ?
a) Torpedo b) Cyclostome
c) Eel d) Channa
- Which of the following fishes are popularly known as three brothers ?
a) Rohu, Catla and Mrigal
b) Rohu, Catla and *Anabas*
c) Catla, Mahasheer and Rohu
d) Major carp, medium carp and minor carp
- Which of the following fishes appears like a snake ?
a) Snake headed fish b) Sucker fish
c) Flute fish d) Pipe fish
- Which of the following fishes doesn't have scales ?
a) Mrigal
b) Magur
c) Singhi
d) Both Magur and Singhi
- All the fishes move horizontally in water excepting one. Which is that fish that swims vertically ?
a) Sea horse b) Globe fish
c) Porcupine fish d) African lung fish

16. Which of the following fishes is characterized by the presence of hammer like structure on head ?

- a) Hammer headed Shark
- b) Tiger Shark
- c) Eagle Shark
- d) Whale Shark

17. Hard scales or scutes are found on the body of crocodiles, snakes etc. But which of the following fishes possesses dermal bony scutes or exoskeletal plates ?

- a) Flute Fish b) Pipe Fish
- c) Mahaseer d) Magur

18. Which of the following male fishes bears a brood pouch for storing fertilized eggs ?

- a) Sea horse (b) Eel
- c) Flute fish d) Flat fish

19. Which of the following fishes exhibits mimicry ?

- a) Sea horse
- b) Pipe fish
- c) Both seahorse and pipe fish
- d) Snake headed fish

20. Fishes are usually edible. But which of the following are not edible because of poisonous nature ?

- a) Scorpion fish and porcupine fish
- b) Flying fish, Bowfin fish and Trunk fish
- c) African lung fish, South American lung fish and Australian lung fish
- d) Cotton fish, Spoon bill and Sturgeon

ANSWERS

- 1. (b) 2. (d) 3. (a) 4. (d) 5. (b)
- 6. (c) 7. (a) 8. (c) 9. (c) 10.(d)
- 11. (a) 12. (a) 13. (a) 14.(d) 15. (a)
- 16. (a) 17. (b) 18.(a) 19. (c) 20.(a)

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5W'S + H :

(Why, Who, What, When, Where and How)

FUNGUS

Nityananda Swain

Q. Doctors often use the term fungus infection. What do they actually mean by this ?

As you know, infections may occur due to attack by bacteria, viruses, and parasites. But the infections that occur by fungus are termed fungus infections or fungal infections. The plural of fungus is fungi (pronounced as 'funji').

Although diseases caused by fungi were known earlier than the bacterial diseases, its study was not given due attention. Because, most of the diseases caused by them were not that serious. However, presently the scenario is changed. The fungus infections are extremely common; even a few of them are quite serious and may cause death of the patient.

In developed countries, most of the bacterial infections have been satisfactorily controlled by the use of various antibiotics. But at present time, the Fungus infections have raised its ugly heads and thus have assumed a greater significance diseases. Even our body also harbours a lot of them without any ill effects.

Q. Are the fungi a different class of microorganisms ?

Yes, they are different with their own specific characteristics. Do not think that you are not familiar with fungus and fungal

infections. In fact, the word fungus is a Latin word meaning 'mushroom'. You must have seen different varieties of mushrooms sold in the market and grown on the ground. You must have enjoyed it as a culinary item too.

Not only that; some of you might have suffered from ringworm infection, ulceration in the folds between fingers and toes especially during rainy season, severe itching and discolouration in the thigh-folds or depigmented patches on face, chest etc. Most of these conditions are due to fungal infections.

The Yeast your mothers and sisters use while preparing cakes is nothing but a type of fungus. Yeast is unicellular and the simplest of the fungus family.

Q. Do they differ from bacteria ? If yes, how ?

You have already been told that bacteria are prokaryotic cells. On the otherhand, fungi are eukaryotes. Its cellwalls are thick. They possess distinct nuclei with nuclear membrane. They have paired chromosomes too.

Fungi grow as single cells as in yeast or as multiple cellular filaments as in various mushrooms. They obtain their food from dead organic matter or from living organisms.

Q. How do doctors study fungi?

They collect the sample from the infected lesion and examine their structure under a microscope. But before putting it under the microscope, they treat the sample with potassium hydroxide solution. This

alkaline solution digests all other cellular materials but not fungi. As a result the fungi are seen clear and distinct. The fungi can be grown in specific culture medium; but its culture takes days or weeks.

Q. How do fungal infections affect us ?

The fungal infections are called 'mycoses'. Mycoses affect human beings as well as plants and animals.

Human fungal infections are classified into two main types :- the superficially seated infections and deepseated infection. The former is more common. The superficial infections or ringworm infections belong to the superficial category. Such type of tinea infections, though chronic, are mild in nature. On the otherhand, the deep-seated mycoses affect tissues beneath the skin and the internal organs of the body.

Q. What are the common superficial fungal diseases ?

In the superficial variety, fungus thrive and multiply in the most superficial and dead layers of the skin as well as in its appendages like nails and hair. One of the common examples of the superficial mycoses is the 'tinea versicolor'. These infective lesions appear on the skin surface mostly of the face, neck chest, abdomen, upper limbs and back. The disease is more prevalent in adolescents and young adults. The lesions appear as depigmented brown patches which slightly itch and give off fine scales.

A fungus infection of the scalp is known as tinea capitis and that of the bearded portions of the neck and face is known as 'tinea barbae',. Since the latter is supposed to have come from the infected shaving instruments used by the barbers, this condition is otherwise termed 'barber's itch'.

Tinea corporis or tinea infection of the body begins with red, slightly elevated scaly patches. On examination, they reveal minute vesicles or tiny blister like projections. New patches arise from the peripheral region of the lesion while the central region shows clearing up.

Tinea cruris is also not uncommon. It is the fungal infection that effects the contact surfaces of the scrotum, genital areas, anal region and the inner areas of the thighs. Excruciating itching is its chief symptom.

Candidiasis is the infection of the skin or mucous membrane with a type of fungus called '*Candida albicans*'. It affects skin, mouth, birth canal, respiratory passages like bronchi or lungs. It may even invade the blood stream too. The newborn infants may be infected by this organism during their passage through the birth canal.

The patients with debilitating diseases like diabetes or cancer or those who are on immunosuppressive drugs may become very vulnerable to fungal infections. Because of the immunodeficiency, the AIDS patients often are its victims.

Q. Can the fungi cause poisoning ?

You might have heard about mushroom poisoning. There are certain types of mushrooms when eaten, may cause toxic effect. The effects are manifested as diarrhoea, vomiting, muscle cramps, allergic rashes etc.

The fungus named '*Aspergillus flavus*' often infect groundnut, corn and peas. This fungus is highly toxic to animals and birds and probably to man as well . It has very harmful effects on the liver and possibly has carcinogenic properties.

Q. How can one prevent fungal infections ?

Superficial fungal infections almost do not occur if personal hygienic measures are strictly adhered to. Taking regular bath using antiseptic toilet soaps, applying shampoo on the hair at least once every fortnight, wearing, clean clothes, washing of inner wears as well as stockings regularly etc. go a long way in preventing mycoses.

As the infections may spread from one person to another, infected persons should not let others use their personal items such as clothes, towels, handkerchiefs etc.

Q. How are the patients with fungal infections treated?

They are treated with antifungal drugs, antifungal cream and powder etc.

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GUIDELINES FOR CONTRIBUTING ARTICLES FOR THE MAGAZINE

1. "SCIENCE HORIZON" aims at developing the scientific outlook of students as well as the general people and seeks to give them information on scientific developments. It is published as a monthly magazine.
2. The authors desirous of writing and contributing articles to the magazine should first assimilate the ideas of the theme and present it in simple language and popular style.
3. The authors are requested to write clearly on one side of A/4 size paper. The relevant pictures in 4cm X 6 cm size are welcome. Photo copies of manuscripts are not accepted for consideration.
4. Each article will be ordinarily of two to three printed pages in A/4 size papers.
5. The article shall be profusely illustrated with pictures.
6. At the end of the article the author should give the references and suggestions for further reading.
7. The reference of books, journals, sources, ideas and essential points collected by the writer should be mentioned in the bibliography. This will enhance the quality and fidelity of the writing and give the reader an opportunity for making further studies.
8. Matter translated from other languages and illustrations should indicate the original sources otherwise those would not be accepted. The articles which are not selected are not returned to the authors. However, if the author wants, such articles may be collected from our office.
9. As far as practicable the articles should be based on contemporary science and must be easily comprehensible to students at the secondary level.
10. The writers should present difficult concepts of science through stories of everyday life, heart-rendering songs, pictures, satirical cartoons or attractive dramas.
11. All units in the articles should be given in the metric system.
12. The title of the article should be brief and attractive. Moreover, subtitles may be given in long articles. The writings should be coherent and cohesive.
13. There should not be repetition of specific words. While ensuring the contemporary spirit of the writing, it should reflect some valuable lesson for the society. It is also necessary to avoid mistakes in spelling, language use and factual details.
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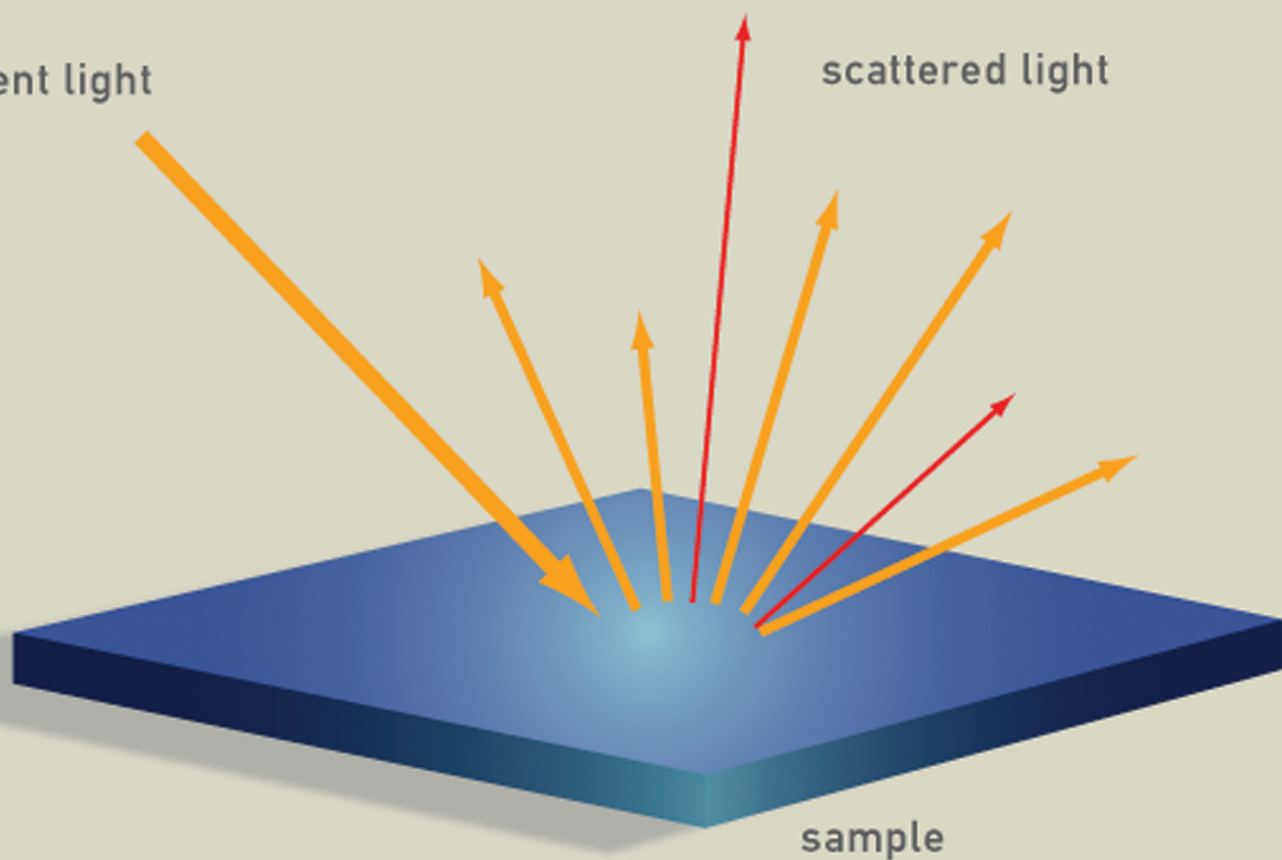
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