EVERYMAN'S SCIENCE

Vol. XLI No. 6 (Feb. '07 –Mar. '07)

COVER PHOTOGRAPHS

Past General Presidents of ISCA

1. Sir U. N. Brahmachari (1936)
2. R.B.T.S. Venkatraman (1937)
3. Prof. Rt. Hon. Lord Rutherford of Nelson *(1938)
4. Sir James H. Jeans (1938)
5. Prof. J. C. Ghosh (1939)
6. Prof. B. Sahani (1940)
7. Sir Ardeshir Dalal (1941)

* Lord Rutherford unfortunately passed away before the Science Congress and Sir James H. Jeans presided over the Congress in his place.

Printed and published by Prof. S. P. Mukherjee on behalf of Indian Science Congress Association and printed at Seva Mudran, 43, Kailash Bose Street, Kolkata-700 006 and published at Indian Science Congress Association, 14, Dr. Biresh Guha Street, Kolkata-700 017, with Prof. S. P. Mukherjee as Editor.

Annual Subscription : **(6 issues)**
Institutional Rs. 200/- ; Individual Rs. 50/-
Price : Rs. 10/- per issue

CONTENTS

EDITORIAL

SCIENCE, SOCIETY AND THE NEW CULTURE

Traditionally, science always got a backseat in the cultural world. A scientist is rarely esteemed in the society in the same way as a musician, or a literateur, or a film director is. When we talk of culture, we think of great works in literature, painting, music, film and so on. Science maintains a safe distance from the cultural world, the inner core of the society. Quite often scientists do not speak with the rest of the society or they do not have the proper language to express themselves to the ordinary man. Science has a self-imposed, near-saintly tolerance for failure. It aims at rational interpretation of observed data. It is not guided by emotion or passion. Science always attracted committed students, self-sacrificing researchers and very clean money–money with little political strings attached to it. It is considered as a noble endeavour. Nevertheless, science played a very effective role in shaping the modern society. Technology, the offspring of science, brought a remarkable social and cultural transformation. Science, therefore, is inherent in culture.

The Rede lecture of C P Snow delivered in 1959 defined two cultures–literary and scientific. Coleridge defined culture as the "harmonious development of those qualities and faculties which characterize our humanity". Snow recognized "the intellectual, aesthetic and moral values inherent in the pursuit of science". Scientific activities do not always proceed through experimental methods, do not always lead to quantitative data, and do not always tread the path of falsification. Science, again, is not alone in seeking natural laws and replicable results. Science is rather a cultural system that exhibits to us an alienated, interest-determined image of reality relevant to a particular space and time. Science never claims that it has reached the "ultimate". All scientific laws, all experimental results and all phenomena discovered by sciences are valid till the present point of time.

Till date science has a steady output of wonderful products. It has given us new consumables, new equipments and new methods of communication. In his book 'Experience and Nature' Dewey claimed "of all things, communication is the most wonderful". The statement made in 1939 may be preposterous, but it is neither false nor mundane in nature. Communication technology, mostly based on eletronics and computer, has bred a different culture that has been successful in creating a new intensely mediated environment. This is far from the communication between the two cultures postulated later as a third culture by Snow. Setting aside the debate between the two cultures, a new third culture has emerged. For the last two decades technology supersaturated our cultural environment. This technology is extremely malleable ; it provides a new medium for expressing ideas, representing relationship and modeling just about anything. Not only that this new environment has affected the music, literature or painting of the new generation, but it has given us a different system of human interaction. Technology is now the guiding factor in all sorts of human interaction—mobile communication, banking facilities, trade, distance learning and so on. Technology is even affecting the language ; a new sort of abbreviations or short forms of words, particularly in English, is emerging. Dictionaries cannot track them fast enough. Most of them have their origin in sciences. A programmer can design systems of virtually unlimited complexity with an absolute authority so that all his objects vividly exhibit their obedient behaviour. Such authority could not be exercised by an emperor in arranging his troops in a battle-field or a by a music director in his composition of a melody.

Unlike the culture of "sciences" this new culture has not maintained a distance from the inner core of the society. The Stars of this new culture already grace the cover pages of popular journals or magazines. It may be noticed that scientists, even of the suture of Einestein, needed much longer time to be worshipped by the society. Bill Gates is better known than his contemporary science laureates.

Going back to the basics of the two cultures, the purpose of science is to pursue the truth of the universe. Similarly, the objective of arts or humanities is to express the human condition. These two cultures have plenty of overlap. The new culture strays from both of these. It aims to make life enjoyable, useful and easier. It is not a celebration of its origin in science or engineering. It is guided by convenience, affordability, accuracy and promptness. It is concerned with creation, not with creativity. Its thrust is not on pursuing truth, but on pursuing novelty. Definitely, one can argue if we should call it a new culture. Perhaps it needs much longer span of time to be classified as culture. But the gravity of this technology-bred culture is too strong to ignore. The cultural matrix is changing with greater acceleration than it did anytime earlier.

Prof. P. N. Ghosh

"Courage is contagious. When a brave man takes a stand, the spines of others are stiffened".

— Billy Graham

PRESIDENTIAL ADDRESS

SCIENCE AND INDUSTRY

SIR ARDESHIR DALAL* I.C.S. (RETD.)

I feel that the authorities of the Indian Science Congress Association have made a very bold departure in electing a layman to the honour of the Presidentship for the year and, deeply conscious as I am of the honour, I confess to a feeling of diffidence in occupying a post which has been adorned by so many distinguished scientists before me. If my address falls short of the standard set by my predecesors, the responsibility of it should in part be borne by those who have elected me. The only reason for their choice, as far as I can see, lies in the fact that I may lay some claims to be an industrialist. So close and intimate is the relationship between Science and industry and so strongly is that fact being brought home to us in these days that the Association felt perhaps that they would like to have the views of an industrialist on the relationship of Science to industry with particular reference to the practical problems which have arisen in India since the beginning of the war.

VALUE OF RESEARCH IN INDUSTRY

A substantial part of the export trade of India has been lost since the war. Science can help in the utilization within the country itself of some of the raw materials which used to be exported. Researches are being conducted for instance on the use in India for lubrication purposes of some of the oil seeds of which the export has dwindled down and the surplus of which is likely to create serious economic trouble for the cultivator. Even a more acute problem is the stoppage of the import of many commodities essential for the economic life of the country, such as machinery, chemicals, etc. It is imperative that India should make herself self-sufficient with regard to such materials as are vital to the maintenance of her economic and industrial life so that the situation which had arisen during the last war and which has arisen once again may never recur. It is here that Science can be of the greatest assistance to industry. Research has been described as the mother of industry and while some of the older and more traditional industries may have originated without the aid of Science, it cannot be denied that all industries today depend upon Science and research not only for their progress and improvement but also for their survival. Sad experience has proved to us beyond all doubt that, under modern conditions, no nation, however peacefully inclined, can expect even to live an independent existence unless it is highly industrialized. It is the industrial potential that is convertible into the war potential and the country that has the highest industrial potential and is prepared to convert it in the shortest time into war potential that stands the best chance in modern warfare. As we have seen, it is not man power that counts in the highly mechanized warfare of the present day, but planes, tanks, guns, ships and the factories, plants and workshops behind them. The lesson for India is plain and she can only neglect it at her peril. It is no longer the question of a balanced economy or of mere material progress. It is necessary for India's very existence that the country should be highly industrialized.

* General President, Twenty-Eighth Indian Science Congress held during 31st January to 5th February, 1941 at Banaras.

This lesson was first taught during the last world war. Owing to its superior scientific organization and equipment Germany was able to withstand the Allies much longer than she could otherwise have done. At the beginning of that war, England found that she was deficient in many forms of optical glasses, dyestuffs, chemicals and other necessities for the conduct of modern warfare. She set herself to remedy these drawbacks. A very important dye industry was created and the whole of scientific and research talent of the country was organized by the creation of the Department of Scientific and Industrial Research. It is not necessary for me to enter into the details of the organization and working of the D. S. I. R. with which many of you must be familiar. An interesting feature of the organization, however, to which the attention of the authorities in India needs to be drawn is that the administrative organization of the D. S. I. R. is entirely composed of technical men, while the Advisory Council, which guides and controls its activities, is mainly composed of distinguished scientists with the addition of two or three well-known industrialists and business men. The words of Lord Rutherford to the Twenty-fifth Indian Science Congress, though frequently quoted since then, will bear repetition as they have an important bearing on the policy of the Government of India towards the recently created Board of Scientific and Industrial Research. He said

> "In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the Government, rests with research councils or committees who are not themselves State servants but distinguished representatives of Pure Science and industry. It is to be hoped that if any comparable organization is developed in India, there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned. It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but of course the responsibility for allocating the necessary funds ultimately rests with the Government."

There has been a tendency in the past in India for scientific and research work to be monopolized by Government Department and although valuable results have been obtained, e.g., by the Survey of India, the Geological Survey, the Botanical Survey and in the investigation of tropical diseases, it is very necessary that organized industrial research should as far as possible be left to scientists and industrialists although of course Government has to see that the grants it makes are properly utilized.

BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Industrial research was organized on a country-wide basis in America as well as in several countries of the British Empire following the lessons of the last war. In India also the war revealed the helplessness of the country. The transport service was disorganized owing to lack of railway material; supplies of dyes, important chemical and many important medicines were almost completely stopped and prices of textiles shot up so high as to be beyond the means of poor people. In 1915 the Government of India addressed the Secretary of State as follows

> "After the war India will consider herself entitled to demand the utmost help which the Government can afford to enable her to take a place, so far as circumstances permit, as a manufacturing country."

This policy was accepted by the Secretary of State and the India Industrial Commission, under the Chairmanship of Sir Thomas Holland, was set up as a result, Unforturnately, however, the impetus

to industrialization provided by the war died down after a few years and many of the industries which were started during the war languished and died. The gathering storm clouds of a new war drew the attention of Indian scientists to the unorganized state of scientific and industrial research in India and repeated appeals were made for the constitution of a body on the model of the D. S. I. R. The urgent need for the appointement of such a body was voiced by Professor J. C. Ghosh in his presidential address to the Association at Lahore in 1939 and was reiterated in a resolution of this body last year at Madras. The same point was made by Colonel Chopra in his presidential address to the National Institute of Sciences in Madras last year and by Sir M. Visvesvaraya in an address to the Indian Institute of Science, Bangalore. We, therefore, cordially welcome the recent appointment of the Board of scientific and Industrial Research by the government of India in response to the demand of scientists throughout the country. Our thanks are due to the present Commerce Member, Sir Ramaswami Mudaliar, who lost very little time in appreciating the urgency of the constitution of such a body under the condition created by the war.

I am a member of the Board and keenly interested in its sucess. Any observations which I may make upon it are made in a purely constructive spirit with the object of enhancing its utility to the country. In the first place then, I may be permitted to say that although the beginning of the Board, like most beginnings, may be small, its conception must be large and liberal. It must not, in its composition or working, bear the appearance of a mere *ad hoc* body created to meet the immediate exigencies of the war. The demands of the war are no doubt urgent and must have priority over other demands, but the Board should function as a body charged with the organization and promotion of industrial research throughout the country, and coordinate the immediate needs of the war with the long-range policy of the industrial development of the country as a whole. While concentrating on what is immediately required to meet war needs, it must also be in a position to survey the long-term industrial requirements of the country and to plan progamme of research to meet them. Perhaps after the urgent demands of the war are over, its composition can be enlarged and made more representative of the Universities, Government scientific services, the non-official scientific bodies and the industrialists of India so as to enable it to pursue its ultimate plan and policy.

No institution, however well conceived and designed, can flourish except in suitable political atmosphere and conditions. It was the unfortunate experience of the last war that industries created under the stress of the war languished and died in the postwar period for want of encouragement and protection from Government. The activities of the Board will not lead to the creation of new industries unless industrialists are assured of reasonable protection from Government in the post-war period, when foreign competition will be keen.

I have already quoted the words of Lord Rutherford as a warning against excessive Government control. The progress hitherto made by the Board is not as rapid as we would have wished in war time. This is partly due to the constitution of the Board under which executive authority is concentrated in a central department of Government and partly to the inadequate staff provided for the very urgent and important work that has to be done. There is one other aspect on which I desire to touch and that is the financial. Even for a beginning, a grant of Rupees five lakhs is inadequate and shows to my mind an inadequate conception of the magnitude of the tasks involved. Associated with the Department of scientific and Industrial Research in Great Britain are the great National Physical Laboratory at Teddington and important Boards, such as the Fuel Research Board, the Food Investigation Board, the Forest Products and Building Research Institutes and a

number of similar bodies as well as Research Associations. While we must necessarily make a very modest beginning, the development of the Alipore Test House into a National Physical and Chemical Laboratory seems to be obviously and urgently required. In a subsequent part of this address I shall dwell upon the necessities of a Fuel Research Board to investigate the very pressing problems of fuel and power, upon which the whole industrial structure of the country has to be based. All this work will require large funds but I have not the slightest doubt that the money so spent will be repaid manifold. It has been estimated that the annual expenditure on research in Great Britain in normal times before the war was roughly six million pounds, of which one-half was spent on research directed to industrial needs, including the money spent by Government, University Departments and private firms. The figure for the U.S.A. is estimated to be 300 million dollars, while the corresponding figure of the U.S.S.R. is reported to be of the nature of 120 billion roubles. With the exception of the U.S.A. and the U.S.S.R., there is no country in the world with natural resources so vast and varied as India. With the expenditure of even a fraction of the amount spent by the countries just mentioned on industrial research, these resources can be investigated and developed so as to place India in the front rank of the industrial countries of the world.

THE STEEL INDUSTRY IN INDIA

I propose now in the second part of my address to speak to you on some developments in the steel industry in India during the last ten years; but before doing so I should like to make a few remarks on the raw materials which are commonly used in the manufacture of iron, namely, iron ore, coal and limestone, and particularly coal, which is the most important of our raw material and of the most general interest.

IRON ORE

So far as iron ore is concerned, India is one of the richest countries in the world, being endowed by nature with very extensive deposits of very rich ore. The Singhbhum—Orissa field is the most extensive in India. The tonnage of this field has been estimated by Mr. H. C. Jones of the Geological Survey, at 3,000 millions, and, if anything, it is probably an underestimate. Practically the whole of this ore is hematite, with an iron content of sixty to sixty-nine percent.

COAL

While the position regarding iron ore is highly satisfactory, that regarding coal, particularly the coal required for the smelting of the iron ore, is far from satisfactory. Dr. Fox has estimated the resources of Indian coal over four feet in thickness up to 2,000 feet in depth and twenty percent in ash at 24,000 million tons, of which coal of good quality up to 18% ash is 6,000 million tons, while coking coal suitable for metallurgical purposes is only 1,400 million tons. Coking coal in India is confined to the Gondwana coal beds of the Damodar Basin. On the existing methods of working coal the total life of the coking coals of India is estimated at about fifty years. This is a position which neither the Government nor those interested in the metallurgical industry can view with equanimity. The most recent Committee appointed by the Government of India to investigate the position and suggest remedies was the Burrows Committee of 1937. The terms of reference to the Committee were unfortunately not comprehensive enough and the legislative measures taken by Government as a result of the recommendations of the Committee are mainly confined to the ensuring of safety in mines. The problem of Indian coking coals is, however, one of conservation as well as of safety and if proper attention is paid to conservation, the problem of safety will more or less automtically be solved. Legislation in the interest of safety which

places additional burdens on the industry without assisting it to dispose of its production in a more scientific manner, is likely to worsen the situation by hastening the uneconomic exploitation of the good coals by the smaller colliery owners. What is required is the rationalization of production as well as of consumption. In order to achieve the rationalization of consumption, a thorough chemical and physical survey of the coal fields beginning with the Jharia coal field, in conjunction with a scheme of coal utilization research is absolutely necessary. For the purpose it is necessary to create a Fuel Research Board as a branch of the Board of Scientific and Industrial Research with a proper personnel, adequate staff and funds.

FUEL RESEARCH BOARD

Power is a *sine qua non* of the development of all industries and the proper conservation and utilization of the coal resources of the country is the first question that requires to be tackled in any consideration of the power resources of the country. The geological survey of the various coal fields has been excellently and exhaustively carried out at great expense to Government and it is high time that a scientific, chemical and physical survey were also carried out. Such a servey has been instituted in Great Britain and has resulted in a mass of most valuable information regarding British coals which has in many instances completely altered the attitude of the industry to many varieties of coal and enabled a more efficient use to be made of them.

On the production side the most important problem is that of the coordinated sequence of working the coal seams. Perhaps the worst feature of the working of Indian colleries is the exploitation of the richer coal from the lower seams for immediate profit and the neglect of the upper seams resulting in subsidences, fires and destruction of valuable coals. The coordinated sequence of working will prevent this destruction of top seams and will eliminate to a large extent the necessity of stowing altogether. No. 16 seam in the Jharia coal field is a case in point. This coal has good cooking properties but because of its high ash content and doubtful swelling tendencies it has been comparatively unexploited, either as a steam or coking coal.

The washing of coals is another question affecting production. In many cases the ash in the Jharia coals is inherent or when present in a free condition is of about the same specific gravity as the coal itself, thus making the separation impossible or difficult, but it has been proved that in certain of our high ash seams the ash content can be reduced by liquid flotation. 11 and 16 seams Jharia come into this category and further research is necessary to determine whether it is economically feasible to wash these coals with a view to reduce their ash content.

On the consumption side, the chemical and physical survey into our coal seams in conjunction with coal utilization research will in the first place enable us to determine the range and variety of coals suitable for coking as well as boiler purposes. Research is necessary in order to ascertain whether with proper blending and mixing the demands of the metallurgical industry need be confined to the very limited Jharia field. Several experiments have been carried out in the past, but further systematic research by the Board suggested above into blending with high ash coking coals, with swelling coking coals and with non-coking coals may result in the conservation of good coals and an extension of the range of coals available for metallurgical purposes.

Similar research is also required in the case of power coals. A certain amount of information is already available but is mainly confined to the mixing of the high volatile coal in the Raneegunge field with the low volatile coal in the Jharia field for the export market and bunkering only. These low volatile coals from the Jharia are good metallurgical coals and research will doubtless produce suitable blends for export and power

requirements without encroachment on these valuable low volatile coking coals.

The utilization of high ash coals for electrical generation at the sources of production and the distrubution of the energy thus supplied over large areas is another problem of the first magnitude. The erection of a large power station on the coal fields for the distribution of cheap power to surrounding areas has already been advocated from many sources and has engaged the attention of the Government of Bihar. Further investigation of the suitability of the coal for such a purpose will help greatly towards the fulfilment of this very desirable project and should form one of the first objects of enquiry by the proposed Board.

Low temperature carbonization tests with various classes of coal, particularly of high ash, which are unsuitable for metallurgical purposes and also unsuitable on account of high ash content for transport to distant areas for power purposes, should provide another field for the activities of the Board. A number of scientists from the platform of this Congress as well as outside have advocated the cheap production of domestic coke on a mass scale and the utilization of the resultant tar for industrial purposes. The present very small production of soft coke is capable of very great extension if a market can be found for the coke as well as the resultant tar, even if the gases are ignored for the present. The economic difficulties in the way of such a proposal need not be minimized but practical experiments have already been carried out at Patna under the auspices of the Bihar Government and these would seem to indicate that further research may prove successful. Should this prove to be the case, there would be an adequate supply of raw material for the foundation of hydrogenation plants. This may be regarded as a distant aim as such plants have not proved too successful in other countries, but with the cheap India coals and the large quantities of tars which would be available from their low temprature carbonization success may be easier of attainment in India than in other countries.

The Board should also investigate the question of the scientific preparation of coal for the market and buying and selling on specification. This would mean the complete abandonment of the existing unscientific system of grading. The seams which were originally graded, have become exhausted or are nearing exhaustion or have deteriorated to such an extent that the classification is in many cases no longer applicable. The disposal of the metalliferous production of the country has long been established on the international basis of scientific specification and it would be equitable to both buyer and seller alike to establish the buying and selling of coal and coke on a similar basis.

If my proposal for the establishment of a Fuel Research Board is approved, I would suggest that as the Jharia coal field is practically the sole source of our coking coals and is also the center of the Indian School of Mines, the headquarters of the Board should be situated at Dhanbad and the School of Mines and its laboratories which should be adequately equipped for the purpose, should be utilized for the investigations of the Board.

THE TATA IRON AND STEEL COMPANY : PROGRESS IN THE LAST DECADE

The last decade has seen a great expansion of the Steel Industry in India, accompanied by improvement in the various processes and the application of scientific methods of control. You will forgive me if I confine my remarks to the works of the Tata Iron and Steel Company alone, as the steel-making plant at Bhadravati in the Mysore State was put up in 1936 and has an annual capacity of about 20,000 tons only, while the plant of the Steel Corporation of Bengal with an estimated capacity of two hundred to two hundred and fifty thousand tons of finished steel, has begun operation very recently. In terms of tonnage, the progress can be measured by the fact that while the Tata Iron

and Steel Company produced 422,000 tons of finished steel in 1929-30, the corresponding production in 1939-40 was 777,000 tons. Ten years ago only thirty per cent of the demand of the country for steel was met by the indigenous industry, whereas in 1939-40 about eighty-four per cent of the demand was so met and the day is not distant when India will be able to supply not only the whole demand of the country except in a few very specialized directions but also to spare some steel for export.

COKE OVEN

Following the sequence of the manufacturing processes of steel, I begin with the coke ovens, where the coal is converted into coke. Ten years ago we had three batteries of Wilputte Coke Ovens and two batteries of the still older Koppers Coke Ovens which together produced 720,000 tons of coke, 22,300 tons of tar and 6,600 tons of ammonium sulphate. By 1940 all except one of the Wilputte batteries were replaced by three modern batteries of Simon-Carves Coke Ovens containing 54 to 55 ovens in each battery at a cost of Rupees one crore and sixty-five lakhs. These batteries are of the twinflue "Underjet" type capable of carbonizing 1,300 to 1,500 tons of coal each per working day. Arrangements have been provided for firing the ovens with coke oven gas or with the cheaper blast furnace cleaned gas. Firing the coke ovens with blast furnace gas releases the more valuable coke oven gas for use in steel-making furnaces in other parts of the plant. The twinflue construction assures a more uniform heating throughout the length and height of the oven with a resulting uniformity of the coke produced. As stated in the preceding part of the address, all coals do not give good coke and careful investigations have to be carried out in the blending and mixing of different varieties of coal. To this end three large slot bunkers of the capacity of 2,000 tons each have been installed. Coal wagons, as they arrive from the collieries, are taken over to the selected bunkers and unloaded. The coal is then mixed mechanically in the required proportions from the three bunkers and suitable mixed coal is conveyed by mechanical conveyors to the ovens into which it is charged.

The three principal by-products of the coke ovens are coke oven gas, ammonia which is turned into ammonium sulphate and tar. The sulphuric acid for the manufacutre of the ammonium sulphate is made in a recently installed contact process plant producing fifty tons of 100% acid per day.

So far the manufacture of benzol as a by-product of the coke ovens has only been attempted on a very small-scale in India. A plant is now nearing completion at Jamshedpur for the manufacture of benzol and toluole for the Government of India. When it comes into operation, it will be of great assistance in the manufacture of high explosives for the ordnance factories. The plant is designed for extracting benzol motor spirit and toluole and is being installed by Messrs. Simon-Carves.

BLAST FURNACES

The next stage in the manufacturing process is the blast furance for the production of pig iron. Ten years ago, Jamshedpur had four blast furnaces; two of the capacity of 900 tons, one of 750 tons and one of 250 tons per day. The small blast furnace was completely rebuilt in 1936 and its capacity was increased to 550 tons. An entirely modern blast furnace was installed last year. The diameter of its hearth is 22 feet 6 inches, of the bosh 26 feet 6 inches and of the top 19 feet. Its height is 95 feet and volume 35,160 cubic feet. For the one year that this furnance has been in operation it is estimated to have produced more iron than has ever been produced elsewhere on a furnace of similar size over a similar period. The total pig iron capacity of the Jamshedpur plant is a million and a quarter tons per annum.

For every ton of iron made, a blast furnace produces roughly 100,000 cubic feet of gas. This blast furnace gas contains about 14 grains of dust per cubic foot of gas at N. T. P. This gas has considerable fuel value, but owing to its dirty condition its use in industrial plants, such as blast furnace stoves and boilers is restricted. It has been realized that considerable fuel economy can be effected if this gas is cleaned. In the last ten years the Steel Company has installed two large gas cleaning plants, each with a capacity of fourteen million cubic feet of blast furnace gas at N. T. P. per hour. Both the plants clean the gas to a purity of 0.08 grains of solids per cubic foot of gas at N. T. P. The older of these two plants is the Lodge Cottrell plant of the dry type which came into operation in 1934. The second gas cleaning plant is of the Brassert design. This plant consists of wooden-hurdle wet washers which not only cool the dirty blast furnace gas but also remove about eighty per cent of the solids from the gas. This semi-cleaned gas is then passed through the Cottrell wet electric precipitators which precipitate the rest of the solids and deliver clean gas to specification.

FUEL ECONOMY

The old concepts of fuel economy and energy distribution have been completely revolutionized by the modern scientific use of coke oven and blast furnace gases. Fuel economy and distribution of energy in a large plant like that of the Tata Iron and Steel Company is a highly specialized job, which is in charge of a special department of the pant, designated the Energy and Economy Department. The efforts of this department have succeeded in reducing the overall fuel rate from 3.56 tons of coal per ton of steel in 1930-31 to 2.19 tons in 1939-40. Modern practice aims at reducing the use of coal as fuel and replacing it by the more efficient by-product fuels, such as coke oven gas, blast furnace gas, coke dust, etc. The use of mixed gases in this connection requires special mention.

The cleaning of the blast furnance gas permits of its use in coke ovens and releases a corresponding amount of the richer coke oven gas for use elsewhere at the plant. Blast furnace gas has a comparatively low heating value of about 110 B.T.U. per cubic foot of gas, while coke oven gas has a value of about 470 B. T. U. per cubic foot. Modern practice tends to a greater use of coke oven gas or a mixture of coke oven and cleaned blast furnace gas in steel-making and re-heating furnaces, replacing to that extent coal which has been used so far in the form of producer gas. Fuel costs are thus greatly reduced. For the successful use of the gases it is necessary to have steady pressure of gas at the consuming ends. For that purpose two large dry gas holders for the storage of blast furnace and coke oven gas respectively have recently been installed. These gas holders act as reservoirs which smooth out the fluctuations of the gas caused by the furnace irregularities and thus assure continuous operation of boilers, coke ovens and other consuming centers. The blast furnace gas holder is a huge structure 283 feet high, 176 feet in diameter, capable of holding 5 1/2 million cubic feet of gas at N. T. P. The coke oven gas holder is 192 feet high, 1/2 feet in diameter and holds 11/2 million cubic feet of coke oven gas.

STEEL-MAKING PRACTICE

The last ten years have also seen important developments in steel-making practice and a considerable increase in production.

Steel-making operations at Jamshedpur are carried out in two types of plants, the Open Hearth and the Duplex. The Open Hearth is the oldest part of the Jamshedpur plant. Four out of the seven furnaces which we were working ten years ago, have been remodelled along modern lines and an eighth furnace has been built. The ingot production from this plant has been increased during the last ten years by over 100,000 tons per year, the figure for 1929-30 being 242,000 tons as compared with

345,000 tons in 1939-40. The Duplex steel-making process, as its name implies, consists of two operations,

1. blowing the molten pig iron in acid-lined Bessemer converters to remove the silicon and manganese and most of the carbon, and
2. transferring the blown metal to basic-lined Open Hearth tilting furnaces where the phosphorus is removed and the steel finished to chemical specification.

Improvements to this plant during the last ten years have resulted in increase of production from 340,00 tons in 1929-30 to 670,000 tons in 1939-40. In addition to these two steel-making plants a four-ton electric furnace was installed in 1936 mainly for the manufacture of electric castings, while two five-ton electric furnaces have only recently been installed and are being utilized for the manufacture of class steel, spring steel and alloy steel. The installation of these electric furnaces has been of the greatest assistance in the making of superior quality alloy steel required by the Defence Department.

A NEW STEEL-MAKING PROCESS

The most important advance made during the last decade, from the point of view of scientific research, is the practical development of the rapid dephosphorizing process. As this matter has never been the subject of public discussion in India so far, a few details will not be out of place here. As is well-known, Indian pig iron contains about 3 to 4% phosphorus. This per centage of phosphorus in the iron neither lends itself to the straight basic Bessemer process nor to the straight acid Bessemer process. The phosphorus has to be removed to 0.05% for most commercial specifications though as much as 0.10% is admissible in certain products. The removal of this phosphorus is normally effected by the action of basic and oxidizing slags in Open Hearth furnaces. At the best of times this is a slow operation taking from one to several hours even in the quick working Open Hearth furnaces of our Duplex plant. In 1935, when our General Manager, Mr. Ghandy, and myself were on leave in Europe, our attention was drawn to certain developments in France, where a French Steel Engineer, M. Perrin, had carried out successful experiments in the rapid deoxidation of steel by violent mixing together of slag and steel so as to obtain a considerably greater area of contact between them than could ever be obtained in the conventional Open Hearth furnaces. This idea of the violent mixing of slag and steel was also considered applicable to the dephosphorizing operation. After a study of the French experiments, large-scale investigation over a long period was carried out at Jamshedpur and ultimately a practical method was evolved for operating the dephosphorizing process on a commercial scale under Indian conditions. This new process consists in blowing molten pig iron in an acid Bessemer converter to remove all the silicon and manganese and as much of the carbon as required. This blown metal is then poured from a considerable height into a synthetic molten basic oxidizing slag contained in a ladle. The metal comes into very intimate contact with the slag and the phosphorus is rapidly removed in the course of two or three minutes, instead of as many hours, in the normal Open Hearth process. As the steel and slag separate, the steel is finished to analysis and cast into ingots.

The process is subject to exact control and steel of basic Bessemer quality can be made directly from the pig iron. Moreover, the dephosphorized metal can be further treated in an Acid Open Hearth furnace and steel of first class Open Hearth quality can be made. Thus for the first time in India it becomes possible to make acid steel out of Indian basic pig iron. A plant for the manufacture of steel by this process is now under contruction.

The successful development of this process may be regarded as the most important advance in steel-making practice that the young Indian steel industry

has made. It is likely to have far-reaching effects on the establishment of several new industries in India, such as locomotive manufacture and the manufacture of railway wheels, tyres and axles, for which acid steel is specified.

RAILS

In the manufacture of rails, advance has been made as a result of metallurgical research during the last ten years. Investigations have shown that medium manganese rails with a lower carbon and higher manganese content of 1.10 to 1.40% have superior properties of wear and resistance as compared to straight carbon rails with higher carbon and lower manganese content. There is a growing tendency to replace straight carbon rails with medium manganese rails. On the other hand, high chromium rails were found unsatisfactory.

An interesting advance has been the installation of Sandberg Ovens for the Sandberg controlled cooling process for rails. All over the world the controlled cooling of rails has come to be looked upon as a definite and desirable advance on the old practice of cooling rails on open hot-beds. The Tata Iron and Steel company have obtained exclusive rights in India for the working of the Sandberg process. They have installed four Sandberg Ovens for the controlled cooling of their rails. Experiments are also being conducted in the welding of rails in the track. This aims at giving longer lengths in the track between joints and helps to provide a smoother ride.

PLATES

In the Plate Mill, the most interesting development in the last decade is the installation of a modern normalizing furnace for plates. This furnace was first installed to normalize some of the high tensile steel plates for the new Howrah Bridge. By the aid of this furnace it is now possible to produce in India normalized plates which had formerly to be imported. The furnace is also used to normalize certain structural sections. Thus materials with a new range of physical properties have been made available to the designing engineers. It is worth noting that Indian plates have largely replaced foreign plates even for the most exacting demands, such as for barges and ships.

Ten years ago, the Sheet Mill at Jamshedpur consisted of five hand-operated units and the total annual production was 38,000 tons.

SHEETS

The rolling of sheets was an extremely strenuous manual operation calling for considerable physical exertion. Production was low, defects and rejections were high. Today we have only four hand-operated mills and three mechanized units with an output of 170,000 tons. These new mechanized units have produced tonnages which, as far as can be ascertained, constitute a world record for this type of equipment. Besides the ordinary quality mild steel sheets, the Jamshedpur plant now turns out different classes of sheets with a high grade finish, including "Tiscor" and high carbon sheets. Panel plates for coach building are supplied to the Railways and the various engineering firms. Other special developments in sheet manufacture are the rolling of drum stock for the manufacture of drums and containers, enamelling stock for deep-drawing and subsequent enamelling, furniture stock and, lastly, special sheets for steel helmets for the army.

LOW-ALLOY STEELS

It is owing to applied research that most of the significant advances in the steel industry at Jamshedpur during the last decade have been made possible. I have already mentioned the case of the rapid dephosphorizing steel. The development of low-alloy steels is another very important instance. Engineers in general and transportation engineers in particular are beginning to realize that ordinary carbon steel performs its functions only at the expense of unnecessary dead weight and excessive

loss due to its low resistance to corrosion and abrasion. The problem of providing suitable materials for lighter weight is not one relating to mechanical strength alone. It requires the integration of several properties in one material, such as strength, resistance to impact, corrosion and abrasion, ease of forming, satisfactory welding, etc., as well as moderate cost. With this end in view, metallurgical research was conducted at Jamshedpur, resulting in the development and commercial manufacture of a low alloy, high-tensile steel containing copper and chromium known as "Tiscrom". This steel is being employed in the construction of the new Howrah Bridge.

The introduction of India of another low-alloy high-tensile steel, sold in America under the trade name "Corten" deserves mention. Research conducted in America had shown that the addition of a high percentage of silicon and phosphorus to alloy steel, containing chromium and copper, resulted in a low-alloy, high-tensile steel of the same properties as those of Tiscrom but with the additional important property that it could be readily welded by all methods of rapid welding such as oxy-acetylene and automatic electric welding. After an investigation into the possibilities of the manufacture of this steel in India and an examintion of the claims put forward for it, the Tata Iron and Steel Company obtained exclusive rights for the manufacture and marketing of this steel in India under the trade name of "Tiscor".

SPECIAL STEELS

Reference has already been made to the installation of the electric furnaces. Among the special qualities of iron and steel manufactured from these furnaces are chrome-manganese steel for crane track wheels, thirteen per cent manganese steel for crusher jaws and similar hard wearing parts of machinery, nickel-chrome heat-resisting steel and cast iron for various casting required to withstand high temperature and nickel-chrome-molybdenum steel for crane pinions, mill rolls, etc. The manufacture at Jamshedpur of special alloy steel rolls has enabled the Steel Company to replace similar rolls of foreign manufacture.

Since the outbreak of the war, intensive research work has been undertaken for Government in connection with the manufacture of armoured vehicles in India, and as a result a bullet-proof armour plate of special alloy steel which has stood the firing tests and has been accepted by Government, has been developed. Suitable steels for the manufacture of armour piercing shot and for steel helmets have also been produced. Research work was undertaken at the instance of Government in regard to the supply of steel suitable for telegraph wires. This steel has now been successfully manufactured and the wire rolled at the works of the Indian Steel and Wire Products out of this materials has met with the approval of the Department of Posts and Telegraphs.

Researches are being carried out on behalf of the Defence Department in connection with the welding of chrome-molybdenum steel plates for aircraft manufacture and in other directions.

Most of the high speed steel requirements of the plant for machine tools are now being met by the remelting of tool scrap in the high frequency induction furnace in our laboratories. High chrome and stainless steels have been produced in the furnace in small quantitites.

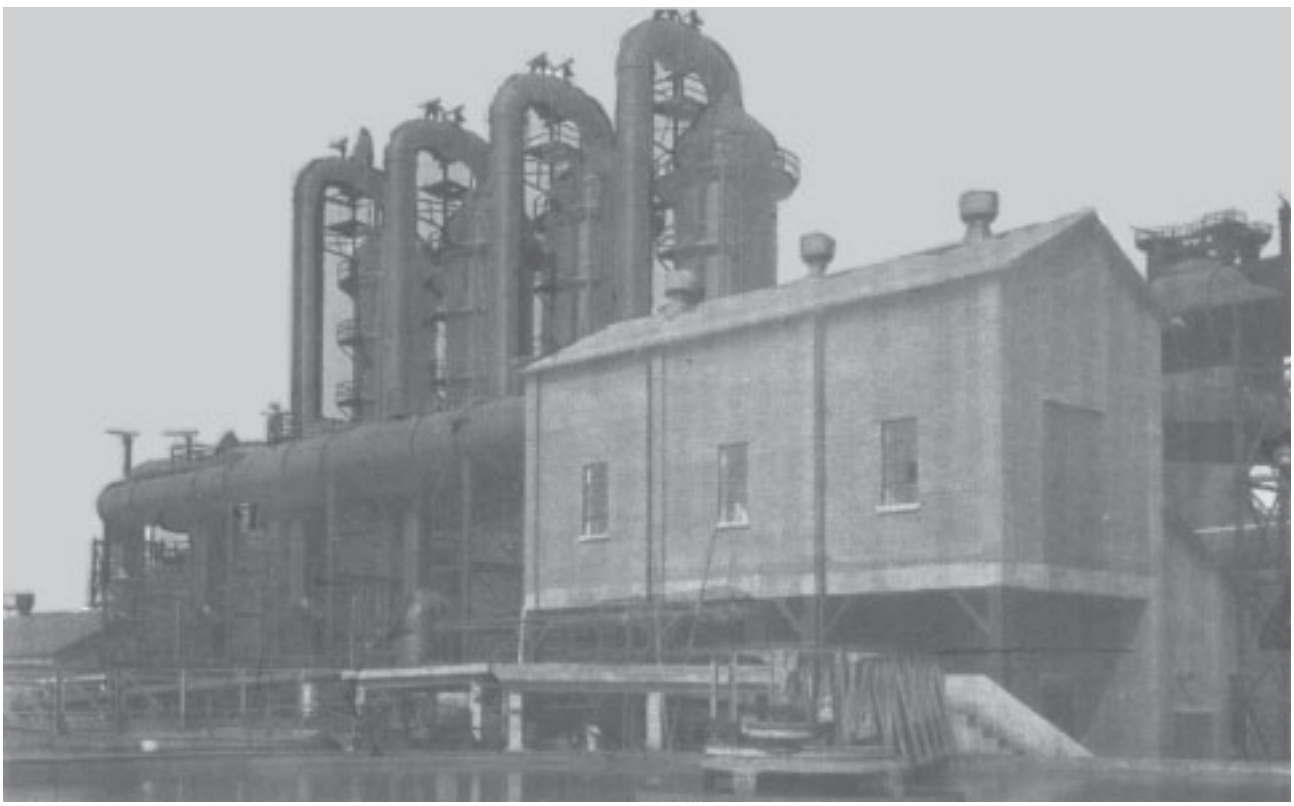
Besides metallurgical research, fuel research, chemical research and research in refractories are being pursued. Researches of the fuel department in blending and mixing have resulted in the determination of the most suitable varieties of coals for coking and similar purposes. Research on refractories has enabled us to evolve a better class of refractories for the use of the steel plant. Indian raw magnesite was at one time considered unsuitable for use in basic steel furnaces. Investigations carried out at Jamshedpur

have now made it possible to produce in India the Steel Company's entire requirements of finished magnesite. Metal-cased magnesite bricks made at Jamshedpur have given very encouraging results for the superstructure of basic furnaces. Chrome magnesite brick for use above the slag line in basic Open Hearth furnances in place of silica brick is another important development in the refractory field. Other interesting developments in brick manufacture are investigations into the possibilities of the manufacture of forsterite, semisilica, micaschist and mullite bricks. An entirely new process has been developed for the manufacture of mullite refractories using cyanite, silimanite and andalusites, India having practically a monopoly of the first two. Very productive work has also been accomplished with regard to high-temperature mortars. Superior types of mortars for high temperature work are now being locally made, replacing many of the imported brands.

A NUCLEUS FOR A NATIONAL METALLURGICAL LABORATORY

To facilitate research work, a modern well-equipped laboratory was erected in 1937 at a cost of over Rupees ten lakhs. May I express the hope that with the facilities for metallurgical research provided by this laboratory and its workers, Jamshedpur may in the near future become the centre of a National Metallurgical Laboratory and Research Institute and thus be enabled to play a greater and worthier part in the development of the metallurgical industry in India.

When the titanic conflict now being waged ends, as end it must, in the triumph of the democracies and the cause of human freedom, I pray that India may emerge from it with the foundations of its industrial as well as political freedom well and truly laid, so that she may be properly equipped to play her rightful part in peace and in war as a worthy member of this great commonwealth of nations.



TELEMEDICINE : FUTURE IN INDIA

Kaushlendra K. Pandey, Asha Agarwal, S. N. Singh*

Telemedicine primarily refers to use of Telecommunication for diagnosis and treatment of disease. Telemedicine is the use of electronic information and communication technologies to provide and support healthcare when distance separates the participants. Reaching medical services to remote parts of India is a daunting task and rushing specialists' advice and care in an emergency is nearly impossible.

That is now beginning to change because of the Internet. Medical specialists are fast becoming available for consultation through video conferencing, web cameras, online sharing of reports and 'telemedicine' software.

INTRODUCTION

Telemedicine is a method by which patients can be examined, investigated, monitored and treated, with the patients and the doctors located in different places. *Tele* is a Greek word meaning "distance" and *Mederi* is a Latin word meaning "to heal". TIME magazine called Telemedicine "healing by wire". Though initially considered "futuristic" and "experimental", Telemedicine today is a reality and has come to stay. In Telemedicine, one transfers the expertise, not the patients. Hospitals of the future will help treat patients from all over the world without geographical limitations. High quality medical services can be brought to the patients, rather than transporting the patients to distant and expensive tertiary care centers. A major goal of telemedicine is to eliminate unnecessary travelling of patients and their escorts. Image acquisition, image storage, image display and processing, and image transfer represent the basis of telemedicine. Telemedicine is becoming an integral part of healthcare service in several countries, including the UK, USA, Canada, Italy, Germany, Japan, Greece, Norway and also now in India.

* Deptt of Pathology, G. S. V. M. Medical College, Kanpur. E-mail : pandeykk@iitk.ac.in

Telemedicine avoids unnecessary, travel and expense for the patients and the family improves outcomes and even save lives. Once the "virtual presence" of the specialist is acknowledged, a patient can access resources in a tertiary referral center without the constraints of distance. Patients can stay at home, enjoying much needed family support. In a large Telemedicine project in the USA, 83% of patients who would have been transferred to an urban hospital remained in their community reducing the cost[1] by at least 40 to 50%. This also ensures maximal utilization of suburban hospital. The general practitioner in the rural/suburban area often feels than he would loose his patient to the city consultant. With telemedicine the community doctor continues to primarily treat the patient under a specialist's umbrella. With modern software/ hardware at either end, 90% of the normal interaction can be accomplished through telemedicine.

A basic Telemedicine system consists of a personal computer, a telephone line, a scanner and a webcam. Telemedicine covers a wide range of activities. In the past, it was primarily Teleradiology, transferring high resolution X-rays, ultrasound, CT scans, MRIs and ECGs. Today, the same system

can enable a doctor to conduct a detailed clinical examination remotely[2]. What's more, gloves with special sensors are available, which give tactile feedback from a transmitted image.

THE INDIAN SCENE

With a heterogeneous geographical set-up of India, the population is spread out far and wide. Not everyone has access to healthcare services. The huge population makes the government's job more difficult in planning healthcare delivery system and making facilities available for everybody at every place. Since specialists are concentrated mostly in towns or cities, it is difficult for people living in remote places to get access to specialized healthcare services. Some studies have shown that in the case of rural population, the risk of death is twice that of urban patients with similar ailments. The reasons relate discovery time, transport time and inexperienced providers. Telemdicine has the potential to solve all these problems.

Telemedicine is important in the Indian contest, because of available statistics : Though over 620 million people live in rural India, medical specialists are mostly confined to urban areas. There is only one hospital bed available for 1,333 Indians, and one doctor per 15,500 people. Only 9 percent of our one billion people are covered under health schemes. Add to this the difficulty posed by India's vast geographical spread, and it is obvious why healthcare providers are looking to Telemedicine to reduce India's healthcare problems.

Rural patients have to travel huge distances, and thus incur considerable expenses every time they need to consult a doctor. In some of these cases, the same treatment could have been carried out by a local doctor with advice from a specialist living elsewhere. Further, as in any profession, medical specialists tend to focus more on large metros rather than sparsely populated towns–which works to the detriment of the non-urban population.

One of the biggest benefits, of course, is elimination of unnecessary travel, expense and even strain. Once the virtual presence of a specialist is acknowledged, a patient can access medical resources without the constraints of distance. It also solves the problem of retaining specialists in non-urban areas. For instance, since Chennai has three medical universities, there are more neurologists and neurosurgeons in the city than in the states of the North-East put together. The increasing availability of telecommunication infrastructure and video conferencing equipment can make a doctor virtual and make available his knowledge to anyone, anywhere in the country.

With the nation's healthcare system undergoing profound changes and experiencing relentless financial pressure, Telemedicine is being investigated for its utility in urban as well as rural settings. To the extent that Telemedicine offers a mechanism for centralizing specialists and supporting primary care clinicians, managed care–plans may find certain applications efficient and attractive in the cities and suburbs where their patients are concentrated. Some academic medical centers and other organizations, faced with reduced revenues and even exclusion from locally managed care networks, are exploring Telemedicine as they seek to develop new regional, national, and international markets for their highly specialized clinicians. In these contexts, Telemedicine has the potential to radically reshape healthcare in both positive and negative ways and to fundamentally alter personal face-to-face relationship that has been the model for medical care for generations.

Telemedicine system is quite user-friendly and is like any other computerized electronic system. The ground systems mainly consist of customized medical software integrated with computer hardware, along with medical diagnostic instruments connected through the satellite-based VSAT or terrestrial communication link. Normally, the medical records of the patients can be sent to specialist doctors either in advance or on real-time basis. Specialist Doctors will, in turn, study and provide diagnosis and treatment through video-conferencing with the patients and the local doctors.

A short duration training is sufficient for both super specialty hospital doctors and rural doctors to handle the system. Hospital technicians can take care of operation and maintenance.

Though telemedicine had not yet made a significant impact on mainstream medicine, the crystal ball reveals that remote consultation will be soon commonplace in specialties where images form a major part of the consultation. A non-specialist centre can get a specialist's opinion, and a specialist can get a second opinon. Radiology, pathology and ultrasound centers will interact electronically in real-time to obtain images. In specialities like dermatology, accident and emergency medicine, and fetal medicine, video-conferencing will allow the specialist to interact with the primary physician with or without the presence of the patient. Remote face-to face video consultation may even be perceived as less threatening and more acceptable in certain situations like psychiatric consulatations. Workstations with the necessary software will be a common feature in the homes of specialists. Like most other professionals, the telespecialist of the future will offer advice from his home without having to travel to long distance to a hospital. Junior hospital staff now depends on telephonic advice, which has considerable limitations.

The first generation of telemedicine enthusiasts, however, should not forget that technology should be used as a support to treat patients and not viewed as a goal in itself. The challenge today is not just to overcome technological barriers. Rather, the challenge is why, where and how to implement which technology and at what cost. A 'needs' assessment is critical. Due to enormous pressure from powerful vendors, the perceived needs for telemedicine may not conform to actual needs.

Though preliminary trials with Telemedicine in India have revealed high levels of satisfaction among patients, general practitioners, specialists and technologists, questions are often raised-and rightly so-on whether telemedicine is the result of a technology push rather than a clinical pull. There are no easy answers. But information technology has changed, is changing, and will continue to change the delivery of healthcare worldwide.

The efficacy of telemedicine has already been shown through the network established by the Indian Space Research Organization (ISRO), which has connected 22 super-specialty hospitals with 78 rural and remote hospitals across the country through its geo-stationary satellite[3]. This network has enabled thousands of patients in remote places such as Jammu and Kashmir, Andaman and Nicobar Islands, the Lakshadweep Island, and tribal areas of the central and northeastern regions of India to gain access to consultations with expert in super-specialty medical institutions. ISRO has also provided connectivity for mobile telemedicine units in village, particularly in the areas of community health and ophthalmology.

As telemedicine technologies and processes gradually mature, the extent and breadth of medical specialties where telemedicine technologies could prove clinically useful should expand. Indeed, reports of telemedicine implementations are appearing in orthopaedics, dermatology, psychiatry, oncology, neurology, pediatrics, internal medicine, ophthalmology and surgery.

The price of the underlying technologies for telemedicine is dropping and so is the number of available specialists. These trends, combined with the increased availability of telecommunications facilities, indicate that telemedicine will become more common.

REFERENCES

1. D. A. Perednia, A. Allent : *JAMA* ; **273** : 483-8, 2005.
2. L. W. Kaye, *Telemed J.* **3** ; 243, 2005, *Neural India* ; **53** ; 27-31, 2005.
3. Sanjay P. Sood and J. S. Bhatia : Internet as the backbone for Telemedicine : How far/ close are we? Presented at All India Seminar on Challenges Ahead with Information Technology**,** organized by IE & SLIET, Longowal, 19-20 January, 2002.

CAVES AND CAVERNS

Madhumita Das[1], Shreerup Goswami[2]* and B. C. Guru[3]

The unique landforms of hollow places of large dimensions below the ground surface are known as caves. In this article, formation of caves is enumerated briefly. The processes involved in cavern formation (i.e. corrasion and solution), and their origin are analyzed. Karst topography, karst aquifer, natural bridge, speleothems, and life in caves are also discussed.

INTRODUCTION

Magnificent geomorphological features of the Earth, caves have always aroused great interest in mankind. A cave is an underground cavity or a deep hollow place of significantly large dimension below the ground surface. Large caves are called caverns. Caves are fragile natural resources that may contain records of archeological, palaeontological, and palaeoenvironmental change. The branch of science that deals with the study of caves is called Speleology and Spelunking is the hobby of exploring caves. There are geologists and other professional scientists as well as amateurs who become speleologists.

FORMATION OF CAVES

Caves are produced by erosional work (mainly corrosion and abrasion) (Fig 1) Corrasion means erosion by the abrasive action of running water containing sand, pebbles, and other debris. This is in contrast to "corrosion" which means a chemical action such as formation of rust, or the "eating away" of a substance as nitric acid corrodes copper. Corrasion or Solution involves the dissolution of soluble materials through the process of disintegration and decomposition of carbonate rocks. Abrasion or Corrasion involves the breaking down of rocks and removal of loosened materials of the rocks with the help of erosional tools like boulders, pebbles, cobbles, etc.

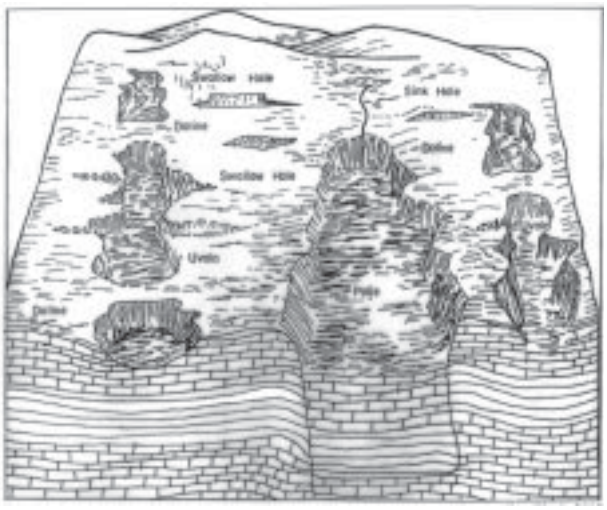


Fig. 1. *Development of sink holes, swallow holes, uvalas, sinkikg creek, blind valley and karst valley (Singh, 2003)*

Earlier speleologists attributed the major role in cavern formation to corrasional activity. Streams in caverns can often be found enlarging their channels, and it was supposed that cave systems had been formed by this process. However, it is difficult to understand how corrasion would be possible if an initial passage was not already present in the rock. Again, the question arises as to how was the cavity

[1]Department of Geology, Utkal University, Vani Vihar, Bhubaneswar-751004 (Orissa), [2]Department of Environmental Science, F. M. University, Vyasa Vihar, Balasore-756019 (Orissa), [3]Department of Zoology, Utkal University, Vani Vihar, Bhubaneswar-751004 (Orissa), *Corresponding author, E-mail : goswamishreerup@yahoo.com

initiated? The history of speleology involves a conflict between these two kinds of questions of cavern formation. Each questions appears deficient in certain respects.

Majority of the caves are formed due to solvent action of water in limestone formations, and these are called solution caves with openigs or passages to the surface. The cave passages are invariably smaller and narrower than the cavity behind them[1]. Many caves are single chambered wheras others are interconnected and situated at different levels. Solution caves are formed when slightly acidic groundwater slowly dissolves the limestone formation along cracks. CO_2 is practically present in all surface water. So, when water (containing CO_2) reacts with Limestone, Calcium bicarbonate forms which is highly soluble and gets readily removed by water.

$$H_2O + CO_2 + CaCO_3 \rightarrow Ca\ (HCO_3)$$

Gradually over many thousands of years, numerous passages and chambers are formed. In many caves underground rivers, pools and waterfalls are present.

The history of many caverns involved two cycles of events, first a phreatic cycle, in which caverns were formed by solution, and secondly a vadose cycle, following a drop in the water table. In this second cycle, the dripstones have begun to form. Caves rarely enlarge very much in vadose conditions. To the concept of two cycles in cavern formation, Bretz introduced the concept of an epoch of deposition in the history of many caves[2]. He suggested that after the initial development of caverns a period of clay filling of the passage and chambers occured before the lowering of the water table. He showed that many caves are compeletely filled up with cave-fill and this fill is now being eroded by streams. Caverns with little fill often contain fragmentary remnants of formerly extensive fills, in the form of deposits high on the walls and in pockets and branching passages. Cave fills may generally consist of clay, sand, or gravel, and also of conglomerates or cemented gravels. These materials are all considered to have been formed by deposition in stream flowing through the caves after original excavation of the cavities. Some of the cave-fill, exhibit the pattern of cross stratification. Cave-fills of clastic materials are deposited towards the end and after the integration and mature development of cavern passages.

Speleologists have recognised that most caves follow the patterns of joints in the rock; they are "joint controlled". Plans of most caves in folded rock reflect local rock structures. The passages are joint controlled faults which exert very little influence and a passage rarely follows a fault for any great distance[3].

KARST TOPOGRAPHY

Landforms porduced by chemical weathering or chemical erosion of carbonate rocks, mainly limestones ($CaCO_3$) or dolomites {Ca Mg $(CO_3)_2$}, by surface or subsurface waters are called Karst Topography. Karst toppgraphic features actually refer to the Karst region of erstwhile western Yugoslavia which are covered with numerous solution holes, ravines, gullies, clefts, lapies and narrow valleys. The Karst region extends over a length of 480 km, a width of 80 km and rises to the height of 2,500 m above MSL[4]. Numerous caves, stalactites and stalagmites are formed below the surface. So, the limestone topography with sinkholes and other similar features is universally called Karst topography. The more pure, thick and massive the limestone formations are, the larger are the caves. Most of the caves are damp and cool and the temperature remains uniform throughout the year. Dry caverns have two or more levels and are referred to as galleried caverns. As many as five cavern levels have been observed. Galleries in tiers or rows indicate how the water table has shifted in the past.

Other caves may form due to escape of volcanic gas or lava. Caves may also form by the swirling

action of spray beneath a waterfall. The cave of the Winds at Niagra Falls is of this type. Sometimes caves result due to the action of ocean waves along the coasts and these usually do not extend very far into the land. One famous sea cave lies in the Blue Grotto at Capri, a famous islet in the Bay of Naples, Italy.

KARST AQUIFER

Karst is a unique type of landscape that forms the chemical solution of bedrock in limestone terrains. An aquifer is a body of rock that is permeable enough to bear water. Karst aquifers are distinctive because as limestones dissolve, heterogeneous and large underground water flow pathways are created. These features make Karst aquifers important water resources (providing water to about 25% of the world's population). At the same time, these features also make karst aquifers complex, highly variable in time and space (with respect to water availability), and more susceptible to groundwater contamination.

Caves provide an especially useful inside window to these aquifers, where a range of hydrogeologic processes can be studied so that water-resource use and management can be better planned.

NATURAL BRIDGE

An underground natural passageway may have a constricted part of its roof intact. This makes a natural bridge. Natural bridge may develop in Sandstone, granites or Quartzites, but limestones are prticularly suitable because of their underground suitability[5]. The natural bridge in (U.S.A.) Virginia developed in Limestone is the remnant of a cavern roof. The passage way is called natural tunnel.

SPELEOTHEMS

Various mineral formations and deposits associated with caves are called speleothems. They are indeed beautiful structures and a wonderful gift of the nature to mankind. They look like statues; long, thin straws, gleaming icicles suspended from the roof **(stalctites)**, stubby posts rising from the floor **(stalagmites)** flowing curtains and draperies. These are formed due to dripping of water into the cave from the above. Stalactites and Stalagmites may be beautifully tinted. Sometimes the stalactites growing downwards and the stalagmites growing upwards meet together and form a continuous column from the floor to the ceiling and are known as **columns** and **pillars**. Another depositional form known as **helictite** develops where the water entering the cave is not sufficient to give rise to drops that fall but only to keep the surface wet. Under such conditions, the helictite deposit does not necessarily extend along vertical lines but may grow in any direction, depending upon the chance orientation of the crystal axes of calcium carbonate. They, therefore, grow in all kinds of shape and size[6].

Calcite ($CaCO_3$) is the common constituent of speleothems. As limestone is dissolved by vadose water, the pH of the solution rises but in equilibrium with a relatively high CO_2 partial pressure. When the water enters an aerated cave, the excess dissolved CO_2 diffuses into the cave atmosphere, and calcite is deposited[7]. Calc-cinter or **travertine** (a banded calcareous rock) or gypsum ($CaSO_4.2H_2O$) may occur in caves. Near the mouths of caves associated with marked evaporation, much softer travertine called **calc-tufa** is formed. Speleothems and clastic deposits in caves offer excellent opportunities to date cave evolution. Clastic sediments in several levels of Mammoth Cave show magnetic polarity reversals that document the down cutting of the cave for at least 1 million years and possibly 2 million years[8]. Cave deposits are of immense importance in documenting Pleistocene climatic changes on the continents, to correlate with the deep-sea record.

SOME FAMOUS CAVES

Caves are found throughout the world. In the

United States more than 100 caves are open to the visitors. Two important National Parks are the Mammoth Cave in Kentucky and the Carlsbad Caverns in New Mexico. Mammoth cave has approximately tens of thousands of sinkholes and a stream called Echo River. Carlsbad cave has dimensions of 1219m, 190.5m and 300m as length, width and depth, respectively. It is a multiple level cave with beautiful stalactites and stalagmites. World's longest known cavern is Holloch cave of Switzerlnd, which is 85.2 kms in length[9].

Awarenes of the extensive solution development of limestone along the southern perimeter of Europe continues to increse. Thus at Gibralter, St. Michael's cave was discovered only during fortification work in 1942, it is large enough to serve today as an underground amphitheater for concerts[10].

In India we have the following important caves at :

Dehradun, Uttaranchal (Robert cave, Sahasradhara)

Southwest Bihar (Guptadham cave, 1.5km long)

Bastar District, Chhatishgarh (Kutumbsar Cave)

Andhra Pradesh (Gupta Godavari Cave, Borra Cave, Betamcherle Cave)

Orissa (Khandagiri Cave, Udayagiri Cave, Gupteswar Cave and others in Keonjhar and Jaharsuguda with cave paintings)

Jammu (Vaishnodevi Cave) and Kashmir (Amarnath Cave)

LIFE IN CAVES

Caves provide habitat for unique and endangered species. There are three different zones in caves, the area just inside the entrance, a twilight area in which some light penetrates and the interior portions in total darkness. Each area has different type of plants and animals suitable to the environment.

Temporary Tenants

Those who live a part of their lives in caves are referred as temporary tenants. Most large carnivorous animals like bears, mountain lions, wild cats, etc. live near the entrance. They sleep, hibernate, rear and bear young and sometimes eat in the cave. Some kinds of animals live in the caves during the daytime clinging to the ceiling with their claws. At dusk, they fly out to feed. Some birds like South American oil-birds, owls and jackdaws live in the caves. Bons of cave bear, hyena, leopard, wolf and lion have been discovered in European caves. This indicates that these animals must have spent some time in the caves during the last advance of glaciers.

PERMANENT DWELLERS

Animals that live all their lives in caves are called permanent dwellers like many kinds of fish, salamanders, crayfish, insects and spiders. Since eyes are useless in darkness they have become rudimentary. The cave animals are partially or totally blind and in general are pale in colour. They are carnivorous, preying on each other because only a few fungus plants can survive without sunlight in the underground.

The bodies of cave animals are modified in various ways suitable to the environment. The cave cricket has no wings. Cave crustaceans have long and sensitive feelers. The blind fish (*Amblyopsis spelaeus*) lives deep within caves and has become completely bleached and its eyes have been reduced to mere vestiges. Sensitive papillae are developed on the head to compensate lack of vision. Salamanders are white, have degenerate eyes or no eyes at all.

CAVE AND HUMAN HISTORY

People lived in caves during the Palaeolithic or Old Stone Age (Before 9000 B.C.). Caves have been used for this purpose in nearly all parts of the world. Some of the earliest evidence of cave dwellers comes from a cave near Beijing, China. Fossils of Peking man have been found, i.e. an

early form of man who lived 30,000 years ago. Remains of cave dwellers of about the same age have also been found from Africa. Cave dwellers are known as **Troglodytes**. Information about Neanderthal Man and Cro-Magnon man comes from remains found in European caves, who took shelter to protect themselves from cold during last glacial advance. The remains include hearth sites, graves, tools and weapons, paintings, drawings and carvings on the walls and ceilings. Archaeologists suggest that the Old Stone Age Man actually lived outdoors when the weather permitted.

In ancient and mediaval times, hermits and monks often lived in natural caves or in caves they dug in the sides of cliffs. Even today, People of Goreme valley of central Turkey, Bushmen of Africa, Veddas of Sri Lanka and Tasadays of Philippines live in caves.

In India the famous Ajanta & Ellora caves of Maharastra and Khandagiri-Udayagiri caves of Orissa have been converted to tourist places. Elaborate structures have been curred out within these caves. Caves were used as temples in ancient Greece and Egypt. Many Buddhist temples in Orissa and Bihar and the wonderful cave temples of Elephanta, an island in Mumbai harbour, are also indicative of Indian culture and heritage.

Caves not only attract mankind for the mystery and adventure, but they have always played a significant role in unravelling the course of human history. So, caves should be preserved and converted into National Parks for the future generation.

REFERENCES

1. S. K. Garg, A Text Book of Geology, 1st edition, 296, Khanna Publishers, New Delhi, 1983.
2. J. H. Bretz, *of Geology*, **50 (6)**, 675-811, 1942.
3. T. Aley, *Cave Notes*, **7(1)**, 2-4, 1965.
4. S. Singh, Physical Geography, 273, Prayag Pustak Bhawan, Allahabad, 2003
5. E. Ahmed, Geomorphology, 221, Kalyani Publishers, Ludhinana, 1985
6. P. Dayal, A Text Book of Geomorphology, 2nd edition, 373, Shukla Book Depot, 1996
7. Arthur L. Bloom, Geomorphology : A Systematic Analysis of Late Cenozoic Landforms, 2nd edition, 169, Prentice-Hall, Inc., U.S.A., 1992
8. V. A. Schmidt, *Science*, **236**, 1098-1099, 1982
9. W. D. Thornbury, *Geomorphology*, 328, John Wiley & Sons. Inc., 1969
10. D. K. Todd, Groundwater Hydrology, 2nd edition, 40, John Wiley & Sons. Inc., 1995

DO YOU KNOW ?

Q1. A 1000 c.c beaker is filled with dry sand up to the top. How much water can be poured into it so that all is absorbed.

Q2. Which thing lives for 17 years but is active only for 5 weeks, spending the rest of its life sleeping?

Q3. Do twins have identical finger prints?

BIO-ENZYMATIC SOIL STABILIZATION IN ROAD CONSTRUCTION

G. Dhinakaran*, C. Venkatasubramanian† and R. Prasanna Kumar†

Bio-enzyme, liquid organic formula, is used as a soil stabilizer, which enhances the engineering characteristics of soil through cationic exchange. It provides engineers with an opportunity to improve the characteristics of dirt roads constructed with soil, having a high percentage fines, through bio-enzymatic stabilization. This paper presents the possibility of using bio-enzyme as soil stabilizer, design possibilites, applications and economical and ecological benefits of bio-enzyme.

INTRODUCTION

Bio-enzyme is a natural, non-toxic, non-flammable, non-corrosive liquid enzyme formulation fermented from vegetable extracts that improves the engineering qualities of soil, facilitates higher soil compaction densities and increases stability. Enzymes catalyze reactions between the clay and the organic cations and accelerate the cationic exchange process to reduce adsorbed layer thickness. For other types of chemical stabilization, chemicals are mixed with soil, which is difficult to mix thoroughly, but bio-enzyme is easy to use as it can be mixed with water at optimum moisture content and then sprayed over soil for compaction. The decreasing availability and increasing cost of construction materials along with the uncertain economic climate forces engineers to consider more economical methods to build roads using locally available materials which are outside the existing specifications.

The situation becomes even more critical when the increasing demand for roads in underdeveloped rural areas and informal settlements is considered. In addition, increasing pressures on the mining, forestry and agricultural industries to minimize production cost necessitate cost-effective construction of roads with optimum performance and low maintenance cost. One economically feasible solution for achieving these objectives is the use of bio-enzymes in soil stabilization.

BEHAVIOUR OF CLAY PARTICLES

The mineralogy of clay particles produces a thin platy structure with large surface areas and a net negative charge. Because of the large surface area and negative charge in clay particles, electrostatic forces often control their behaviour in a soil water mixture rather than simple gravitational forces. To balance the negative charge, positively charged ions from in a diffuse swarm around the clay particle. This creates a film of water around the clay particle that remains attached or absorbed on the clay surface. This layer has an ordered structure different from that of free water. The negatively charged clay platelet and the swarm of cations are referred to as an electrical double layer. The absorbed water in the electrical double layer gives clay particles their plasticity or the ability to deform without cracking. As the thickness of the double

* Corresponding author dhinaji@gmail.com

†School of Civil Engineering, SASTRA, Deemed University, Thanjavur 613 402 Tamil Nadu, India.

layer increases, the plasticity of the soil increases. In addition, as the double layer increases the clay platelets exert greater repulsive forces and push each other further apart. In some cases, the clays can swell enough to cause significant damage to structures constructed using them.

Cation Exchange Effects

The thickness of the electrical double layer can be reduced by cation exchange. The cations surrounding the clay particles are termed "exchangeable cations" because, in most cases, one type may be exchanged with cations of another type. Typical cations in soils are sodium, magnesium, calcium, iron, and potassium. A cation with a higher valence (positive charge) or smaller diameter can balance the negative charge on the clay particle in a shorter distance for a given concentration level. For example, if the negative charge is initially balanced by sodium cations with a 1 + charge (Na^+) and the cations are exchanged with calcium cations with a 2 + charge ($Ca2^+$), then the double electrical layer thickness will be reduced by half. This reduces the water absorbed on the clay paticle, which in turn reduces the plasticity of the clay particle and the tendency for swelling. The loss of absorbed water also tends to increase the strength of the molecular structure of the clay.

MECHANISM OF SOIL STABILIZATION WITH BIO-ENZYME

Bio-enzyme is an organic soil stabilizer produced by a fermentation process, which utilizes micro-organism to produce enzymes, which are non-toxic and environmentally friendly. When applied in soil the enzyme attaches molecules to the clay platelets, the negative charges on the clay platelets are neutralized through this process and the size of the electrical double layer shrinks. This limits further absorption of water or the resultant swelling with loss of density. Reactions, which might otherwise take years to occur, can be carried out in weeks. While some soil strength gain will become apparent within days, field research indicates that the strength will continue to increase over a period of several weeks.

In a case study, one type of bio-enzyme has been used for stabilization of different types of soil with varying index properties. Detailed laboratory tests were carried out to ascertain the benefits in terms of reduction in design thickness. To assess the suitability of Bio-enzyme as soil stabilizer, five types of soil were taken for the study with low clay content to very high clay content. Laboratory tests were done to determine the engineering properties of soil and strength characteristics of soil with and without Bio-enzyme stabilization.

NEW APPROACH OF DESIGN

Bio-enzyme offers road engineer a cost effective solution with regards to the construction of roads in areas where the soil has a high percentage of fines. Bio-enzyme stabilized soil can be used as a sub base, base or driving surface depending upon the requirements of the road. In areas where low traffic intensities restrict substantial investments in road construction, such as forestry, rural and agricultural areas, the economy still needs to be stimulated by a decent infrastructure. Roads, which form an integral part of this infrastructure, should have limited life-cycle cost and a long life span to benefit the local economy. Soil stabilization with bio-enzyme provides governments an opportunity to provide high quality road structures to developing areas with low cost. In such areas stabilized soil can provide a good riding smoothness without an asphalt layer for a considered amount of time. Tarring can take after three or more years when the budget has sufficient means or the road can be utilized as a dirt road for a considerable amount of time. This design concept is being followed by some private agencies in some countries such as Brazil and Peru. In India, also, this design approach has been adopted as experiment field trial sections. The performance of field trials will determine and

validate the new concept. In the new design approach, a bio-enzyme treated soil layer (with 20% aggregates of 40 mm) is laid in place of granular base course thus saving arises in terms of pavement thickness and aggregates. The details are shown in **Tables 1 & 2**.

Table 1—Pavement Design Thickness on Clayey soil without Stabilization

Cumulative Traffic (msa)	Total Pavement Thickness (mm)	Pavement Design Thickness			
		Bituminous Surfacing		Granular Base (mm)	Granular Sub base (mm)
		Wearing Coarse (mm)	Binder Coarse (mm)		
1	660	20 PC	—	225	435
2	715	20 PC	50 BM	225	440
3	750	20 PC	70 BM	250	440
5	795	25 SDBC	70 DBM	250	450
10	850	20 BC	100 DBM	250	450

Table 2—Pavement Design Thickness on Clayey Soil with Stabilization

Cumulative Traffic (msa)	Total Pavement Thickness (mm)	Pavement Design Thickness			
		Bituminous Surfacing		Granular Base (mm)	Granular Sub base (mm)
		Wearing Coarse (mm)	Binder Coarse (mm)		
1	430	20 PC	—	225	205
2	490	20 PC	50 BM	225	215
3	530	20 PC	50 BM	250	230
5	580	25 SDBC	55 DBM	250	250
10	660	40 BC	70 DBM	250	300

BENEFITS

Bio-enzymatic soil stabilization has immediate positive influences on the economy of rural areas where the road network has been stabilized. Fuel consumption of vehicles will be reduced because of the improved traffic flow on these roads. **Table-3** shows the comparative results of conventional and bio-enzyme design with 12% saving in economy in roads with bio-enzyme stabilization.

Utilization of products such as bio-enzyme can have a positive effect on the environment. First of all, bio-enzymes are non-aggressive products, which do not radically alter the chemical composition of the soil, which they stabilize. Being non-toxic in nature, they do not pose a health threat to the labourers used in the construction of roads. And by providing engineers with the possiblity to utilize a relatively wider range of soil types and reducing the need for large quantities of crushed rock in the construction of roads, they reduce the need for mining of aggregates for road construction.

CONCLUSION

Bio-enzyme, a bio-enzymatic soil stabilizer, offers engineers the possibility to reduce life cycle

Table-3—Design Comparison for a Road with CBR 4 and msa = 1

Soil	Conventional Design			Bio-enzyme Design		
		Cost/m^2	Thickness mm	Thickness mm	Cost/m^2	
1	Sand Gravel Mix	76.50	255	–	–	Sand Gravel Mix
2	WBM-Grade II	45.75	75	225	240	WBM-Grade II
3	WBM-Grade II	45.75	75	–	–	WBM-Grade II
4	WBM-Grade III	50.25	75	–	–	WBM-Grade III
5	Pre-mix carpet with seal coat	80.00	20	8	22.50	Only Seal Coat
	Total	298.25	500	233	262.50	
	Savings					35.75 (12%)

cost of roads by reducing the construction and maintenance cost. By altering the cationic structure of soil, bio-enzyme increase the load bearing capacity of soil of such an extent that the soil, which is deemed not suitable for conventional road construction purposes, can be utilized in the construction of high quality road structures. Bio-enzyme application does not require specialized equipment ; ordinary road construction equipment is more than sufficient to execute satisfactorily the stabilization of soil. Bio-enzyme is a non-toxic, environmentally friendly substance, which causes no health threat to the applicators and the environment.

DO YOU KNOW ?

Q4. Which sea animal is the greatest diver?

Q5. The famous Cartier necklace, made for the Maharaja of Patiala, in 1920, had a fabulous number of diamonds. Guess the number.

Q6. What is the highest wind speed ever recorded?

WHY DOES HIV MANIFEST INTO AIDS IN HUMANS

Soumen Bhattacharjee*

The Human Immunodeficiency Virus or HIV is the primary causative viral agent resulting in AIDS in humans. The human immunodeficiency virus type 1 (HIV– 1) is most prevalent. The time in between the first infection and initiation of antibody synthesis is usually 6-12 weeks. When immune system damage is more severe, people may experience opportunistic infections. The median time to receive an AIDS diagnosis is 7-10 years. The main target of the virus is a $CD4^+$ T lymphocyte (T-cell).

What are Viruses ?

Viruses [Latin *virus*, poison or venom] are unique group of infectious agents having simple, acellular organisation and pattern of reproduction. A complete virus particle or virion consists of one or more molecules of DNA or RNA enclosed in a coat of protein called *capsid* and sometimes also in other layers derived from host cell membranes. These additional layers may be very complex and contain carbohydrates, lipids, and additional proteins of viral origin. Virions that contain only genome and capsid, are considered *naked*, whereas when surrounded by a lipid bilayer (or *envelope*), the capsid plus the genome is termed the *nucleocapsid*. The envelope is generally made up of proteins and sugars. A virus cannot reproduce on its own. It needs a "host" cell in order to reproduce or make copies of itself.

Viruses consist of genetic material (RNA or DNA) and the envelope shell encases the genetic material. All cells in the human body have DNA or Deoxyribonucleic Acid as their genetic material. A virus whose genetic material is DNA would infect a host cell by injecting its viral DNA into the cell. Then, through a series of events the viral DNA becomes part of the cells DNA. The cell no longer makes copies of itself; instead it "unknowingly" becomes a "virus factory" and makes copies of the virus that infected it.

* Department of Zoology, Balurghat College, P. O. Balurghat, Dist. South Dinajpur-733101 West Bengal.

WHAT IS HIV (HIV–1 AND HIV–2) ?

Not all viruses have DNA as their genetic material. Some have a different genetic material called RNA or Ribonucleic Acid. RNA contains genetic codes just like DNA, but the structure and makeup are different from DNA. Moreover, RNA cannot direct the production of new viruses directly.

This group of viruses, whose genetic material is RNA, is called *Retrovirus*. The Human Immunodeficiency Virus or HIV belongs to this family of viruses. Like all viruses, HIV depends on the cells it infects to make new copies of itself. One of the main targets of HIV is a white blood cell called a $CD4^+$ T lymphocyte.

HIV is a fairly complex RNA virus, which contains two identical copes of a positive sense (i.e. mRNA) single-stranded RNA strand about 9,500 nucleotides long. The genetic material of HIV contains 9 different genes encoding 15 proteins. The RNA strands may be linked to each other to form a genomic RNA dimer. The RNA dimer is in turn associated with a basic nucleocapsid. The

ribonucleoprotein particle is encapsidated by a capsid made up of a capsid protein. The capsid environment also contains other viral proteins such as *integrase* and *reverse transcriptase* (not shown in the **Figure 1**). It also contains a wide variety of other

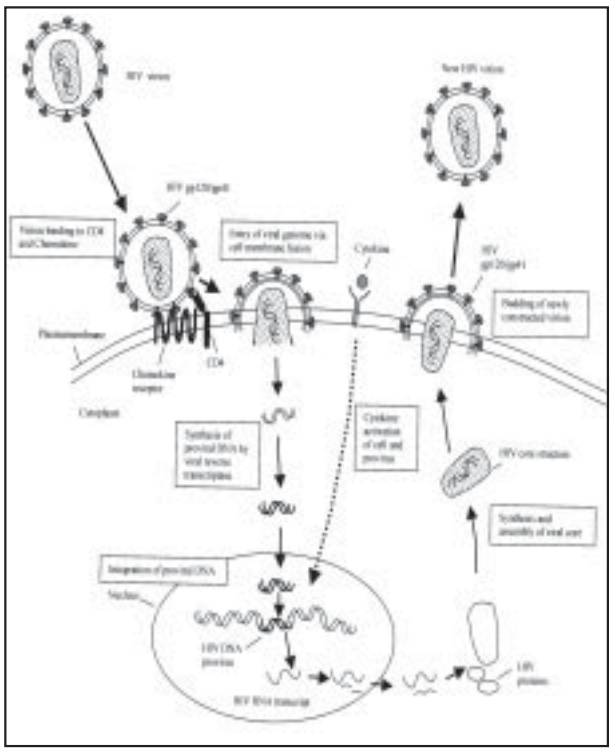


Fig. 1. *The Cycle of Human Immunodeficiency Virus (HIV)*

macromolecules derived from the cell including tRNAlys3, which serves as a primer for reverse transcription. The capsid has an icosahedral structure. The capsid is in turn encapsidated by a layer of matrix protein. This matrix protein is associated with a lipid bilayer or envelope. The HIV envelope is derived from the host cell plasmamembrane and is acquired when the virus buds through the cell membrane. The major HIV protein associated with the envelope is gp120/41. This functions as the viral antireceptor or attachment protein.

In 1984, three years after the first reports of AIDS, researchers discovered the primary causative viral agent, the human immunodeficiency virus type 1 (HIV–1). In 1986, a second type of HIV, called HIV–2, was isolated from AIDS patients in West Africa, where it may have been present decades earlier. HIV-2 infections are predominantly found in Africa. West African nations with a prevalence of HIV-2 of more than 1% in the general population are Cape Verde, Ivory Coast, Gambia, Guinea-Bissau, Mali, Mauritania, Nigeria, and Sierra Leone. Other West African countries reporting HIV-2 are Benin, Burkina Faso, Ghana, Guinea, Liberia, Niger, São Tomé, Senegal, and Togo. Angola and Mozambique are other African nations where the prevalence of HIV-2 is more than 1%.

The first case of HIV-2 infection in the United States was diagnosed in 1987. Demographic, climical, and laboratory data on persons with HIV-2 infection in the USA shows that, of the 79 infected persons, 66 are black and 51 are male. Fifty-two were born in West Africa, 1 in Kenya, 7 in the United States, 2 in India, and 2 in Europe.

Both HIV-1 and HIV-2 have the same modes of transmission and are associated with similar opportunistic infections and AIDS. However, in persons infected with HIV-2, immunodeficiency seems to develop more slowly and to be milder. Compared with persons infected with HIV-1, those with HIV-2 are less infectious early in the course of infection.

WHAT IS AIDS?

AIDS stands for Acquired Immune Deficiency Syndrome. An HIV-positive person receives an AIDS diagnosis after developing one of the AIDS indicator illnesses. An HIV-positive person can also receive an AIDS diagnosis on the basis of certain blood tests (CD4 counts) and may not have experienced any serious illnesses. A positive HIV test does not mean that a person has AIDS.

Over time, infection with HIV can weaken the immune system to the point that the system has difficulty in fighting off certain infections. These types of infections are known as opportunistic

infections. Many of the infections that cause problems or that can be life threatening for people with AIDS are usually controlled by a healthy immune system.

HOW DOES HIV INFECT AND DESTROY T CELLS?

Human $CD4^+$ T lymphocytes, macrophages, microglial, dendritic and Langerhans cells are believed to be targets for HIV-1 infection. The CD4 transmembrane protein along with one of several chemokine receptors of T lymphocytes is believed to be necessary for viral attachment and fusion to occur (see **Figure 1**). Although HIV can infect a number of cells in the body, the main target is a $CD4^+$ T helper cell, a type of T-cell. T-cells are an important part of the immune system because they help facilitate the body's response to many common but potentially fatal infections. Without enough T-cells, the body's immune system is unable to defend ifself against many infections. By ways that are not yet completely understood, HIV's life cycle directly or indirectly causes a reduction in the number of T-cells in the body, eventually resulting in an increased risk of infections.

After HIV enters the body–through unsafe sex, contaminated needles, blood transfusions or from mother to child (vertical or perinatal transmission), it comes in contact with its favorite host cell–the T-cells. When this happens, HIV hijacks the host cell's cellular machinery to reproduce thousands of copies of itself.

STEPS OF VIRAL ESTABLISHMENT AND MULTIPLICATION

Viral Attachment : Once HIV comes in contact with a $CD4^+$ T-cell, it must attach ifself to the cell so that it can fuse with the cell and inject its genetic material into it. Attachment is a specific binding between proteins on the surface of the virus and proteins that serve as receptors on the surface of the T-cell. Normally, these receptors help the cell to communicate with other cells. Two receptors in particular, CD4 and a β-chemokine receptor (either CCR5 or CXCR4), are used by HIV to stick onto the cell. On the surface of the viral envelope, two sets of proteins (also known as *antireceptors*) called gp 120 and gp41 attach to CD4 and CCR5/CXCR4. Scientists have found that people who naturally lack these cellular receptors because of a genetic mutation, or those who have them blocked by natural chemokines (chemical messengers), may not get infected as readily with HIV or may progress more slowly to AIDS.

Viral Penetration and Fusion : After attachment is completed, viral penetration occurs. Penetration allows the nucleocapsid of the virus to be injected directly into the cell's cytoplasm. The viral protein gp120 actually contains three sugar-coated proteins (glycoproteins) and, once gp 120 attaches itself to CD4, these three proteins spread apart. This allows the gp41 protein, which is normally hidden by the gp 120 proteins, to become exposed and bind to the chemokine receptor. Once this has occurred, the viral envelope and the cell membrane are brought into direct contact and they essentially melt into each other.

Uncoating : Once HIV has penetrated the cell membrane, it is ready to release its genetic information (RNA) into the cell. The nucleocapsid needs to be partially dissolved so that the virus's RNA can be converted into DNA, a necessary step if HIV's genetic material is to be incorporated into the T-cell's genetic core.

Reverse-Transcription : The process by which HIV's RNA is converted to DNA is called reverse transcription. HIV uses its own reverse transcriptase enzyme to accomplish this transcription. The single-stranded viral RNA is transcribed into a double strand of DNA, which contains the instructions HIV needs to hijack a T-cell's genetic machinery in order to reproduce itself.

Integration : If HIV succeeds in translating its instructions from RNA to DNA, HIV must then insert its DNA (also called the *preintegration complex*) into the cell' chromosomal DNA. This process is called *integration*. In order for integration to occur, the newly translated DNA must be transported across the nuclear membrane into the nucleus. Presently it is known that Viral Protein R (VPR), which is carried by HIV, may facilitate the movement of the preintegration complex to the nucleus. Once the viral RNA has successfully bridged the nuclear membrane and been escorted to the nucleus, HIV uses an enzyme called *integrase* to insert HIV's double-stranded DNA into the cell's existing DNA.

Viral Latency and Protein Synthesis : After successful integration of the viral DNA, the host cell is now latently infected with HIV. This viral DNA is referred to as *provirus*. The HIV provirus now awaits activation. When the immune cell becomes activated, this latent provirus awakens and instructs the cellular machinery to produce the necessary components of HIV. From the viral DNA, two strands of RNA are constructed and transported out of the nucleus. One strand is translated into subunits of HIV such as protease, reverse transcriptase, integrase, and other structural proteins. The other strand becomes the genetic material for the new viruses.

Cleavage and Virus Assembly : Once the various viral subunits have been produced and processed, they must be separated for the final assembly into new virus. This separation, or cleavage, is accomplished by the viral protease enzyme.

If cleavage is successfully completed, the HIV subunits combine to make up the content of the new virons. In the next step of the viral life cycle, the structural subunits of HIV mesh with the host cell's membrane and begin to deform a section of the membrane. This allows the nucleocapsid to take shape and the viral RNA is wound tightly to fit inside the nucleocapsid.

Budding : The final step of the viral life cycle is called budding. In this process, the genetic material enclosed in the nucleocapsid merges with the deformed cell membrane to form the new viral envelope. With its genetic material tucked away in its nucleocapsid and a new outer coat made from the host cell's membrane, the newly formed HIV pinches off and enters into circulation, ready to start the whole process again.

How the Disease Symptom Starts?

Primary HIV infection is the first stage of HIV disease, when the virus first establishes itself in the body. The time in between the first infection and initiation of antibody synthesis is usually 6-12 weeks. Some people newly infected with HIV will experience some "flu-like" symptoms. These symptoms, which usually last no more than a few days, might include fevers, chills, night sweats and rashes. Other people either do not experience "acute infection", or have symptoms so mild that they may not notice them. However, there are no common symptoms for individuals diagnosed with AIDS. When immune system damage is more severe, people may experience opportunistic infections. The median time to receive an AIDS diagnosis among those infected with HIV is 7-10 years.

During HIV's life cycle, the $CD4^+$ T-cell, known as the host cell, is altered and perhaps damaged, causing the death of the cell. Proposed mechanisms for HIV killing of T cells include the formation of giant cell syncytia through the interactions of gp 120 with CD4 and chemokine receptors, the accumulation of unintegrated linear forms of viral DNA, the pro-apoptotic effects of the viral Tat, Neff, and Viper proteins, and the adverse effects conferred by the metabolic burden that HIV replication places on the infected cell.

The exact mechanism of CD4 cell depletion in AIDS patients is not known, but several indirect mechanisms are known by which HIV can cause CD4 cell depletion in laboratory studies and could

operate in vivo also. Scientists are not exactly sure how the cell dies but have come up with a number of suggested scenarios :

- First, After the cell becomes infected with a virus or other pathogen, internal signals may tell it to commit suicide. This is known as apoptosis or programmed cell death–a self-destruction program intended to kill the cell with the hopes of killing the virus as well.
- A second possible mechanism for the death of the cell is that, as thousands of HIV particles bud or escape from the cell, this may severely damage the cell's membrane, resulting in the loss of the cell.
- Another possible cause for the cell's death is that, other cells of the immune system, known as killer cells, recognize that the cell is infected and inject it with chemicals that destroy it.

Whatever the mechanism of the cell's death, there is one less T-cell in the body, and when this happens in a monumental scale, $CD4^+$ T-cells begin to decline in the body. Over time, there are not enough T-cells to defend the body. At this stage, a person is said to have acquired immunodeficiency syndrome, or AIDS, and becomes susceptible to infections that a healthy immune system could deal with. If this process of immune destruction is halted, a weakened immune system may be able to repair some of the damage over time.

Does HIV Really Cause AIDS in Human!

In early 1990s, Dr. Peter Duesberg, an expert in retroviruses at the University of California, Berkeley, USA, along with many scientists, doctors, researchers and patients have demanded that, the entire thrust of AIDS research be reconsidered, that the increasing evidence discrediting the HIV hypothesis be published and that science, not dogma be the criterion for funding AIDS research. According to many prominent and eminent scientists, the "HIV-causes AIDS" hypothesis is a "hoax" and is not supportable by experimental and epidemiological facts. They contend that, HIV does not follow Henle-Koch postulates of 1840 and 1890 and violates six cardinal rules of virology. However supporters of the said hypothesis hold that, although there are many unanswered questions about the pathogenesis of AIDS, with the seroepidemiological evidence pointing toward HIV as the cause of AIDS spurred research to improve the sensitivity of the detection methods. Better methods of virus isolation now show that HIV infection is present in essentially all AIDS patients. Increasing experimental facts are now able to answer most of the questions raised by the "dissident" group. Although many questions remain to be answered, a huge and continuously growing body of scientific evidence has cleared many of the "myths" and shows that HIV causes AIDS.

REFERENCES

1. Kong PD, Wyatt R, Robinson J, Sweet RW, Sodroski J, Hendrickson WA. *Nature* **393 (6686)**, 648-59, 1998.
2. Kozak SL. Heard JM, Kabat D. *J Virol*. **76(4)**, 1802-15, 2002.
3. Campbell SM. Crowe SM, Mak J. *J Clin. Virol*. **22(3)**, 217-27, 2001.
4. Chan DC, Kim PS. *Cell*. **93(5)**, 681-4, 1998.
5. McDonald D, Vodicka MA, Lucero G, Svitkina TM, Borisy GG, Emerman M, Hope TJ. *J Cell. Biol*. **159(3)**, 441-52, 2002.
6. Heinzinger NK, Bukinsky, MI, Haggerty SA, Ragland AM, Kewalramani V, Lee MA, Gendelman HE, Ratner L, Stevenson M, Emerman *M. Proc. Nal. Acad. Sci. USA*. **91(15)**, 7311-5, 1994.

7. Jordan A, Defechereux P, Verdin E. *EMBO J.* **20(7)**, 1726-38, 2001.

8. Chen BK, Gandhi RT, Baltimore D. *J Virol.* **70(9)**, 6044-53, 1996.

9. Goh WC, Rogel ME, Kinsey CM, Michael SF, Fultz PN, Nowak MA, Hahn BH, Emerman M. HIV-1 *Nat. Med.* **4(1)**, 65-71, 1998.

10. Wilk T. Gross I, Gowen BE, Rutten T, de Haas F, Welker R, Krausslich HG, Boulanger P, Fuller SD. *J. Virol.* **75(2)**, 759-71, 2001.

11. *Useful Web References* :

- www.aids.org. Non-profit organization for the free and open exchange of information in the fight against AIDS.
- www.aidsinfo.nih.gov. AIDSinfo is sponsored by the National Institutes of Health (NIH) Office of AIDS Research, NIAID, National Library of Medicine, CDC, Health Resources and Service Administration, and Centers for Medicare and Medicaid Services.
- www.lightparty.com/Health/Aids.html. Story by Stephen Simac
- www.niaid.nih.gov. Maintained by the Office of Comunications and Public Liaision National Institute of Allergy and Infectious Diseases (NIAID), National Institutes of Health Bethesda, MD 20892.

DO YOU KNOW ?

Q7. Does the size of the Camel's hump change?

Q8. Who brought noodles to China and Pasta to Italy?

FORECASTING BIOLOGICAL LIMITS OF ATHLETES IN SPORTS

Naresh Kumar* and L. P. Rai†

Forecasting of human performance in sports is very important as well as a difficult task from many angles. It helps in targeting still higher goals and encourages the sports persons to challenge the limits. A general perception that men perform better than women in athletics, is being examined by analyzing time series data for two athletic events, namely swimming and race. Data pertaining to world records for these events have been collected from various sources and are being analyzed with the help of two well-known mathematical models viz. Logistic model and Gompertz model. It was noticed that these models do not capture the actual empirical trends. Attempts have been made to modify the logistic model and the modified model has been empirically tested. This modified model showed higher explanatory power for all the data sets in this study and it may provide a dependable framework in demand forecasting and innovation diffusion analyses. Men's performance has almost reached the saturation level whereas women are fast improving their records.

INTRODUCTION

Body movement in human being is a natural biological phenomenon and motion in the form of running and swimming can be achieved by all ages. Ability to compete in nature is defined in terms of degrees of healthfulness in all creatures, irrespective of gender bias. It has been observed from time eternal that men and women perform at different levels in athletic activities, particularly in swimming and race, where men have always performed better. However, natural limits are being challenged in many walks of life and with the passage of time it is being noticed that the difference is shrinking over the years particularly in long distance events[1]. In this context certain issues deserve to be explored. Are athletes approaching the limit of human performance? Further, will women athletes outreach men? To get answers to these queries, data pertaining to running and swimming for men and women have been analyzed with the help of mathematical models.

METHODOLOGY

Many growth phenomena in nature, such as demography and biology including growth of human population, organisms, etc. follow an S-shaped pattern. Various mathematical models are available in literature, which can easily capture these growth patterns. These models include the well-known models proposed by Pearl[2] and Gompertz[3]. These models have been applied to describe the performance of male and female participants in race and swimming activites in the Olympics. Mathematical modeling of growth trends requires time series data, which have been

* Email : nareshqumar@yahoo.com,lp_rai@yahoo.com

† Corresponding author : National Institute of Science Technology and Development Studies K. S. Krishnan Marg, New Delhi-110012, India

collected for these events from the inter-school contest report[4]. Data relate to 100m, 800m and 10,000m for runing and 100m for swimming for both the sexes. To analyze this data and for making future projections SYSTAT[5] package has been used. In some of the cases, Logistic and Gompertz models do not converge, hence an attempt has been made to modify the logistic model. This modified Logistic model is found to be applicable in all of the cases except that of 100m races for men. The results obtained with the help of this model have been compared with those of the Logistic and Gompertz models, wherever they are applicable. These models are being briefly described below for the convenience of readers.

LOGISTIC MODEL

The logistic model, which describes the natural growth phenomenon, is one of the most commonly used growth models, depicting an S-shaped curve. In its simplest mathematical form, it is expressed as :

$$\frac{dy}{dt} = \alpha y(K - y),$$

which on integration yields

$$y = \frac{K}{1 + \beta e^{-\alpha K t}} \qquad (1)$$

Here 'β' and 'α' are constants, K is the carrying capacity of the system and $0 \le y \le K$. The maximum growth rate occurs at the point of inflection $y = K/2$ and also the curve is symmetrical at this point.

GOMPERTZ MODEL

This model, proposed by Gompertz, is written in the following mathematical form :

$$Y = Ke^{-\alpha e^{-\beta t}}$$

where K is the upper asymptotic limit and lies between $(-\infty, 0)$, to $(+\infty, K)$. Its point of inflection is at $(\log \beta/K, K/e)$ and the curve is asymmetrical about the Y-axis.

Modified Logistic Model :

As in some of the case studies, the above two models did not work, a new model had to be looked into. Accordingly, a variant of logistic model was tried out, which captures the growth trend in most of the cases. To arrive at this formulation, the original model, defined by Verhulst[6] and given below, has been used :

$$\frac{dN}{dt} = \alpha N\left(1 - \frac{N}{K}\right)$$

In the modified model, a constraint factor {1 + N/K) was introduced. The above differential equation can be mathematicly written as :

$$\frac{dN}{dt} = \alpha N\left(1 - \frac{N}{K}\right)\left(1 + \frac{N}{K}\right)$$

which on integration yields

$$N(t) = \frac{K}{\left(1 + e^{-2(\alpha t + \beta K^2)}\right)^{1/2}} \qquad (3)$$

K represents the carrying capacity, α is the growth rate and β is a constant.

ANALYSIS

The cases analyzed in this study, include race competition for Olympics : 100m, 800m and World Marathon 10,000m and Olympics 100m freestyle swimming for both men and women. The data pertaining to these items are graphically presented

in **Figures 1-4** and are, also, listed in **Tables A-D**.

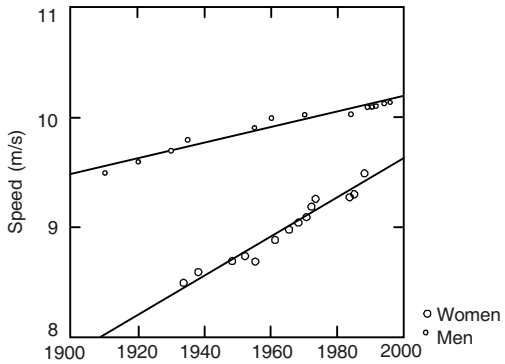


Fig. 1. Speed World Records for 100 m Running

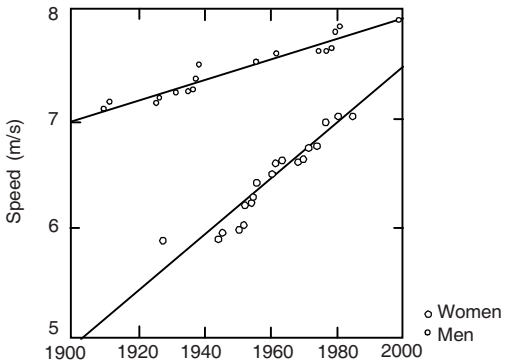


Fig. 2. Speed World Records for 800 m Running

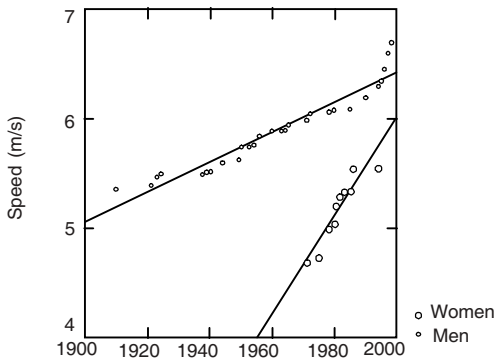


Fig. 3. Speed World Records for 10000 m Running

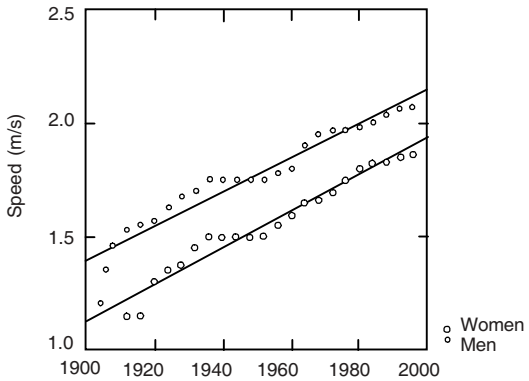


Fig. 4. Speed World Records for 100 m Swimming

Table A : World Record Speed (m/s) for 100m

Women		Men	
Year	**Observed**	**Year**	**Observed**
1934	8.50	1910	9.50
1938	8.60	1920	9.60
1948	8.70	1930	9.70
1952	8.75	1935	9.80
1961	8.90	1955	9.90
1965	9.00	1960	10.00
1968	9.05	1970	10.02
1970	9.10	1984	10.03
1972	9.20	1989	10.10
1973	9.27	1990	10.11
1984	9.30	1991	10.12
1985	9.32	1994	10.14
1988	9.50	1996	10.15

Table B : World Record Speed (m/s) for 800m

Women		Men	
Year	**Observed**	**Year**	**Observed**
1927	5.90	1909	7.10
1944	5.92	1911	7.15
1945	5.97	1925	7.16
1950	6.00	1926	7.20
1951	6.03	1931	7.25
1952	6.24	1935	7.26
1953	6.25	1936	7.27
1954	6.30	1937	7.35
1955	6.42	1938	7.50
1960	6.50	1955	7.52
1961	6.60	1961	7.60
1963	6.62	1974	7.62
1968	6.63	1976	7.63
1969	6.64	1977	7.64
1971	6.75	1979	7.80
1973	6.77	1980	7.85
1976	6.97	1998	7.90
1980	7.03		
1984	7.04		

Table C : World Record Speed (m/s) for 10,000m

Women		Men	
Year	Observed	Year	Observed
1971	4.70	1920	5.36
1975	4.75	1930	5.50
1978	5.00	1940	5.53
1980	5.05	1950	5.75
1981	5.20	1960	5.89
1982	5.30	1970	5.95
1983	5.33	1980	6.08
1985	5.35	1990	6.20
1986	5.55		
1994	5.56		

Table D : World Record speed (m/s) for 100m Freestyle Swimming

Observed		
Year	Women	Men
1904		1.200
1908		1.460
1912	1.15	1.530
1916	1.15	1.550
1920	1.30	1.570
1924	1.35	1.630
1928	1.37	1.680
1932	1.45	1.700
1936	1.50	1.750
1940	1.50	1.750
1944	1.50	1.750
1948	1.50	1.750
1952	1.50	1.750
1956	1.55	1.780
1960	1.60	1.800
1964	1.65	1.900
1968	1.67	1.950
1972	1.70	1.970
1976	1.75	1.970
1980	1.80	1.980
1984	1.82	2.000
1988	1.83	2.040
1992	1.85	2.060
1996	1.86	2.070

A close look at the general trend spread over the full time span in most of the cases reveals a logistic type growth pattern in different phases. Parameters estimated with the help of SYSTAT package are listed in **Tables–1 and 2**. **Table–3** contains model projections for 100m running and projections for 800m running are tabulated in **Table–4**. Similarly, projections for 10,000m marathons are listed in **Table–5**. Results obtained for freestyle 100m swimming are given in **Table–6**. Since incremental growth, reprsenting the physical efficiency, for all the cases is very small; these projections have been made for a longer period up to the year 2050 AD.

Concluding Remarks

Modeling and prediction of human performance is not an easy task. The trends over time of athletic records are asymmetric and performance in any event is participation and time dependent. At the time of introduction of a new event, the records improve slowly, then improve faster and ultimately reach the saturation level. To capture these trends, Logistic and Gompertz models have been used. Traditionally, these models are capable of capturing natural growth patterns. However, in some of the cases analyzed, they failed, which necessitated the search for a new model. Accordingly a Modified Logistic Model, as given in equation[3], was proposed.

In swimming and race, men have always perfomed better, but over the years, it has been noticed that the difference is shrinking particularly in long distance events. An analysis of World Olympic Records shows that women have been able to improve consistently their old records faster as compared to those of men in running. They seem to be moving much nearer to men's record in sprints than that in long race and swimming. Sports scholars and Biologists have given many explanations for difference in the performance between men and women. Their attmept to forecast differences between men and women speed records, without predicting the limitations of speed for either sex, failed miserably as the performance and growth

Table 1 : Parameter Estimates for Running

Men*									
Params.	100m			800m			10000m		
	Gom.	Logistic	Mod. Logistic	Gom.	Logistic	Mod. Logistic	Gom.	Logistic	Mod. Logistic
K	10.336			7.459		10.124	10.591	9.245	6.711
α	0.089			–11.017		0.010	0.685	0.769	0.189
β	0.016			38.480		–0.028	0.003	0.006	–0.044
MSE	428.007			315.260		315.260	89.372	89.372	89.372
CRS	0.897			0.000		0.993	0.986	0.986	0.897
Women**									
K			13.434			14.102	6.096	6.021	5.665
α			0.016			0.032	0.295	0.327	0.110
β			–0.020			–0.037	0.056	0.011	–0.055
MSE			352.505			264.395	89.654	89.655	89.660
CRS			0.970			0.915	0.914	0.915	0.937

* Logistic and Modified Logistic models for 100m and Logistic model for 800m didn't work.

** Gompertz and Logistic models didn't work for 100m and 800m race.

Table 2 : Parameter Estimates for 100m Swimming

Params.	Men			Women		
	Gom.	Logistic	Mod. Logistic	Gom.	Logistic	Mod. Logistic
K	2.158	2.214	2.081	2.207	2.207	1.903
α	0.592	0.622	0.040	0.867	0.867	0.047
β	0.023	0.010	8.739	0.008	0.008	–0.985
MSE	0.622	25.528	25.522	18.188	18.188	18.185
CRS	0.040	0.935	0.918	0.966	0.966	0.985

Table 3 : Projections of Speed (m/s) for 100m Running

	Men*	Women**
Year	Gom.	Mod. Logistic
2000	10.147	09.658
2010	10.178	09.847
2020	10.205	10.041
2030	10.229	10.237
2040	10.248	10.437
2050	10.265	10.639

* Logistic and Modified Logistic models didn't work

** Gompertz and Logistic models didn't work

Table 4 : Projections of Speed (m/s) for 800m Running

		Men+	Women++
Year	Gom.	Mod. Logistic	Mod. Logistic
2000	7.918	7.934	7.567
2010	8.007	8.033	7.875
2020	8.094	8.131	8.197
2030	8.180	8.231	8.532
2040	8.265	8.331	8.880
2050	8.349	8.431	9.242

+Logistic model didn't work. ++Gompertz and Logistic models didn't work.

do not show uniform trends always due to several constraints like physiological and biological.

Projections obtained **(Tables–3 to 6)** with the help of these models and newly proposed modified logistic model show that there is scope for improvement in speed records in the case of swimming for both the cases and women may outreach men in the next few decades. Further

Table 5 : Projections of Speed (m/s) for 10,000m Running

Year	Men			Women		
	Gom.	Logistic	Mod. Logistic	Gom.	Logistic	Mod. Logistic
2000	6.315	6.314	6.457	5.765	5.756	5.649
2010	6.427	6.425	6.610	5.904	5.880	5.663
2020	6.538	6.534	6.768	5.985	5.947	5.665
2030	6.646	6.640	6.929	6.032	5.982	5.665
2040	6.752	6.744	7.095	6.059	6.000	5.665
2050	6.857	6.845	7.264	6.075	6.010	5.665

Table 6 : Projections of Speed (m/s) for 100m Freestyle Swimming

Year	Men			Women		
	Gom.	Logistic	Mod. Logistic	Gom.	Logistic	Mod. Logistic
2000	2.061	2.061	2.060	1.885	1.885	1.874
2010	2.091	2.088	2.071	1.932	1.932	1.890
2020	2.116	2.113	2.077	1.973	1.973	1.898
2030	2.039	2.131	2.079	2.008	2.008	1.901
2040	2.155	2.148	2.080	2.039	2.039	1.902
2050	2.171	2.161	2.081	2.065	2.065	1.902

women's projected winning times show a sharp upward movement indicating a considerable improvement in future. The available trends show that there is a possibility for improvement in speed records of women in the case of 100m and 800m running and for 100m swimming. In the case of 10,000m World marathon, women are still lagging behind. It may be concluded here that for short distances women are performing better while for long distances say, marathon it is not so.

REFERENCES

1. B. J. Whipp, and S. A. Ward, *Nature* **355** 25, 1992.
2. R. Pearl, *Review of Biology* **2**, 532-548, 1927.
3. B. Gompertz, *Phil. Trans. Roy. Soc.* **115**, 513, 1825.
4. P. Passey, V. Kakkar, and N. Kapoor, Assessing Time Trends in Sex Differences in Running and Swimming : Will Women Ever Catch up?, Nirmal Rai Inter-School Mathematics Symposium, **Springdales**, New Delhi, 2001.
5. SYSTAT, SYSTAT Inc., USA, 1994.
6. P. F. Verhulst, *Corr. Math. Physics* **10**, 113, 1838.

DO YOU KNOW ?

Q9. What is fathom?

Q10. What is the oxygen percentage in air near Mount Everest?

MATHEMATICAL MODELLING IN CONTINUOUS CASTING

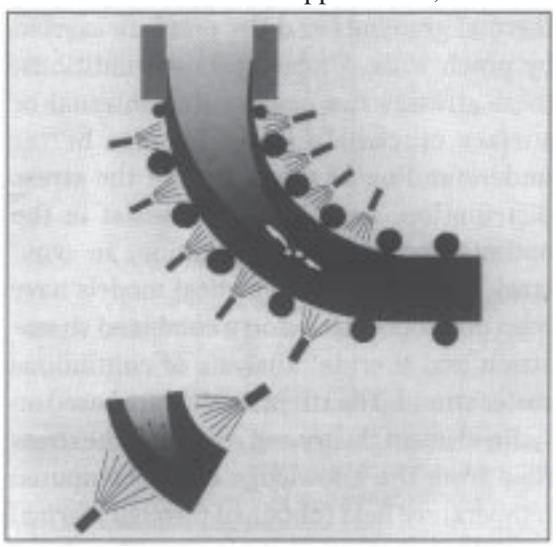
A. K. Ray, Amitabha Paul, Rajeev Kr. Singh*

Mathematical modelling plays an important role in analyzing the problems associated with continuous casting. Mathematical models for continuous caster can be classified under the following heads :

- Thermal models for caster strand
- Models for prediction of stress in solidifying shell
- Models for prediction of shell displacement and associated stress due to bulging
- Models for computing mould thermal distortion and taper
- Modelling of fluid flow in mould
- On-line models for :
  - Control of water flow in secondary cooling
  - Development of expert system

THERMAL MODELS FOR CASTER STRAND

In the early 1960s the computer processors were so slow that for industrial applications, numerical methods were not very popular. Design calculations such as finding the metallurgical length of a casting machine were performed using simple empirical equations that could be solved by hand, for example :



Shell thickness = K. (Distance from meniscus/ Casting Speed)$^{0.5}$

K was found from costly plant trials, sometimes resulting in breakouts.

The finite difference models for shell solidification developed in 1970s could accurately predict such useful information as :

- Shell thickness at mould exit
- Metallurgical length of the caster
- Surface temperature profile of the strand

These models have been extensively used for eliminating the cause of cracks and redesigning spray zones and support systems. Today, refined versions of the solidification models are standard tools for casting engineers and designers.

MODELS FOR PREDICTION OF STRESS IN SOLIDIFYING SHELL

During continuous casting, stresses develop in the solid shell as a result of changing thermal gradients and the pressure exerted by pinch rolls. Under certain conditions, these stresses can cause either internal or surface cracks. In order to have better understanding of the nature of the stress distribution, and thereby to assist in the optimisation of casting conditions to avoid crack formation, mathematical models have been developed, based on a combined stress-strain and thermal analysis of continuous caster strand. The stress models are based on finite-element theory and computes the stress field from the knowledge of the computed

* AGM Technology Dissemination Centre, RDCIS, Ranchi
Reproduced from 'Steel Plant Technologies—an overview' published by Research & Development Centre for Iron & Steel, Steel Authority of India Ltd. Ranchi-834002, in 2004

temperature field (obtained through thermal model) and the roll pressure. The stress models made a landmark qualitative insight-reheating of the strand surface in between the spray zones causes compression stresses there, which in turn force the sub-surface under tension. This is shown in the calculated stress distribution in Fig. 1. The sub-surface, where the solidification front is formed, is very brittle because the luquid films between the dendrite are easily pulled apart. Thus, the reheating generates cracks at the solidification front.

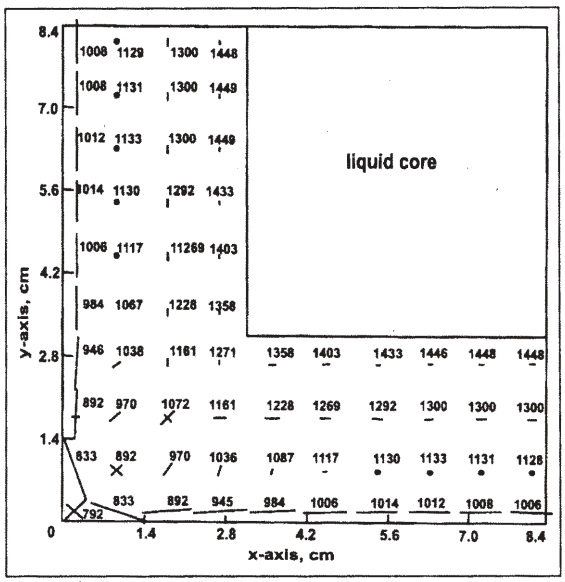


Fig. 1. Calculated stress distribution in soldifying shell : (after 148°C reheat) temperature is in °C ; crosses have lengths proportional to principal stresses and tic marks indicate compression)

MODELS FOR PREDICTION OF SHELL DISPLACEMENT AND ASSOCIATED STRESS DUE TO BULGING

In continuous casting of slab, one of the important phenomena is bulging caused by ferrostatic pressure acting on the solidifying shell between two support rolls which leads to the formation of internal defects such as segregation cracks. The bulging, theoretically consists of creep, plastic and elastic deflection. The estimation of bulging was carried out earlier with analytical solutions using bending beam theory. With the advancement of computational speed, better simulation of bulging and unbending using finite element technique are being performed today. **Fig. 2** shows finite element computation of inelastic strain in a longitudinal section through the strand shell, while it moves downwards over a uniform sequence of rolls. The contours are superimposed on the magnified distortion, to show the well known phenomena of "negative bulging" just past the

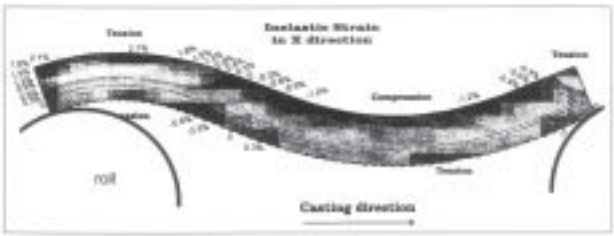


Fig. 2. In elastic strain contours and distorted shape of strand section between rolls (magnified)

upstream roll and downstream movement of the point of maximum bulge past the midway point between rolls. The most detrimental strain are the tensile regions found across the solidification front almost directly above the rolls. Extensive parametric studies were performed using the finite element models to quantify the effects of important parameters on bulging. These results were used to develop empirical correlation for prediction of bulging, which have been widely used in caster design.

MODEL FOR COMPUTING MOULD THERMAL DISTORTION AND TAPER

Heat extraction in mould during casting is not uniform. Therefore, thermal gradient developes in the mould plate. Attempts have been made to measure the temperature of the mould plate at different locations in running casters using embedded thermocouples. Using the temperature data, 2-D or 3-D thermal models for mould plates have been developed for computation of mould plate temperature profile. A typical temperature contours of billet mould wall depicted in Fig. 3, shows that the maximum hot face temperature develops at the meniscus.

Using the calculated temperature profile of the

mould wall, 3-D elasto-plastic finite element models have been developed to calculate the distorted shape of billet mould during operation. Fig. 4 shows the calculated temperature profile down the mould and Fig. 5 shows the corresponding distorted shape profile, including the linear taper. The hottest part of the mould just below the mould expands to bulge away from the solidifying steel. Compared with the natural shrinkage of the shell away from the mould, which was calculated later, a gap is predicted to form just below the meniscus. In practice, the shell bulges to touch one face or another, which gives rise to non-uniform heat transfer. The resulting temperature fluctuations in the shell cause stress leading to longitudinal cracks and other problems. To prevent this, more taper in the upper part of the mould is required. Such modelling is ideally suited to optimise taper design. This led to the development of parabolic taper, which is a common practice in high quality billet casting operations today.

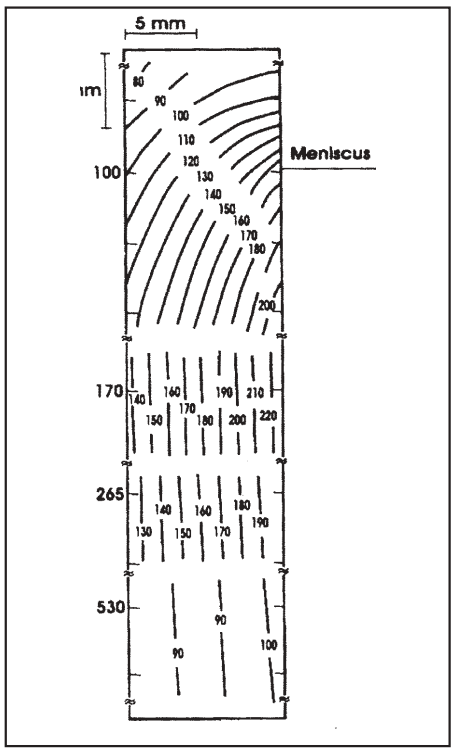


Fig. 3. Calculated temperature contours (9.5 mm billet mould wall for casting high carbon steel at 2 m/min with 11 m/s water velocity)

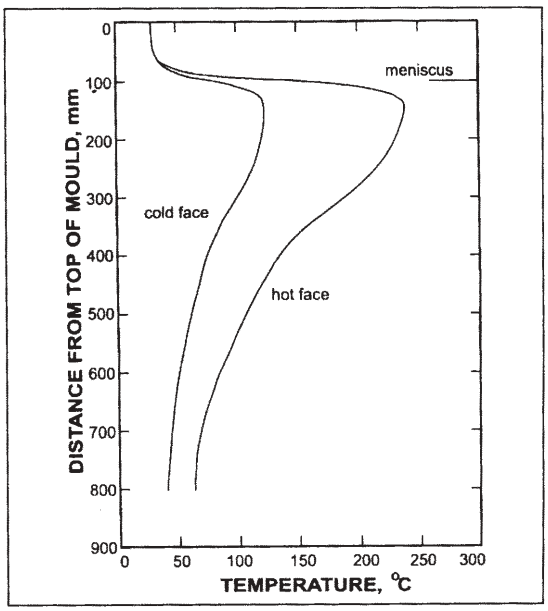


Fig. 4. Hot and cold fact temperature profiles calculated in billet mlould wall (12.7 mm thick)

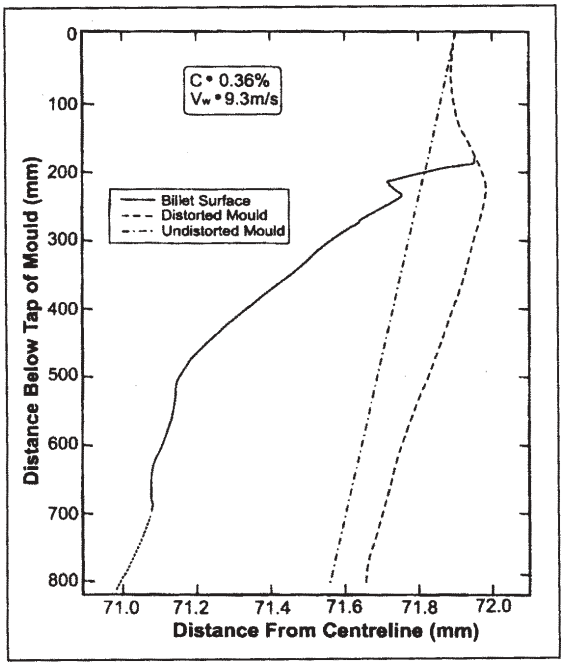


Fig. 5. Axial profile of billet and mould dimenstions during operation showing tendency of billet surface to shrink away from mould wall.

MODELLING OF FLUID FLOW IN MOULD

Flow in the mould region during continuous casting influences many important phenomena,

namely the flow and entrainment of the top surface powder/flux layers, top surface contour and level fluctuations and entrapment of sub-surface inclusions and gas bubbles. Decreasing costs and increasing power of computation, are making it easier to apply mathematical models as a tool to understand the phenomena occurring inside the mould.

ON-LINE MODELS

With the increase in computer power, yesterday's off line models can now run as real-time process control models. Spray water flow rates are now being virtually controlled dynamically using 1-D finite difference models as open loop control models that update at least every minute. These models adjust water flow to ensure that each portion of the strand surface experiences the desired temperature profile.

Brimacombe envisioned "intelligent mould" controlled by an advanced process model. Such a model would simultaneously manage flow control, casting speed, narrow face taper mould and spray cooling water, powder feeding, and electromagnetic forces in order to minimize defects. By responding the sensor feedback, including liquid level, thermocouple signals, mould friction, and perhaps even mould-steel velocity sensors, such a model could also identify impending problems and take immediate corrective action.

Breakout detection systems were the first practical example of the "intelligent mould". This was made possible by the discovery of the "thermal signature" of sticker break-out. Once the thermal signals of other defects are clearly understood, on-line models could be developed to take appropriate action.

GLOSSARY

Finite Element Computation : A technique for solving differential equation through numerical methods.

Negative Bulging : Distortion of the solidifying shell towards the centre of the strand.

Ferrostatic Pressure : Pressure exerted by the liquid steel on the solidifying shell.

Intelligent Mould : A mould capable of taking corrective measures during casting by itself.

Thermal Signature : Mould temperature profile just before break-out.

SOMETHING TO THINK ABOUT

SPLASHING OF A DROP

H.S. Ray*

If a liquid drop is allowed to fall from a height on a flat plate, it generally splashes spitting into smaller bubbles. Why does this happen? A simple explanation will be that while surface tension forces create a drop with minimized surface area, the impact breaks the drop into pieces torn apart against surface tension.

The phenomenon has recently studied by a high speed camera which in the past set aside many commonly held notions. For example it had shown conclusively that the recoil of a gun starts after a bullet leaves the barrel and therefore it can not spoil the aim. In a recent article published in Scientific American 9 June 2005, p 360 the authors have published some interesting findings of high speed photography of splashing to say that there is something more in spalshing. The authors, physicists in the University of Chicago released alcohol drops in vacuum chamber into a dry glass plate and photographed splashing using camera speed of 47,000 frames per second. At roughly 1/6th normal atmospheric pressure, splashing completely disappeared and droplets simply pancaked without visible undulations. The investigators suspect that fallen drops splatter because the atmoshpere press on them and distabilise their outward spread.

* Emeritus Professor, Central Glass and Ceramic Research Institute, Kolkata-700 032

SHORT COMMUNICATION

FAT AS THE FIT FUEL

D. Balasubramanian*

The hummingbird is perhaps the smallest bird in the world. The bird itself is no bigger than three inches and weighs just about four grams. Compare that with the rupee coin, which weighs six grams and is one inch in diameter. The eggs of the hummingbird, usually laid in pairs, are no bigger than coffee beans! Truly an exquisite creation, the humming-bird has been photographed for the first time in beautiful detail by Esther and Robert Tyrrell and the pictures appear in the June 1990 issue of ***The National Geographic*** magazine. For those who are impressed by the size and sweep of the eagle, the Brahmani kite, the ostrich or the mythical Roc bird, the hummingbird is a gentle reminder that small is beautiful. In fact, as the recent scientific report by Suarez and co-workers shows, its extreme efficiency will put its big brothers to shame.

Native to the tropics and to Southwest America, the hummingbird feeds exclusively on the nectar that it sucks out of tubular flowers through its long capillary tube or straw of a beak. For good reason too, since it has to forage for food by the energy-wise costly act of hovering. It also needs energy to keep its body warm, and of course to stay afloat in air. With its miniscule weight, it needs to flap its wings almost once every second, so as to keep in flight and not be blown off. In a bird like this, the rate of utilization of energy or metabolism is thus necesarily very high ; the general rule, in fact, is that the rate increases as the body weight decreases. The concentrated sugar solution of the nectar suits its needs perfectly, to the extent that where there are no flowers, there are no hummingbirds.

FOUR-MINUTE FEEDS

Consider the situation from the bird's point of view. Given its size, its stomach and intestines cannot be too big either. A typical feed or each meal averages about a drop or two of nectar–recall that it takes twenty drops to make one milliliter. And it takes about four minutes flat for the bird to clear half of this meal, and it is time to feed again. It is estimated that the hummingbird has to feed about 15 times an hour! Added to this is the habit of the hummingbirds to migrate in winter. The distance covered in such migration can be as large as 3,000 km, roughly the distance from Jammu to Knyakumari. Granted the four-minute feed schedule and the need for nectar, what does the humingbird eat during migration? Where does it get its food and how does it store its fuel for such long flights? The answer is as startling as it is ingenious–the bird relies on two different energy stores for the two acts of foraging and migratory flying. Dr Suarez and co-workers report on this finding in the December 1990 issue of the ***PNAS, USA***.

FAT AS FUEL FOR FLYING

Living beings store two types of fuel for their bodily energy needs–fats and carbohydrates. Sugars are typical examples of the latter, and are stored

* L. V. Prasad Eye Institute, LV Prasad Marg, Banjara Hills, Hyderabad 500034, e-mail : dbala@lubly:itph.net. Article published earlier in The Hindu, Reproduced with permission.

usually as starch and glycogen. In order to derive energy from them, the organism oxidizes them using oxygen from the inhaled air. Oxidative metabolism, as this is called, is the same as burning them in air, but with an important difference. Burning is done using a fire while metabolism occurs at body temperature, catalyzed by the enzymes present in the body cells. Hans Krebs showed, over fifty years ago, that the metabolic reaction path of sugars goes through a cycle or the molecular mill called the citric acid cycle. Typically, such metabolic oxidation of one gram of glucose yields about 4 calories of energy.

The other source of bodily energy is fat, which is oxidized using what is called the fatty acid metabolism. It takes more oxygen to oxidize fats than sugars, but the amount of energy obtained from fats is also higher. One gram of the model fat cyclohexane yields 11 calories, almost three times that from glucose. However, what is interesting about oxidative metabolism is that both the sugar pathway and the fatty acid pathway merge in their final stages into the citric acid cycle. In effect, both the fuels finally feed into the same reactor mill. Which fuel to use then is a matter of convenience or contingency. This is precisely where the hummingbirds display a remarkable knowledge of "properties of matter".

FATS PACK EASILY

Fats are compact, lightweight and do not mix with or absorb water. As a result, fats are easily packaged and stored neatly. In contrast, carbohydrates are a lot more open in their structure and fluffier (cotton is a good example), and also pick up a lot of water. And they are less efficient as fuels than fats. The Suarez team monitored hummingbird metabolism and discovered that the bird preferentially uses carbohydrate as fuel while it is foraging, but switches to fat during migratory flights. Burning fat is more economical, more efficient and leads to a lower weight loss, all features well suited for the activity of long distance flying. In fact, the bird prepares in advance for migration by first converting the nectar that it eats into fat and storing it up in its body. Prior to migration, the birds were seen to store as much as a tenth of their body weight daily as fat! Compare this with what a modern jetliner does. The Airbus A320, which weighs about 70 tons 'All-Up', carries as much as 18.5 tons of fuel (the fat called aviation petrol) when absolutely necessary.

COST-BENEFIT ANALYSIS

If fat is the more convenient fuel, why not use it all the time? Remember that the primary food is sugar and it costs energy to chemically convert and store it in the form of fat, which is later utilized during long flying bouts. This route of sugar to fat to energy is only 80% as efficient as the direct route of sugar to energy; given that fat yields thrice as much energy, this means that the process of converting sugar into fat is a pretty uphill one. Unless circumstances are truly dire, it still pays to burn the poorer fuel, sugar! And the hummingbird ensures that it gets its supply of nectar by fighting with others for ownership of flower territory, and also cuts energetically expensive activities such as courtship, mating, aggression and migration to the minimum and switches fuel strategies based on what is best in the long run.

The desert animal–the camel–also does a similar fuel-switching from fodder to fat when it has to traverse a desert for weeks together with little food. The camel coverts its usual starchy food into fat and stores it in its celebrated hump. Packaging it into a one-kilogram lump of a hump is far more convenient, even if a bit ungainly, than lugging along three kilos of glycogen all over its body. It is also somewhat difficult in the dry desert since sugars soak up a lot of water as well. As the camel trudges across the desert for a fortnight, the hump simply melts off as the fat is used up–to reappear again in times of plenitude!

We men and women do the same too in a fashion, though not quite as humps but as adipose tissue. The eager and determined dieter who wants to shake off excess poundage does so rapidly in the first week of dieting. This is the period when all the glycogen is burnt off and all the water that is bound to it is also lost–all very encouraging. One stone and one week later comes the turn of the adipose fat to be oxidized. But then we burn less of it for the same energy, and lose little body water since fat does not hold any. There is, subsequently, less loss of weight and more loss of interest in the dieting programme. All because of the fuel-switching strategy that is common to hummingbirds and to humankind alike!

ANSWERS TO "DO YOU KNOW?"

A1. 30-40 percent of the sand volume that means 300-400 cc because the sand bed is 30-40 percent porous.

A2. A type of grasshopper called Cicada.

A3. No.

A4. The whale which can stay underwater up to 2 hours and drive down to the depths of 3000 metres in ocean water.

A5. 2,930 diamonds as a whole almost 1000 carats.

A6. 318 miles per hour, Oklahama, USA, 1999.

A7. Yes it does. Actually it stores fat and when there is no food the hump continues to supply energy and shrinks.

A8. Arabs.

A9. A unit of distance often used to describe depth of ocean. It has come from the Danish word for 'outstretched arms'.

A10. About a third of that at sea level ie about 7% near Mount Everest.

KNOW THY INSTITUTIONS

INTERNATIONAL ADVANCED RESEARCH CENTRE FOR POWDER METALLURGY AND NEW MATERIALS, HYDERABAD

ARCI is a state-of-the-art facility for research & development in advanced materials and associated processing technologies. Having its origin in the Integrated Long Term Programme on Cooperation in Science & Technology (ILTP) signed by the erstwhile USSR and India in the late 1980s, ARCI became operational in April 1995. Today, ARCI functions as a grants-in-aid institution of the Government of India's Department of Science & Technology.

Translating Research to Technology has been ARCI's motto and the Centre has set for itself the task of striving to bridge the gap between conventional research institutes & laboratories and the high-technology industries. Consistent with this overall goal, ARCI has dedicated its efforts towards achieving the following objectives :

- Development of high performance materials and processes for niche market.
- Demonstration of technologies at prototype scale.
- Transfer of technologies to the Indian industry.

In order to achieve the above, ARCI has been taking up technologies while they are in their embryonic stages from laboratories / institutions of CIS countries or Indian laboratories, and jointly developing them to the levels of pilot plants / demonstration centers. The pilot plants / demonstration centers are then primarily utilized

to sensitize the Indian industry to the advantages and cost-effectiveness of the technology under Indian conditions and thereby aid in the smooth transfer of such technologies to the industries. Such conscious efforts to direct research to fuel growth and evolution has resulted in development of technologies, which are ready for adoption by the Indian industries. The Center's efforts to effect technology transfers have been fortified by the attractive schemes set up by the Indian Governement under which the Indian industry can obtain very soft loans for implementing technologies developed by the Indian laboratories and R&D institutions. This has enormously increased the 'salability' of technologies developed by institutions like ARCI.

Surface Engineering, Ceramics, Powder Metallurgy and Laser Processing of materials constitute the four major thrust areas at ARCI. The Powder Metallurgy Programmes are largely aimed at developing value-added products and exotic materials for the Indian industry. There is also significant focus on transformation of the otherwise mine burden to useful P/M products, energy conservation and development of permeable materials for varied applications. The activities in the field of Ceramics have been initiated to create new and advanced materials for high-tech applications. The programmes are primarily oriented towards developing alternative materials for better performance, substituting the import market for high temperature materials and recycling of scrap to produce engineering ceramic powders. In Surface Engineering, ARCI has been judiciously building up facilities to complement and enhance existing national capabilities in the field. The Centre has been continuously striving to provide most cost-effective solutions to combat surface degradation problems in the industry. This is being achieved through indigenization of coating equipment as well as by offering some of the institute's unique coating facilities for jobbing activities to permit the industry access to technologies not available elsewhere in the country.

ARCI Advanced Technoloy Incubator (AAMTI) is being established adjacent to ARCI R&D Campus. Three companies, all technology received from ARCI, have already set up their production facilities in the incubator.

Objectives of establishing AAMTI are

- to minimise the risks involved in commercialisation of ARCI technologies.
- to promote and support small scale entrepreneurs in their effort to innovate and commercially exploit ARCI technologies.
- to deliver the benefits of ARCI networking to members.

Contact

For more information please contact :

The Director

International Advanced Research Centre for Power Metallurgy and New Materials (ARCI)

Balapur PO, HYDERABAD 500 005, Andhra Pradesh, India

Phone : 91-40-24441075/76, 24457104/5/6

Fax : 91-40-24442699/24443168

Email : info at arci dot res dot in

Website:www.arci.res.in

ANNOUNCEMENT

95th Indian Science Congress, January 3-7, 2008, Visakhapatnam

KNOWLEDGE BASED SOCIETY USING ENVIRONMENTALLY SUSTAINABLE SCIENCE AND TECHNOLOGY

Globalization of trade, transport and communiction sectors made the world amenable and accessible in terms of movement of materials, people, business houses, consumerism and knowledge transfer. India with ancient and rich cultural heritage has developed over the years its own wide base for science, engineering and technology with appreciable economic growth attracting global attention for its marketing potential. India is recognized today as fast developing world power in view of the achievements in sectors of space technology, innovative and emerging technologies, various forms of complimentary medicine, information and telecommunication technologies and business process outsourcing. But the question is the acquisition of all these attainments are at the cost of the environmental sustainability on account of ever increasing demand for Development leading to environmental degradation, depletion of natural resources, widening rural-urban divide in quality of life, lack of basic amenities of food, fibre, water and distress related migration to urban slums due to alternating drought-flood cycles.

The country with the capabilities and credentials in science, engineering and technology is grappling with the problem of taking the benefits of science to the needy whether rural or urban. Innumerable federal and state departments are working with a specific agenda of elevating per capita income of the huge populace. The major efforts are in farming sector, National Environmental policy, National Biodiversity Authority, enhancing space technology applications in disaster mitigation, telediagnosis and telemedicine, upgrading efforts in water security, energy options and knowledge transfer systems. Inspite of all this we are not able to bring more people above the poverty line, traditional knowledge remains in minds of families and not in books, disease survey and delivering health care lag behind, agriculture is still chemical dependent, farmers and agricultural labour face total insecurity in the absence of insurance and not so well operating microfinance system. While yojanas such as PURA clusters offer glimmer of hope there is lot more needs to be done.

There occurs a major divorce and dichotomy between science, engineering and technology sectors and social sciences and social action. There is therefore an imperative need to bring benefits of environmentally sustainable vision to the rural and urban poor through social vision and social action delivering social benefits. Government, industry, non-government organizations, self-help groups and community based organizations need to work together with science and technology sector in order to be able to make the benefits of innovative technologies flow to people living under poverty line. Interface meetings with National Knowledge Commission, National Commission of Farmers, social action groups and local government may lead to several viable solutions for providing alternative livelihoods to people to tide over unfavourable weather patterns. Strengthening of the Education system incorporating formal, non-formal and traditional knowledge needs to be addressed.

The 95th session of Indian Science Congress aims to address several thrust areas through plenaries, symposia, panel and round table deliberations to make the world in general and India in particular a knowledge empowered society.

FOCUS AREAS

- Knowledge Systems, Knowledge Base, Dissemination, Access and Applications of Knowledge, Delivery using IT, CT and Space Technology, NKC Chapters for Compilation and Collation of Traditional Knowledge.
- Environmental Up-gradation : Built in safe-guards to promote Clean & Green Concepts in Society; Waste conversion to resource, Agro and Social Forestry.
- Biodiversity Mapping and Management; Threat of Invasive Alien Species, Empowerment of 'Ecosystem People', Benefit flow to stake holders.
- Sustainable Green Revolution, Organic Farming, Compost Technologies.
- Biotechnology and Bio-Entrepreneurship, Rational use of Bioprospecting and Replinishable mode of Bioresources, Biopiracy and Environmental Ethics.
- Water Mission : Drinking water, Water Harvesting, Storage, Treatment and Management; Linking Rivers and Water bodies-Regional and National.
- Space Technology and Information Technology for Disaster Management, Early Warning Systems; Coastal Afforestation; Disease Survey, Telemedicine.
- Marine resources—living and non-living; Marine Biotechnology, Bioactive substances, Mineral extraction, Marine Biodeterioration.
- Nanoscience : Nanomaterials in Industry, Nanotechnology in Medicine and Environmental Management and Remediation.
- Transport systems; National Link Highways, Navigational Engineering, Maps; Energy options-Renewable Energy, Pollution abatement; Mineral Resources Development.
- Green Technologies addressing Environmental challenges-Bio and Phytoremediation, Global warming and Green house gases, Safe landfills.
- Biotherapies, Stem cell Technologies, Regenerative Medicine, Biomodels in Medical Research, Bioethics.
- Traditional and Complementary Medicine and linking with modern medicine.
- Linking Science and Technology with Social Sciences and Social Action.
- PURA Cluster Concept : Challenges, Successes and Failures.
- Interface of Public and Private Industry and Social Action Sectors for effective delivery of Innovative Technologies and Information to target population.
- Training of Trainers : Imparting skills with greater emphasis on women in rural sectors in Alternative Livelihoods to restrict distress related migration to urban areas.
- Public-Private-Social Action Group initiated and sponsored Awareness and Implementation activities relating to IPR, Prevention of spread of Communicable Diseases, Delivery of Health Care and Provision of Drinking water.

For more details please contact :

Dr. Ramamurthi Rallapalli,
General President of ISCA 2007-08
City Camp Office : 9A, Vaikuntapuram,
MR Palli, Tirupati-517502
Tele : +91-877-2241907,
Mobile : 98494-88390, 939388088
Fax : +91-877-2242079
e-mail : isca2008@yahoo.com; rrallapallius@yahoo.com

Prof. L. Venugopal Reddy,
Vice-Chancellor, Andhra Unviersity
Visakhapatnam-530 003.
Tel: +91-891-2755547, 2844333; 2844222
Fax : +91-891-2525611
Grams : "UNIVERSITY"
e-mail : l.venugopalreddy@gmail.com/
l.venugopalreddy@yahoo.com

Conferences / Meetings / Symposia / Seminars

Date	Topic	Contact
31 Aug. to 1 Sep. 2007	National Conference on **Information Technology : Present Practices and Challenges,** New Delhi	**Prof. Vikash Kumar** Asia Pacific Institute of Management, 3 & 4 Institutional Area, Jasola (Sarita Vihar), New Delhi-110025 Email : vikas@asiapacific.edu
9-14 October 2007	The 4th International **Rice Blast Conference,** Changsha	**Ms. Dan Wang,** Agricultural University, Changsha, China Email : jessicawangdan@163.com.
28 Oct to 2 Nov. 2007	12th World Lakes Conference on **Conserving Lakes and Wetlands for Future,** Jaipur	**National Institute of Ecology** 125 (First Floor), Main Road Katwaria Sarai, New Delhi-110016, Email : info@taal2007.org
5-9 November 2007	International Conference on **Research Reactors : Safe Management and Effective Utilization,** Sydney	**IAEA-CN-156** P.O. Box 100 1400 Vienna, Austria Email : official.mail@iaes.org
17-19 December 2007	3rd Indian International Conference on **Artificial Intelligence**, Pune	**Bhanu Prasad** Department of Computer and Information Sciences Florida A & M University Tallahassee, FL 32307 USA Email : bhanupvsr@gmail.com

MEMBERS OF ISCA COUNCIL FOR 2006-2007

General President
Prof. Harsh Gupta, Hyderabad

Immediate Past General President
Dr. I.V. Subba Rao, Secunderabad

General President-Elect
Prof. R. Ramamurthi, Tirupati

General Secretary (Headquarters)
Prof. Avijit Banerji, Kolkata

General Secretary (Outstation)
Prof. S.P. Singh, Kurukshetra

Treasurer
Prof. A.B. Banerjee, Kolkata

Elected Members of the Executive Committee
Prof. P.N. Srivastava, Gurgaon
Dr. Ashok K. Saxena, Kanpur
Dr. M. Sudarshan Reddy, Hyderabad
Prof. B. Satyanarayana, Hyderabad
Prof. Uma Kant, Jaipur
Dr. Geetha Bali, Bangalore
Prof. Ranjit K. Verma, Bodh Gaya
Prof. Nirupama Agrawal, Lucknow
Prof. K.C. Pandey, Lucknow
Prof. Col. Dr. Ranajit Sen, Kolkata

Representative of the Department of Science & Technology, Government of India
Prof. V.S. Ramamurthy, New Delhi

Local Secretaries
T. Balasubramanian, Annamabinagar
Prof. Venugopal P. Mena, Annanalainagar

Past General Presidents/Secretaries/Treasurer
Prof. M.S. Swaminathan, Chennai
Dr. H.N. Sethna, Mumbai
Prof. A.K. Sharma, Kolkata
Prof. M.G.K. Menon, New Delhi
Prof. R.P. Bambah, Chandigarh
Prof. (Mrs.) Archana Sharma, Kolkata
Prof. C.N.R. Rao, Bangalore
Dr. A.P. Mitra, New Delhi
Prof. Yash Pal, Noida
Prof. D.K. Sinha, Kolkata
Dr. Vasant Gowariker, Pune
Dr. S.Z. Qasim, New Delhi
Dr. S.C. Pakrashi, Kolkata
Prof. U.R. Rao, Bangalore
Prof. S.K. Joshi, New Delhi
Dr. P. Rama Rao, Hyderabad
Dr. (Mrs.) Manju Sharma, New Delhi
Dr. R.A. Mashelkar, New Delhi
Dr. R.S. Paroda, Tashkent, Uzbekistan
Prof. S.S. Katiyar, Kanpur
Dr. K. Kasturirangan, Bangalore
Prof. Asis Datta, New Delhi
Prof. N.K. Ganguly, New Delhi
Dr. (Miss) S.P. Arya, New Delhi
Prof. H.P. Tiwari, Allahabad
Prof. S.P. Mukherjee, Kolkata
Dr. (Mrs.) Yogini Pathak, Vadodara
Prof. B.P. Chatterjee, Kolkata
Dr. S.B. Mahato, Kolkata

Sectional Presidents
Dr. M. S. Sachdev, New Delhi
Prof. U.C. Goswami, Guwahati
Prof. Kisore K. Basa, Bhopal
Prof. Anil K. Singh, Mumbai
Prof. M.P. Singh, Lucknow
Mr. Sujit Kumar Mitra, Kolkata
Prof. P.C. Pandey, Kharagpur
Prof. M. Surendra Prasad Babu, Visakhapatnam
Dr. Rakesh Chandra Agrawal, Raipur
Prof. J.C. Misra, Kharagpur
Dr. Amal Roy Chowdhury, Kolkata
Dr. Rakha Hari Das, Delhi
Dr. R.N. Singh, Dehra Dun
Prof. S.M. Reddy, Warangal

Elected Members of the Council
Dr. (Mrs.) Vijay Laxmi Saxena, Kanpur
Mr. Gauravendra Swarup, Kanpur
Prof. V.K. Verma, New Delhi
Dr. Dhyanendra Kumar, Arrah.
Prof. Santosh Kumar, Bhopal
Prof. P.V. Arunachalam, Tirupati.
Dr. K. Jeevan Rao, Hyderabad

Representatives/Co-opted Members
Mr. Nilangshu Bhusan Basu, Kolkata
Dr. H.S. Maiti, Kolkata
Prof. S.P. Mukherjee, Kolkata
Prof. Col. Dr. Ranajit Sen, Kolkata
Prof. Anupam Varma, New Delhi

Editor-in-Chief of Everyman's Science
Prof. S.P. Mukherjee, Kolkata

S & T ACROSS THE WORLD

GAMMA RAY CLOCK

The first ever modulated signals from space in the form of Very High Energy Gamma Rays have been discovered by astronomers using the HESS telescopes.

Regular signals from space have been known since the 1960s, when the first radio pulsar was discovered but this is the first time a signal has been seen at such high energies–100,000 times higher than previously known.

The signal comes from a system called LS5039 which was discovered in 2005. It is a binary system, formed of a massive blue star, twenty times the mass of the sun, and an unknown object, possibly a black hole. The two objects orbit each other, at very short distance, varying between only 1/5 and 2/5 of the separation of the earth from the sun, with one orbit completed every four days.

Different mechanisms can affect the gamma ray signal that reaches earth and by seeing how the signal varies, astronomers can learn a great deal about binary systems.

As it dives towards the blue-giant star, the compact companion is exposed to the strong stellar 'wind' and the intense light radiated by the star, allowing particles to be accelerated to high energies but at the same time making it increasingly difficult for gammarays produced by these particles to escape. The gamma ray signal is strongest when the compact object, thought to be a black hole, is in front of the star as seen from the earth.

(Eurk Alert, Nov 30, 2006)

INACTIVE ENZYMES SPRING TO LIFE

Enzymes are proteins which are not actually alive but come from living cells and perform chemical conversions.

Scientists in the USA have now found that enzymes that were stored in a nanomaterial called functionalized mesoporous silica (FMS) that was kept in a refrigerator long past the expiry date for such enzymes, sprang back to life when taken out. These findings show that it may be possible to exploit such packed enzyme traps for food processing, decontamination, biosensor design, and other activities that require controlling catalysts and sustaining their activity.

In this study, the silica pores were 'functionalized' by lining them with compounds that varied depending on the enzyme that was to be ensnared. When the silica spun FMS pores which are hexagonal in shape and about 30 nanometres in diameter, came into contact with an enzyme in a solution, the enzyme was pulled into place by the oppositely charged FMS and squeezed into shape inside the pore, thus permitting substances inside the solution to be catalysed into the desired product. For example, GI turned glucose into fructose, and standard tests for enzyme activity confirmed that FMS-GI was as potent at a making fructose as enzyme in solution.

According to these scientists, the enzymes work better in such cells, because they get concentrated about 1000 to 10,000 times than in standard lab conditions and this crowding helps to stabilise the enzymes and keep them active.

(Pacific North West National Lab, Nov 30, 2006)

BOOSTING NUTRIENTS IN WHEAT

Scientists in the University of California, USA, have found a way of boosting the protein, zinc and iron contents in wheat, which could benefit millions of people around the world.

The scientists have identified a gene in a variety of wild wheat known as wild emmer wheat, that raises the grain's nutritional content and also makes it grow more quickly. The gene became

nonfunctional for reasons that are not clearly known as mankind began to domesticate wheat.

Conventional breeding methods were used to introduce the gene into cultivated wheat varieties, thereby enhancing the protein, zinc, and iron values of the grain.

Wheat is one of the two major crops in the world, the other being rice, and is estimated to provide 20 percent of all the calories consumed. WHO estimates that over 2 billion people get too little zinc in their diet and more than 160 million children lack adequate intake of protein.

This development will therefore be widely welcomed, more so as the new strain of wheat involves no change in taste.

(Reuters, Nov 25, 2006)

BALL-END SHAFT

The Central Scientific Instruments Organisation (CSIO), Chandigarh, took up a project on "Feasibility Study for Development of Super Precision Ball-end Shaft and Cups", with funding provided by the Bhabha Atomic Research Centre (BARC), Mumbai. The objectives were enhancing technology development within the organisation, optimising the fabrication and metrology process, and delivering a few prototypes of super precision ball-end-shafts (BSEs) and cups.

The project, executed by the National Aspheric Facility (NAF) at CSIO, has been successful and the committed number of super precision cups and balls shafts has been delivered. They are to be deployed in strategic applications by BARC. The desired accuracies in these critical components are of micron-level dimensional integrity, surface profile waviness in sub-micron range and surface smoothness in nanometric range.

The project has resulted in enhancing CSIO's knowledge base in the domain of precision engineering and metrology and it is anticipated that the expertise so gained would be useful in taking up further R&D challenges in this particular field.

(CSIR News, Nov 15, 2006)

TACKLING OIL SPILLS

Scientists at the Integrated Coastal Marine Area Management (ICMAM) for the Gulf of Kutch region have put in place a satellite based model to tackle oil spills and track other such incidents in real time, so that accurate details are provided to disaster managers.

This Oil Spill Trajectory model calculates the time taken by the oil spill to reach the shores, taking into consideration various factors including oil type, location, depth of the sea, wind speed etc.

The model which has been developed under the programme on "Oil Spill Modelling and Mapping of Oil Spill Risk Areas" can forecast the trajectory of an oil spill within three minutes of data input.

Plans are underway to develop the model for 42 sites in the country's marine space, of which 20 have been identified as sensitive owing to offshore assets, unique ecosystem, and heritage sites along the shore.

A habitat specific model for the Gulf of Kutch which is home to atleast 6 single point moorings of leading petrochemical companies is ready and such model for 19 other regions will be ready by March 2009.

(PTI Science Service, Dec 1-15, 2006)

भारतीय विज्ञान कांग्रेस संस्था

14, डा० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

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

Telegram	:	SCICONG : CALCUTTA	Fax	:	91-33-2287-2551
Telephone	:	(033) 2287-4530, 2281-5323	E-mail	:	iscacal@vsnl.net
Website	:	http://sciencecongress.org			iscacal_2004@yahoo.com
		http://sciencecongress.nic.in			

Terms of Membership and Privileges of Members :

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

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

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

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

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

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

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

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

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

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

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

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

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

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

---

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

भारतीय विज्ञान कांग्रेस संस्था

14, डा० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

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

Telegram : SCICONG : CALCUTTA
Telephone : 2287-4530, 2281-5323
Website : http://sciencecongress.nic.in
Fax : 91-33-2287-2551
E-mail : iscacal@vsnl.net
iscacal_2004@yahoo.com

APPLICATION FORM FOR MEMBERSHIP

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

Stamp Size Photograph

Dear Sir,

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

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

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

SECTIONS

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

(Please type or fillup in Block Letters)

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

Academic Qualifications :
(Evidence to be submitted)

Designation :

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

Phone No. & e-mail

Permanent Address :

Yours faithfully

Date : Signature

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