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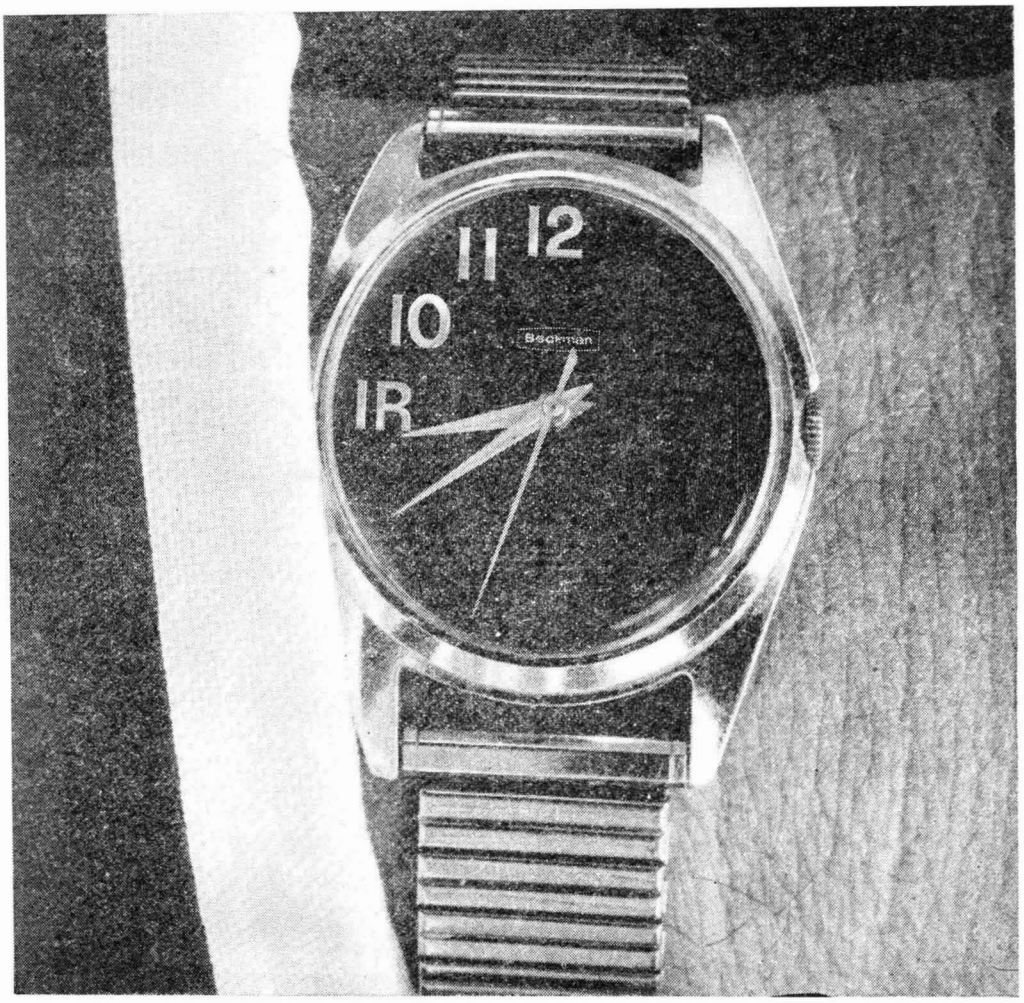

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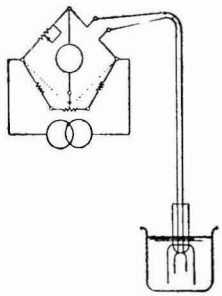

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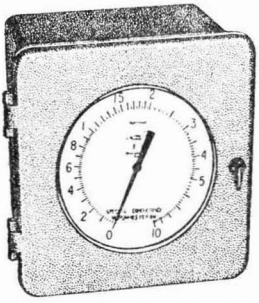

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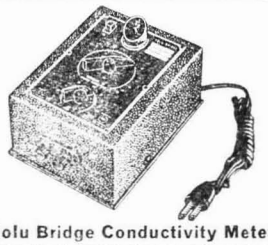

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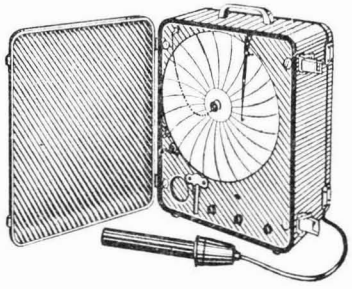

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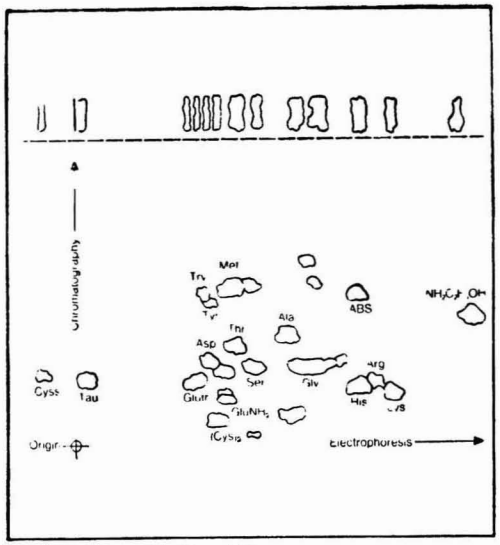

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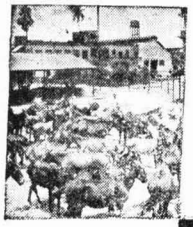

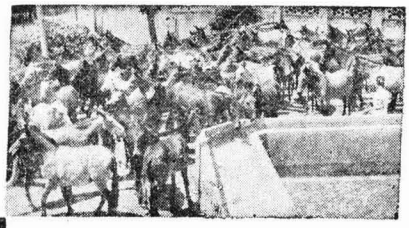

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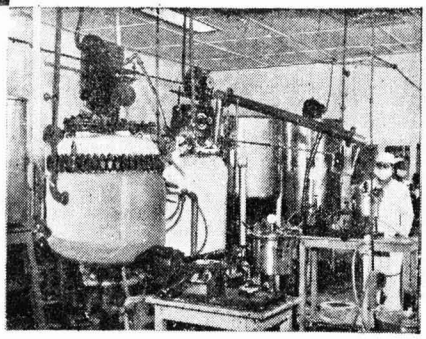

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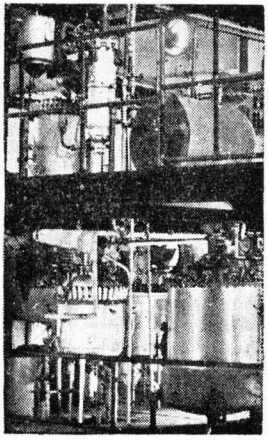

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Current Topics

Opinion Survey of Scientists & Technologists

THE results of a survey of the opinions and attitudes of scientists and technologists in India in respect of their environment and working conditions are incorporated in a report* issued by the Research Survey & Planning Organization of the Council of Scientific & Industrial Research. Conducted primarily to study and isolate social and human factors affecting scientists' motivations and performance in research institutions, the survey had four specific objectives: (1) to study the attitudes of scientists towards science in general and scientific research in India in particular, and towards matters of immediate concern to them, such as their work environment, job conditions, interpersonal relations, etc.; (2) to assess the nature and extent of difficulties scientists often encounter (or feel they encounter) in their work; (3) to correlate the findings in respect of the above points with the personal variables of individuals, such as academic qualifications, age, experience, status, achievements, professional affiliations, etc.; and (4) to establish relationships between scientists, their attitudes and their work environment.

Replies were received from about 2143 scientists located in universities, national laboratories, government research organizations and private/industrial research establishments to an exhaustive questionnaire so planned as to allow the analysis to centre around a number of variables, representing their status in life and their psychological reaction to environmental factors. The findings and the conclusions based on them incorporated in the report are related mainly to (1) the general structure of the sample in terms of age, experience, sector of employment and academic qualifications; (2) socio-economic status of the respondents as revealed through salary, family size and occupation and income of fathers; (3) inter- and intra-sectoral mobility trends among scientists; (4) analysis of professional activities and related attitudes; (5) pattern of internal and external communication; (6) bivariate and multivariate analysis of interrelationships between autonomy in project selection, satisfaction with the projects selected, relations with supervisors, credit for research, etc.; and (7) opinions and evaluation of foreign trained scientists of the working conditions in India and abroad.

Majority of the findings emanating from the survey stress the obvious. There are, however, some points on which the findings tend to depart from the expected trends. On a few points, such as mobility of scientists, average time spent on projects, causes for termination of projects, etc., the survey provides, perhaps for the first time, broad indications which may be of interest to the sponsors of research projects in the country. From the point of view of the respondents' standing, the survey reveals that a majority of the scientists come from low-income families with traditional non-scientific occupations. Private/industrial research establishments pay their scientists comparatively better, especially in senior jobs; scientists in state government research institutions are the lowest paid ones. The earnings of foreign trained scientists are comparatively higher than those of their counterparts trained in India.

Scientists in the universities and industry are found to be most mobile and those in the national laboratories least mobile. Recruitment and job changes are mostly within sectors (except national laboratories). National laboratories attract the largest percentage of scientists from other sectors with the least outflow to other sectors. There is a discernible shift from science teaching and routine scientific work to active research. Higher salary and better research facilities are pointed out as the two major inducements prompting scientists to change their occupation. According to the survey, given a choice, more than 50 per cent of Indian scientists would prefer to work in a research institute or a university laboratory in a foreign country.

In terms of publication activity, the survey shows that the age group 31-45 years is the most productive. By and large, Indian scientists publish their research work in Indian journals; similarly three-fourths of the total society membership is confined to scientific and professional societies in India. The average number of publications and society membership per scientist is higher for universities and private/industrial research institutions than for national laboratories and other government research institutions. Field-wise, the average number of publications is highest in medicine and biological sciences and lowest in engineering and social sciences. A large majority of scientists are currently engaged in applied research, except in universities where fundamental research is preferred. In general, a larger number of projects is completed per scientist in medicine and engineering than in other fields.

Roughly one quarter of the projects undertaken are terminated before completion — a majority of them within a year of their being started. The reasons stated for terminating the projects are promotion, transfer or termination of service, lack

*Aqueil Ahmed & Gupta, S. P. (with the assistance of Bhatnagar, D. K.), *Opinion survey of scientists and technologists*, Survey Report No. 9 (Research Survey & Planning Organization, CSIR, New Delhi), 1967, Pp. 74+viii.

of resources and official cancellation or postponement of the research project or the research programme. Maximum research utilization is claimed by scientists in government and private/industrial sector and least by those in national laboratories and universities.

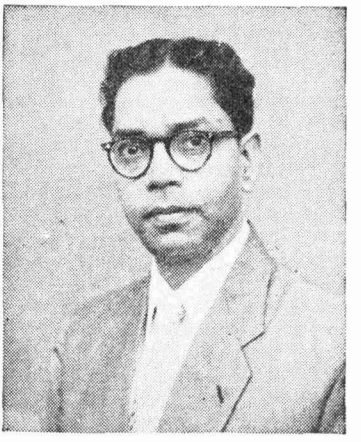
While a majority of scientists express satisfaction with their current research work and harmony with the research supervisors, over 50 per cent of the foreign trained scientists feel the working environment in India less congenial than that in foreign countries.

Dr C. Radhakrishna Rao

DR C. R. RAO, Director, Research & Training School, Indian Statistical Institute, Calcutta, has been elected a fellow of the Royal Society, London.

Dr Rao (*b.* 10 September 1920) passed his M.A. in Mathematics from the Andhra University and M.A. in Statistics from the Calcutta University. At the age of 28 he was appointed Professor of Statistics at the Indian Statistical Institute, Calcutta. Prior to his appointment as Director of the Research & Training School, he was Head of the Division of Theoretical Research & Training for about 15 years. While on deputation at the Duckworth Laboratory, Cambridge, Dr Rao worked on an Anthropometric Project concerning the origin of the ancient inhabitants of Gebel Moya (Africa) and got his Ph.D. for this work. He also worked on a genetical problem in the mapping of chromosomes in mice under Sir Ronald Fisher. He received his Sc.D. also from Cambridge University on the basis of his published work in statistics.

Dr Rao has made fundamental contributions to the theory of estimation. He is responsible for introducing new criteria of large sample estimation to remove some of the anomalies in the existing criteria and to distinguish between estimators which are considered equivalent under the existing criteria. He has provided an elegant theory of the method of least squares using the concept of a generalized universe of singular or rectangular matrices. He has also developed a theory of calculus of generalized inverses and considered its application to problems of mathematical statistics. In the field of combinatorial mathematics, Dr Rao has introduced new combinatorial arrangements called orthogonal arrays of strength. In the area of finite geometrics, he has developed methods for a cyclic generation of linear subspaces and a construction of spreads in geometry. He has also made significant contributions to statistical methods in biometric research. In connection with the theory of probability, Dr Rao's work



Dr C. Radhakrishna Rao

on the characterization of the normal distributions is of great interest.

Dr Rao is the author of over 100 research papers in statistics, besides two books: (1) *Advanced statistical methods in biometric research* and (2) *Linear statistical inference and its applications*, both published by John Wiley & Sons, New York. He is a joint author of three books on the results of anthropometric surveys of Uttar Pradesh and Bengal in India and Gebel Moya in Africa and a book on *Formulae and tables for statistical work*.

Dr Rao is the recipient of Shanti Swarup Bhatnagar Memorial Award of the Council of Scientific & Industrial Research, and the Guy Medal in Silver of the Royal Statistical Society, London. He is a member of the International Statistical Institute, fellow of the National Institute of Sciences of India, and fellow, Institute of Mathematical Statistics, USA.

Biological Membranes*

C. R. KRISHNA MURTI
Central Drug Research Institute, Lucknow

ONE of the most fascinating fields of biochemical research in recent years has been the structure and function of biological membranes. Indeed, from the significance it has in many fundamental biological phenomena and judged from the explosive interest evinced by investigators in unravelling its properties, the biological membrane vies with biochemical genetics in holding the central position in biology today. Although we have gained some understanding of the molecular mechanism of the replication of DNA and RNA, we are woefully trailing behind in regard to our knowledge of structure and function in the living cell[1]. It is gratifying, however, to see the upsurge of interest in membranes which have now been established to be intimately associated with the function of mitochondria, endoplasmic reticulum and the plasma membrane of living cells.

The structure and function of biomembranes has been the subject of many reviews, monographs and symposia in recent years[2-5]. The volume under review presently contains forty-six papers presented at a conference held by the New York Academy of Sciences in October 1965. The medley of papers included in this volume represents a cross-section of current trends in researches on biological membranes and provides a rich fare of reading material. As happens inevitably in such conferences, many papers are reproductions of already published papers with minor changes here and there with an occasional attempt to evaluate critically the experimental approaches and models employed in biomembrane research. From his own research orientation, the reviewer has found the monograph useful and stimulating. What follows is the result of his attempt to draw a cogent picture of the exciting events of this story as they are being unfolded in front of us today. The author of this review confesses, due to his own academic limitation, his failure to evaluate the implication of the mathematical approaches and membrane structure, profound as it is, and confines himself only to the biochemical aspects of the subject.

Structure of Membranes

Though the existence of membranous structures has been known for over a century, it is only after the arrival on the scene of electron microscopy with ultrathin sectioning and sophisticated shadow casting procedures, that it has been possible to visualize them. Examination of several preparations from a variety of cells has led to the enunciation of the concept of unit membrane by Robertson whereby a membrane is considered to consist of a single continuous bilayer of lipid with the nonpolar carbon chains at the centre of the membrane and the polar ends pointed outwards. The membrane is " a chemically asymmetric system with a general pattern of organization of the constituent molecules ". The techniques employed for visualizing membranes are critically reviewed by Robertson in his paper (pp. 421-440). The globular substructure associated with membranes is undoubtedly linked to the idea of elementary unit particles directing function in membranes. The unitary membrane concept, based on an intelligent collation of electron microscopic and X-ray diffraction evidence, is an extension of the earlier model[6] proposed by Danielli and Daveson on permeability, surface tension and electrical conductivity measurements of cells.

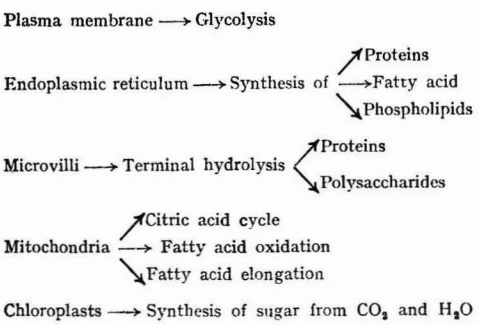
Relevant to the study of living biological membranes is the development of artificial membrane systems or ' biomolecular leaflets ' made by mixing under controlled conditions a phospholipid like lecithin, albumin and cholesterol. Such models have permitted detailed kinetic studies of permeability of ions using radio-tracer diffusion and osmotic flow techniques and also the relative influence of the nature of the phospholipids in determining the thickness of the membranes. The discussion of the possible existence of water-filled pores in such membranes by Hanai, Haydon and Red Wood and Thompson and Huang (pp. 731-744) in relation to diffusion or permeability reveals the usefulness of these artificial ' leaflets ' as experimental tools. The data obtained with such ' leaflets ' must now be correlated with the large volume of information already available on the permeability of synaptic membranes or erythrocyte membranes or the plasma membranes of unicellular organisms.

The chemical structure of biomembranes has been investigated using mainly myelin sheaths, erythrocyte membranes, mitochondrial or microsomal membranes and the membranes of a few gram negative and gram positive bacteria. Techniques for isolating membranes from subcellular structures have also become highly sophisticated now with the availability of density gradient centrifugation and gel filtration procedures. The ratio of protein to lipids in such membranes has been found to vary from 0·5 to 5·0. Cerebrosides constitute the major part of the phospholipids of myelin and sphingomyelin that of erythrocyte membrane[6]. The nature and proportion of the individual phosphatides in mitochondrial and microsomal membrane determine the integrity of their function. Bacterial plasma membranes appear to be devoid of sterols and their fatty acid composition shows wide variation suggestive of a chemical basis for the relative susceptibility of bacterial membranes to antibiotics. The difference in the ionic composition of membranes could be responsible for different rates of ion transport as evident from the studies of Tosteson on sheep red cell membranes (pp. 577-590).

*Based on the proceedings of a conference, *Biolcgical membranes: Recent progress*, held by the New York Academy of Sciences in October 1965, and published in *Ann. N.Y. Acad. Sci.*, **137** (Art. 2) (1966), 403-1048.

Function of Membranes

The main functions of biomembranes are ion transport, provision of a protective guard to the internal mileu of which they form the surrounding barrier, formation of a base matrix on which enzyme organization is achieved and to be the site or locus of specific binding of pharmacologically active substances, antibodies, viral nucleic acids or toxins. Of these, by and large, ion transport has received the maximum attention in view of the availability of elegant radio-tracer techniques. The volume under review contains a dozen papers on this subject along with a very skilful discussion of the theory of membrane permeability by Lowenstein (pp. 441-469). The role of membrane in enzyme organization is evident nowhere better than in mitochondrial systems with which Packer, Stockenius, Chance, Green, Rollenberg and Lehninger have made extremely valuable contributions (pp. 624-708). The location of specific metabolic sequences in the membranes of mitochondria is revealed in five membrane systems as pointed out by Green:



In the words of Green, " The ultrastructure of membranes is the meeting ground of morphology, biochemistry and physiology. It is in the molecular details of the ultrastructural pattern that the biochemist can find the answers to phenomena such as energy transduction, energized translocation of ions and water, active transport, contractility, etc. These molecular details provide the subject material of membrane biochemistry."

Future Trends in Membrane Research

The extensive work on membrane involvement in ion transport and energy transduction has opened out vistas of investigations directed against the understanding of the molecular basis behind nerve impulse transmission or the interconversion of chemical into mechanical and electrical energy at membrane junctions or the transformation of optical energy into chemical energy in two systems so diversified from each other such as the visual system of the animals and the chloroplasts of the green plants. The function of the neuron cell in impulse transmission and integration still awaits elucidation. The phenomenon of cell to cell adhesion, the chemical recognition behind it and the building up of cells into network of tissues remain to be understood in simple chemical terms. There is already behind these properties an implied role of electrical charges and chemical bonds which need to be elucidated more precisely.

The viral DNA membrane interaction as revealed in simple *Escherichia coli*-DNA phage system or vaccinia DNA-Hc La cell system has made it possible to understand the molecular basis of viral pathology. Is there any role of interferon in altering the membrane susceptibility or specificity of the host? Or is the specificity of infection merely a reflection of the chemical composition of the membranes? In pharmacology, the concept of receptor sites of drugs has become one more fashionable peg for hanging hypothesis on modes of drug action. Excepting with the anaesthetics no advance has been made as to the exact molecular nature of such receptors. Does the receptor represent a specific chemical organization on the lipoprotein surface either in primary structure or in tertiary conformation? Several such questions occur to one as one surveys the panorma of investigations rendered possible with membranes.

Conclusion

It is not fair to expect a conference with such wide scope as reviewed above to suggest solutions to problems of membrane structure and function. Presumably there was hardly any time for discussion of the data or if such discussion did take place the comments from ' the pit ' have not been considered worthy of being recorded. Be that as it may, one definite fruitful purpose of the conference has been to bring the different papers into one handy volume revealing several methods of experimentally approaching the innumerable problems that still remain to be solved in the field of the biomembrane biochemistry.

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3. Stoccknius, W., cited in *The interpretation of ultra structure*, edited by R. J. C. Harr (Academic Press Inc., New York), 1962.
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5. Lehninger, A. L., *The mitochondrion* (W. A. Benjamin Inc., New York), 1964.
6. Korn, E. D., *Science, N.Y.*, **153** (1966), 1491.

IQSY Symposium

THE National Physical Laboratory (NPL) was the venue of a Symposium on the International Quiet Sun Year (IQSY), held during 15-17 December 1966 under the joint auspices of the Indian National Committee for IQSY and NPL. The IQSY (January 1964 to December 1965), a follow-up of the International Geophysical Year (IGY) of 1957-58, is one of the largest international cooperative scientific ventures. India is one of some 63 countries participating in the IQSY programme.

The symposium covered the fields of meteorology, ionosphere, cosmic rays, solar activity, geomagnetism, aeronomy and space research. It was attended by over 100 participants from several research institutions and universities.

Over 90 papers (11 from NPL) were submitted for the symposium, which was divided into six sessions, covering different disciplines.

Solar Activity

One session was concerned with the sun itself. The sun was quietest during 23-28 July 1964 which has been subsequently declared as a special interval for intensive study. From August 1964 through January 1965, the activity increased slowly and irregularly, but during the next three months another decrease occurred.

Although the sun was extremely quiet, solar flares occurred on 26 January 1964, accompanied by a solar radio noise burst. Solar X-ray enhancement was recorded with an US satellite during this event, the flux for wavelengths below 8 A. rising to $3{\cdot}3 \times 10^{-3}$ ergs/cm.^{2}/sec., about 100 times larger than the generally recorded value at this time. Another flare occurred on 16 March 1964, accompanied by several ionospheric effects, the largest during the IQSY period. On 5 February 1965, a proton flare accompanying a bright flare of importance 2^+ occurred, and the excess absorption resulting from impact of solar protons was recorded at the polar latitudes with equipment measuring cosmic radio noise.

Several papers were presented by the Astrophysical Observatory, Kodaikanal, NPL, Tata Institute of Fundamental Research (TIFR) and Physical Research Laboratory (PRL), Ahmedabad, describing the sun and its few but distinctive disturbances during this period. The observations of the Kodaikanal Observatory were principally concerned with the behaviour of the sun in the optical region, those of the TIFR in the radio spectrum, and those of PRL concerned the observations in the X-rays monitored from three US solar radiation satellites, 1964-01-D, 1965-16-D and 1965-93-A. The work of NPL concerned the patrolling of the sun through the associated ionospheric effects.

The TIFR work showed that the shape of the quiet corona is consistent with the theoretical prediction based on a smooth corona, while the NPL work indicated that there is a threshold flux of solar radio noise which must be exceeded before a sudden ionospheric disturbance (SID) is observed. The NPL work has also shown that for the few flare events, for which satellite measurements are available, a combination of satellite X-ray data and the accompanying ionospheric effects can provide a powerful tool for the study of D-region aeronomy.

Observations were reported from NPL with a new technique involving minute frequency shifts (of the order of a few cycles) that can be noted with some solar flares, in very stable frequency signals, such as from the ATA time and frequency standard transmissions at 10 Mc/s. from Delhi. Analysis work by Dr Saha and Dr Mitra (NPL) located the seat of this disturbance in the E-region of the ionosphere, through enhanced solar X-ray emission, during flares, in the wavelength range 10-100 A.

Geomagnetic Studies

Important papers presented in the field of geomagnetism concerned the characteristics of the equatorial electrojet. Ground measurements of the quiet-day ranges in the horizontal field at the magnetic observatories of Trivandrum, Kodaikanal, Annamalainagar and Alibag by the India Meteorological Department showed that the width of the electrojet is about the same during solar minimum as during the solar maximum; the half width decreased by only 20 km., from 297 to 276 km., from 1958 to 1964. The location of these electrojets, recorded with magnetometers flown in five rockets over Thumba, and reported by workers of PRL, is found to be in the neighbourhood of 100 km., with an occasional second peak around 150 km. Evidence was presented to show that the southern hemisphere day-time current systems in the ionosphere penetrated into the northern hemisphere up to as much as 11° geographical latitude or about 3° magnetic latitude. A substantial number of sudden commencements were found to occur without any related visible or radio radiation activity of the sun. It was suggested that these were produced as a result of sudden decrease of solar plasma pressure from an M-region beam.

Micropulsations recorded at the National Geophysical Research Institute (NGRI), Hyderabad, were described. The pulsation activity had an inverse relation to magnetic activity.

Ionospheric Studies

Ionospheric soundings — A network of nine stations from Delhi to Trivandrum 'sounded' the ionosphere regularly, hour after hour, day after day, and mapped the ionized regions over India. It was reported that the irregularly appearing layer around 100 km., called sporadic E which at times can be sufficiently intense to reflect even television frequencies, was apparently unaffected by meteoric influx, often cited as a major

cause for its production in the middle latitudes. It was also shown that in the middle latitudes this layer was most likely to occur at 09 and 18 hours.

Satellite radio signals — An interesting study initiated before IQSY and continued through the IQSY period concerned the top side of the ionosphere (above 300 km., normally inaccessible to ground-based sounders) made through ground measurements of radio beacon transmissions from selected satellites. These studies were first initiated at NPL with the Russian satellite Cosmos V in 1962, and were later intensified when the international satellite S-66 was launched by USA for a coordinated reception programme in stations scattered over the globe. In addition to NPL, the stations at Ahmedabad, Hyderabad (DLRL), Kodaikanal and Thumba gradually entered into this programme. The distribution of these stations is such that between these it is possible to map the ionization over a wide geographical area, and identify and examine large-scale ionization clouds in the high atmosphere.

On many nights, and sometimes during day, the satellite signal 'twinkled', and this 'twinkling' could be related to sporadic E and to a diffuse region around 300 km. called spread F. On some days, the ionization in the path of the satellite was found to be unusually large; but there was no evidence of any unusual solar or geomagnetic activity on these days.

Ionospheric absorption — Vertical incidence pulse technique of measuring absorption of radio waves in the ionosphere was employed by All India Radio and PRL. The attenuation in the ionosphere decreased steadily with the decline of solar activity. The absorption (a matter of great concern to radio communication engineers) during IQSY was one-third of that during IGY.

Six papers were presented on the cosmic radio noise technique of absorption measurement. This technique measures attenuation of radio waves of galactic origin, as it passes through the ionosphere. Three such equipment were in operation at NPL during the IQSY, two at Ahmedabad and one each at Thumba and Banaras. New ideas on the reduction techniques were presented from NPL. Papers from PRL, Ahmedabad, and by Dr Saha of NPL indicated how such measurements could indicate electron temperatures in the F-region of the ionosphere.

Ionospheric drifts — The upper atmosphere is a region of strong winds, which at times can be as large as 300 km./hr. It is likely that at the higher levels the electrons and ions move quite differently from the neutral particles. The motion of these ionized particles has been measured, as during the IGY, at a number of stations. All India Radio reported drift velocity at Trivandrum to be about 3 times as large as at Delhi, and the tendency for this velocity to be higher in the evening hours. Difficulties and pitfalls in the interpretation of the records were pointed out by the group of workers from the Andhra University, Waltair, from simultaneous measurements of phase and amplitude of the signals. Comments on the status of the techniques of measurement and interpretation were also made by S. N. Mitra.

Cosmic Rays

At this session, contributions came principally from TIFR and PRL. In a balloon flight made from Hyderabad on 15 April 1966, TIFR found some evidence for the emission of high energy neutrons from the sun in the energy range 50-500 MeV. Vertical proton and helium flux was measured over Hyderabad. The flux of primary protons was found to be between 130 and 100 particles/m.^{2} sterad. sec. and of helium about 15 particles/m.^{2} sterad. sec. These values are essentially the same as during the IGY and it would appear that solar modulation effects on the helium and proton components near equatorial latitudes are very small.

Characteristics of the anisotropy of galactic cosmic rays during IQSY were described by Dr Sarabhai and his colleagues (PRL). From the same group an analysis of solar cosmic rays during 16 flares was presented, and it was shown that the results are consistent with the hypothesis of cosmic radiation flowing away from the sun in intertwined filaments, defined by the magnetic field structure in the solar wind.

Aeronomy

Composition of the atmosphere — Dr Bhatnagar and Dr Mitra (NPL) presented a model of the atmospheric density and temperature to heights of 700 km. from drag observations of 46 satellites. The exospheric temperature was found to be only 900°K. during day and 700°K. during night for the IQSY, as against 2000°K. during day and 1600°K. during night for the IGY. The density at 700 km. was only one-thirtieth of that during the IGY. The air began to be richer in helium and hydrogen above 500 km., whereas during IGY atomic oxygen predominated up to around 1500 km.

Dr Mitra also presented evidence to show that neutral nitric oxide, an important minor constituent of the atmosphere, has a concentration of only about one-billionth of the molecular oxygen at 70 km., and that in the lower ionosphere a complex series of chemical reactions occurs. Negative ions are abundant below 70 km. during day and 90 km. during night.

Atmospheric winds — Dr Bhavsar (PRL) presented results on wind measurements above 100 km. from clouds of sodium, artificially produced with rockets flown from Thumba. The clouds were photographed by a network of stations, about 100 km. apart. It was found that over Trivandrum and at heights above 115 km., the zonal component of the winds is more regular than at middle latitudes. The zonal component is mainly towards east between 115 and 140 km. and towards west between 140 and 180 km. The winds were stronger in the evening than in the morning. Other papers presented concerned airglow.

Meteorology

The major topics covered by the papers on meteorology were ozone, radiation balance, atmospheric electricity and tropospheric turbidity. It

was found that dust pollution in the haze layer at 2500-5000 ft has been much larger from 1962 onwards, both over Delhi and Poona.

Evidence of biannual oscillations in the lower troposphere from observations at two equatorial stations, Gan and Singapore, were reported by Dr Ananthakrishnan of India Meteorological Department. Its likely connection with biannual variation in ozone content of the stratosphere was suggested by Prof. K. R. Ramanathan (PRL). Results of 18 successful meteorological rocket firings, indicating mainly easterly wind flows in the stratosphere and frequent westerlies above 50 km., were presented.

The First International Symposium on Plant Pathology in India

N. S. SUBBA RAO

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THE Indian Phytopathological Society in collaboration with the Indian Council of Agricultural Research (ICAR) organized and conducted the First International Symposium on Plant Pathology at the Indian Agricultural Research Institute (IARI), Delhi, to mark the 20th anniversary of the young society. The deliberations began on 27 December 1966 and extended up to 1 January 1967 and during those days the campus of IARI was indeed a beehive of activity. Thirty-one delegates from overseas and about 300 delegates from India attended the symposium. There were 15 regular sessions and 6 panel discussions which covered probably all aspects of plant pathology from such fundamental aspects like toxins and enzymes to applied aspects such as plant disease control by means of antibiotics. An international exhibition on plant pathology focused attention on practical aspects of the subject both to the specialist and the layman alike.

On the opening day of the symposium, Shri C. Subramaniam, Union Minister for Food, Agriculture, Community Development and Cooperation, Dr B. P. Pal, Director-General, ICAR, and Dr M. S. Swaminathan, Director, IARI, stressed the need for scientific inputs in agriculture and mentioned how challenging it would be for plant pathologists to free the country from hunger and malnutrition by controlling plant diseases and pests.

Cereal Pathology

Dr R. Prasada (IARI, Delhi) pleaded for an international approach to control wheat rusts and showed how wind currents from Nepal, Pakistan, Afganistan and Iran may be responsible for the dissemination of uredospores. Maize rust uredospores secrete a self-inhibitor which prevents its germination. This inhibitor is an unsaturated organic compound which is non-volatile and heat stable, probably a phenolic compound akin to phloroglucinol. Dr M. K. Roy and Dr R. Prasada had something to say about this inhibitor. Dr H. C. Young (Jr) (Oklahama State University, Stillwater, USA) spoke about the variation in virulence and its relation to the use of specific resistance for control of wheat leaf rust and informed that the wheat leaf rust alternate host does not function in the United States of America. Dr L. M. Joshi (IARI, Delhi) showed how external environment would influence the infection of *Puccinia hordei* — maximum infection taking place in 10-12 hr at 20-23°C. Growth and pathogenicity of bunt of paddy was the theme of a paper given by Dr A. Narain (Orissa University of Agriculture and Technology, Bhubaneswar). The paper dealt with teliospore germination of *Neovossia horrida*. Pathogenicity tests confirmed that the fungus causes infection through the flower of paddy during anthesis.

Dr C. S. Holton [United States Department of Agriculture (USDA)] dealt with the subject of survival of oat smut species in the United States of America. He revealed that the disparity in the relative prevalence of *Ustilago avenae* (loose smut) and *U. kolleri* (covered smut) in the USA has increased from 2:1 to 9:1 in less than 4 decades because of the fundamental difference in the ability of the two species to release the spores — the loose smut having proved successful because of its ready release of spores, while the covered smut is not so successful owing to its delayed release of spores. Dr V. V. Chenalu (IARI, Delhi) estimated the losses of wheat in India due to *Alternaria* leaf blight to be as high as 99 per cent in susceptible varieties, such as NP 830, when the infection takes place in the boot leaf stage. A report on the leaf blight disease caused by *Alternaria triticina* and its control measures was given by Dr A. S. Prabhu (IARI). A new downy mildew of maize incited by *Sclerophthora rayssiae* var. *zeae* was reported by Dr M. M. Payak and Dr B. L. Renfro (IARI) who explained the biology, geographical distribution and differential host response to the pathogen. Other papers included a widespread epiphytotic of Gibberella rot in USA by Dr A. J. Ullstrup (Purdue University, Lafayette, USA) and an instance of wilt of maize caused by *Fusarium moniliforme* by the Ranchi Agricultural College workers. The Orissa Agricultural College workers from Bhubaneswar spoke about brestan 60 (triphenyl tin acetate) which they found most effective in controlling blast of rice caused by *Pyricularia setariae* although

aureofungin and ceresan lime dust were more or less equally effective. Dr N. V. Sundaram of Coimbatore was of the opinion that ziram, melprex and copper oxychloride could completely arrest the germination of conidia of *Spacelia sorghi* which causes the sugary disease of sorghum.

Prof. Paul Neergaard (Statens Plantetilsyn, Hellerup, Copenhagen) narrated that about 50 important pathogens occur on rice and stressed the need for seed testing and certification to ward off losses due to seed-borne infections of rice. Several methods to test varietal resistance to blast, bacterial blight, tungro virus, stem rot and sheath blight diseases of rice have been developed at the International Rice Research Institute (IRRI), Manila, and they were well illustrated and described by Dr S. H. Ou of the institute. In the discussion on bacterial blight of rice caused by *Xanthomonas oryzae*, Dr D. N. Srivastava and Shri Y. P. Rao (IARI) mentioned how the epiphytotic is vitally important in any consideration regarding formulations of future agricultural programmes in India. The discussions centred round the practical aspects of control measures of the disease and the introduction of Taichung-Native I variety of rice which has the beneficial property of high yield and non-lodging character coupled with susceptibility to the attack of bacterial blight. Dr T. Muzukami of Japan mentioned that losses due to bacterial blight were about 60 per cent in his country under severe disease conditions, while Dr S. H. Ou (IRRI, Manila) maintained that the losses in yield were well offset by the increased output of grains if Taichung-Native I was cultivated. Another facet of the discussions was that Taichung-Native I offers a fertile substratum for the proliferation of *Xanthomonas oryzae* which would indeed be devastating by cumulative increase in the 'inoculum potential' of the organism in years ahead, although the high yields by the variety may appear attractive in the near future. Dr S. Y. Padmanabhan (CRRI, Cuttack) reported on the trials conducted in different parts of India on the efficacy of chlorine water and streptocycline spray combinations in the control of the disease. Dr K. Ramakrishnan (Agricultural College, Coimbatore) inquired whether enough quantity of the antibiotic could be made available to combat the disease so as to be economical. Dr G. Rangaswami (Agricultural University, Bangalore) and others wanted to know if any *in vitro* tests were performed on the antibacterial property of chlorine water. Dr M. R. S. Iyenger of Baroda added a note of caution by saying that any control measures recommended for bacterial blight must pass through rigorous laboratory and field experiments.

Dr S. Y. Padmanabhan (CRRI) referred to the possibilities of mutation breeding for disease resistance to rice pathogens such as *Helminthosporium*. The Kalyani University workers tested 40 monosporic isolates of *Helminthosporium oryzae* to see if any biochemical characters could be related to variation in parasitism but found no correlation between both the properties. Dr N. L. Dhawan (IARI) presented results of genetic analysis of resistance to leaf blight of maize incited by *Helminthosporium turcicum* in certain inbred lines of the host. It was revealed that the variances of both general combining ability and specific combining ability with regard to expression of disease reaction were highly significant.

Virus Diseases

There were several sessions on virus diseases of plants, including a session on tissue culture studies in plant pathology. The spotlight fell on Dr Karl Maramorosch (Boyce Thomson Institute, New York), both for his eloquent exposition of scientific inquiries and his sense of humour. In fact, a hall packed with audience listened to his popular lecture on the opening day most attentively. The lecture was a scientific elocution interspersed with truly original humour. Dr Maramorosch spoke about the detection of mechanically transmissible virus in seed which requires the use of indicator plants for assaying. The examination of ultrathin sections by electron microscopy could provide evidence for virus detection which, however, is not quite practical either for quarantine work or for seed certification. Insect tissue cultures have been used by Dr Maramorosch to assay viruses accurately and he has been able to devise techniques for raising insects aseptically and grow cells of several species of grasshoppers. Inoculation of such cells *in vitro* with three different plant pathogenic viruses resulted in cell destruction within 5-7 days. In this way, an assay method for plant viruses could be more accurate than local lesion method where wounding of host plants is essential, resulting in the entry of perhaps more than 10,000 virus particles. The Poona workers headed by Dr S. P. Capoor revealed that a preliminary fasting of aphids in grassy shoot of sugarcane would improve the efficiency of aphids to acquire the virus. Dr Kishan Singh of Lucknow narrated that of all the aphids on sugarcane, *Longiunguis sacchari* was the commonest and the aphid successfully transmitted the virus responsible for the grassy shoot disease of sugarcane in northern India. Dr B. B. Nagaich [Central Potato Research Institute (CPRI), Simla] spoke about the variations in the ability of *Myzus persicae* to transmit potato virus Y and leaf roll. Dr S. P. Raychaudhuri and his associates at IARI, Delhi, gave an account of the virus disease of mulberry and mosaic disease of maize in India and indicated that the host range for the latter was confined only to grasses. They also related the fact that the symptom expression of tomato leaf-curl was much delayed when tomato seedlings were root-dipped in 50 p.p.m. gibberellic acid prior to transplanting. It was also mentioned that at least two viruses, tristeza and greening, were present in the die-back affected trees of various citrus species in India. Experimental evidence has proved that soil drenching of large cardamom plants by thiouracil before or at the time of inoculation and dip treatments of infected rhizomes in hydroquinone showed signs of virus inhibition in the case of mosaic disease of cardamom. It was explained how the virus concentration of potato virus X in tomato decreased with increasing levels of both zinc and iron in the medium in which the plants

were raised. The Lucknow University workers provided evidence to show that certain amino acid sprays on tobacco plants either reduced or enhanced the local lesion produced by tobacco mosaic virus (TMV). Dr S. Sarkar (Max Planck Institute für Biologie, Tubingen) detailed the methods by which he has followed the biosynthesis of free infectious nucleic acid and intact nucleoproteid particles of TMV in primary infected tobacco leaves. The only lady participant from overseas, Dr J. Dijkstra (Laboratory of Virology, Wageningen) said that she was able to inhibit the TMV on tobacco leaf discs by floating them on 6-azauracil, an analogue of pyrimidine, although the inhibitory effect was neutralized by prolonged flotation of discs on water. The electron micrographs shown by Dr J. Brack (Czechoslovak Academy of Sciences, Prague) showed some particles in mitochondria of viruliferous leaf hoppers which he interpreted as virus particles.

Dr R. L. Steere (USDA) participated in a panel discussion on serology of viruses and demonstrated a simple agar-gel method for the purification of plant viruses. He also gave an illustrated account of a new freeze-etching unit and showed electron micrographs of recently prepared specimens by using the technique. The technique has new possibilities of studying cell structures and processes of virus multiplication. Dr George Morel (Institut National de la Recherche Agronomique, Versailles, France), a world authority on tissue culture, showed how viruses could be eliminated from plants by repeated culturing of tissues *in vitro*. Dr George Melchers (Max Planck Institute für Biologie, Tubingen) spoke about the genetical aspects in callus-culture work and showed how callus-cultures are distinguished by great genetical inhomogeneity. Dr S. P. Raychaudhuri (IARI, Delhi) gave an account of several viruses maintained in his laboratory on tissue cultures and hoped that such studies would lead to a type culture collection of viruses at a national level.

Dr T. H. King, FAO plant pathologist from Thailand, pointed out the recent occurrences of virus diseases of rice in various parts of Thailand and South-East Asia. Dr S. H. Ou (IRRI, Philippines) explained the symptomatology and transmission of tungro virus, orange leaf virus, yellow dwarf virus and grassy stunt virus with the aid of excellent colour slides. He also mentioned that the diseases of rice known by different local names were found to be one and the same upon careful examination and cited the example of Penyakit mera in Malayasia and tungro disease in the Philippines. Dr S. P. Raychaudhuri mentioned that recently a virus disease of rice showing leaf yellowing symptoms, very much resembling tungro disease and transmitted by *Nephotettix bipunctatus*, has been encountered at Delhi, Cuttack and some parts of West Bengal.

Resistance to Disease and Chemotherapy

Ever since Millardet in France discovered the 'bordeaux' mixture in 1882, the science and technology of plant chemotherapy are ever on the increase. Judging from the report of more than one worker in the symposium, the bordeaux mixture is still holding fort for many a fungal infections of plants. Dr James G. Horsfall (Connecticut Agricultural Experiment Station, New Haven, USA) was undoubtedly the pivotal figure in this scientific deliberation which included a session on resistance and immunity to plant diseases presided over by Dr A. B. Joshi (ICAR). Dr Horsfall listed not only an array of chemicals which inhibit sporulation of *Alternaria solani*, but also explained the physiological mechanism involved in such effect. Apples are susceptible to powdery mildew caused by *Podosphaera leucotricha* and the losses due to it are considerable. It was shown by Dr M. J. Thirumalachar (Hindusthan Antibiotics Ltd, Pimpri) that aureofungin, an antifungal antibiotic, could control the disease on a field scale to the extent of 100 per cent when 4·5 g. of the antibiotic in 100 gallons of water was sprayed on plants. Green tubers of potato are known to contain 'solanin', an antifungal alkaloid. It was again pointed out by Dr M. J. Thirumalachar that in India where storage rots of tubers are considerable, the simple method of storing the tubers after they are greened could profitably be exploited to safeguard against fungal pests during storage of potato. Dr M. R. S. Iyenger of Baroda presented evidence on the antifungal action of streptomycin, while Dr G. Rangaswami of Bangalore showed that an antibiotic from *Streptomyces garyphalus* was potent against *Helminthosporium*. Dr S. Y. Padmanabhan (CRRI, Cuttack) and Dr S. N. S. Srivastava of Simla narrated the results of their studies on several antibiotics including griseofulvin on rice diseases. Indeed, Dr M. S. Swaminathan and Dr M. S. Chatrath (IARI, Delhi) added new light to the deliberations by focusing attention on the role of radiation in plant pathology and plant disease control. Dr C. S. Venkat Ram (United Planters Association of South India, Coimbatore) told how dramatic eradicative control of blister blight of tea was obtained by spraying nickel chloride hexahydrate at the rate of 0·75-1·0 oz. nickel per acre, while Dr V. Agnihothrudu (Rallis India, Bangalore) narrated the control measures of coffee diseases in India. Continuous application of copper fungicides to control grape anthracnose leads to the development of resistant strains of the pathogen; evidence in support of it was presented by Dr M. S. Reddy and Dr A. Appa Rao of Hyderabad. Fungicidal treatments influence the microflora of seeds and Dr D. Suryanarayana of Ludhiana showed how different fungicides have different influences on the microflora of bajra seeds in storage.

Host-Parasite Relations

Prof. T. S. Sadasivan (Madras University), who is well known for his work on the fusariose wilt of cotton, gave an account of the importance of toxins and enzymes in the manifestation of plant diseases. Dr R. Kalyanasundaram of Madras said that fusaric acid, a metabolic product of certain wilt inducing fusaria, interferes with the iron metabolism of test organisms. Dr D. Subramanian of Madras and Dr A. Mahadevan (Annamalai University) laid

emphasis on pectic enzymes in relation to fusarial wilts, while Dr K. V. Srinivasan (Sugarcane Breeding Institute, Coimbatore) showed how *Glomerella tucumanensis* produced pectic enzymes and cellulases both *in vitro* and *in vivo*. Speaking of enzymes, Dr S. Venkateswaran (University of Houston and Georgetown University, Washington) showed how enzymatic changes occur when TMV infected and healthy tobacco tissues were grown in tissue cultures. Even the entry of symbiotic *Rhizobium* into the roots of legumes was shown by Dr N. S. Subba Rao (IARI, Delhi) to be governed by pectic enzymes produced in the root environment. Dr M. J. Thirumalachar spoke about necrotin, a new antibiotic phytotoxin, produced by *Myrothecium roridum*. Several papers dealt with the amino acid metabolism and amino acid composition of plants in health and disease of plants — Dr P. N. Patel (University of Udaipur) on *Pseudomonas* infections of plants, Dr M. V. Nayudu (Venkateswara University, Tirupathi) on *Xanthomonas malvacearum*, Dr A. Narain (Orissa University of Agriculture and Technology, Bhubaneswar) on tikka disease of groundnut, Dr H. C. Arya (University of Rajasthan, Jaipur) on healthy and *Sclerospora graminicola* infected bajra and Dr S. Sinha (Agra College, Agra) on *Colletotrichum graminicolum* infection of sorghum. Dr Sinha also spoke of cicerin, a phytoalexin associated with the blight of gram caused by *Ascochyta rabiei* which evoked considerable interest. The blast of rice caused by *Pyricularia oryzae* was shown by Dr Suryanarayanan (Madras University) to be governed by genotype-nycto temperature reactions. Dr Ramesh Maheswari (Delhi University) crisply summarized that establishment of the rust colonies following inoculations with rust uredospores appear to depend on the properties of host's surface. Dr V. V. Chenalu (IARI) informed that respiratory rates of infected leaves were much higher than those of the healthy ones in the case of cowpea mosaic virus infections. Dr M. S. Dounine (Timirjazev Agricultural Academy, Moscow) gave an account of immunological relations of globulins of plants and their pathogens and stressed their importance in evaluating disease resistance. *Cephalosporium* was found to be a non-pathogenic internal inhabitant of tomato seedlings and detailed studies for the past ten years by Dr C. C. Allison (Ohio State University, Columbus, Ohio, USA) have revealed that the fungus mitigates the symptom development of tomato plants infected by *Fusarium oxysporum f. lycopersici*.

Taxonomy

The Agra session of the symposium provided a chance for the participants to mix pleasure with pursuit of science. A group of taxonomists headed by Dr M. J. Narasimhan discussed the taxonomic position of phytopathogenic fungi in the Botany Department of Agra College. Dr J. A. Von Arx (Centralbureau Voor Schimmelcultures, Baarn, Netherlands) said that the classic system with one division and four classes of fungi Archimycetes, Phycomycetes, Ascomycetes and Basidiomycetes did not agree with phylogenetic considerations. Instead, he proposed four different divisions — Myxomycota, Chytridiomycota, Oomycota and Eumycota. He also distinguished the following classes — Zygomycetes, Endomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes (fungi imperfectii). Shri R. L. Munjal (IARI) discussed the taxonomy of photopathogenic fungi in general, while Dr C. V. Subramanian (Madras University) particularly dealt with the taxonomy of graminicolous pathogens hitherto classified in the form genus *Helminthosporium* but more recently in *Drechslera*. Dr M. J. Thirumalachar dealt with the taxonomy of *Spaceloma* parasitizing *Ficus* spp. The Jobner school of workers headed by Dr N. Prasad spoke about the speciation in *Colletotrichum*. Dr M. M. Payak and Dr L. M. Joshi (IARI) spoke about the taxonomic considerations of berberis aecidia in relation to life cycle of wheat rust in India.

The physiologists did not leave the taxonomists alone. Dr K. S. Deshpande and Dr K. B. Deshpande (Marathwada University, Aurangabad) showed how *Helminthosporium atypica* and *H. apatterne* differed in carbon utilization, pectic enzyme production and even pathogenicity on wheat. Finally, Dr R. Andal (Madras University) differentiated *Fusarium* species on their ability to produce indole compounds in culture and stressed the importance of physiological aids in taxonomy.

Symposium on the Chemistry of Natural & Synthetic Drugs

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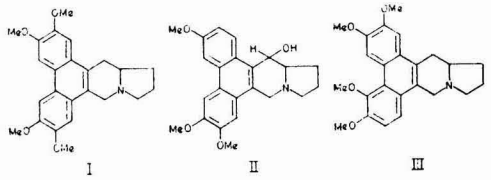
ON the occasion of the fifty-fourth session of the Indian Science Congress, held at Hyderabad, a symposium was organized on the chemistry of natural and synthetic drugs. In all 36 papers were submitted as seen from the abstracts, but actually only one-third of the papers were read during the two-day meeting, apparently due to the absence of the authors who had planned to attend the congress.

Prof. T. R. Govindachari, who presided over the two-day session on 4 and 5 January 1967, inaugurated the symposium with his talk on the tylophora alkaloids. He surveyed the entire field of tylophora alkaloids which are all derivatives of phenanthroindolizidine and discussed in detail the degradative and synthetic work which established the structure of tylophorine (I). The synthesis of tylophorinine and tylocrebrine established the structures (II) and (III) proposed for the natural products. With the discovery of vincaleucoblastine, there is growing interest in the search for natural compounds which are useful as antitumour agents. He reported that some of the tylophora alkaloids have shown cytotoxic activity.



I II III

Prof. Govindachari briefly indicated the possible biogenetic paths for the synthesis of the tylophora alkaloids.

There was greater interest in the chemistry of plant products; eight papers were contributed on natural products and four dealt with synthetic organic chemistry.

Synthetic Chemistry

Dr S. Ray (Lucknow) described the synthesis of 3,4-diphenyl chromenes and chromans which were required for testing as antifertility agents. These coumarins are of interest in view of the antifertility activity of 1,2-diphenyl-3,4-dihydronaphthalenes recently reported by the Upjohn Co.

Dr A. Raychaudhuri (Calcutta) spoke on the structure of the byproduct formed in the preparation of 7-chloro-4-hydroxy-3-carboxyquinoline from diethylethoxymethylene malonate and *m*-chloroaniline. These quinolines might be useful as anticoccidiostatic agents.

Dr T. George (Bombay) described the synthesis of a series of new tricyclic compounds from 4-hydroxycarbostyril. The synthesis of 2,3-dihydro-3-ketoquinolino[3,4-*b*]-1,4-thioxin, 2,3-dihydro-3-keto-4H-quinolino(3,2-*b*)thiazine and their derivatives was reported. NMR spectra of these compounds were discussed in detail. Dr Rajappa (Bombay) (read by Prof. T. R. Govindachari) reported the synthesis of a number of O-aminoacyl derivatives of benzohydroxamic acids. These compounds were found to possess anti-inflammatory activity in mice when administered by subcutaneous route, but were inactive orally.

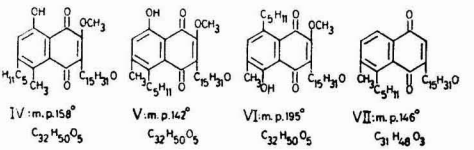
Natural Products

Mrs K. Misra (Allahabad) spoke on the various chemical constituents of guava tree bark which is reported to be of medicinal value. The trunk bark contains leucocyanidin, ellagic acid and 4-β-gentiobioside of ellagic acid. The root bark was found to contain a gallotannin of unusual structure.

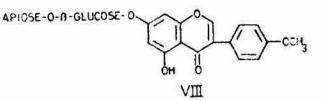
Dr B. S. Joshi (Bombay) reported a series of new germacranolides from the roots of *Neolitsea zeylanica*. Structures were proposed for neolinderane, zeylanine, zeylanicine and zeylanidine based on spectral and degradative evidence.

Prof. S. Rangaswami (Delhi) gave a talk on the quinones isolated from a market drug called 'Saptarangi' which could probably be *Casearia esculenta*. Structures were proposed for the four new naphthoquinones (IV-VII) based on degradative and spectroscopic evidence.

The leaves of *Dalbergia lanceolaria* are reported to possess anti-inflammatory activity. Dr A. Malhotra (Delhi) discussed the structure of a new isoflavone glycoside named lanceolerin, isolated from the leaves. This is shown to have the structure (VIII). 7-Methyltectorigenin and biochanin-A were also isolated from the leaves.



IV: m.p. 158° $C_{32}H_{50}O_5$ V: m.p. 142° $C_{32}H_{50}O_5$ VI: m.p. 195° $C_{32}H_{50}O_5$ VII: m.p. 146° $C_{31}H_{48}O_3$



VIII

Dr A. Banerji (Delhi) read a note on the chemical constituents of some plants which are used in the Ayurvedic system of medicine.

Dr N. Adityachaudhury (Kalyani) presented a paper on the alkaloids of *Papaver nudicaule*. This is shown to contain mainly rhoeadine. Rhoeagenine, dubirheine, protopine, narcotine, narceine and nornarceine are minor constituents.

Dr S. Ghosal (Kalyani) reported the isolation of several simple indole-3-alkylamines from *Desmodium pulchellum* and *Abrus precatorius*. The para-sympathomimetic and musculotropic activities were shown to be due to gramine and tryptamine respectively.

Dr S. Popli (Lucknow) spoke on the isolation of the alkaloids hayatin $C_{36}H_{38}N_2O_6$, hayatinin $C_{37}H_{44}N_2O_6$ and hayatidin $C_{37}H_{40}N_2O_6$ from the roots of *Cissampelos pareira*. These were found to be bisbenzylisoquinoline alkaloids. Hayatin showed neuromuscular blocking activity.

International Conference on Acoustic Noise & Its Control

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AN International Conference on Acoustic Noise and Its Control was held in London during 23-27 January 1967. The conference, sponsored jointly by the Electronics Division of the Institution of Electrical Engineers, Institution of Electronic & Radio Engineers, Institute of Electrical & Electronics Engineers (UK and Eire Section), Institute of Physics, the Physical Society, and the British Acoustical Society was held at the Institution of Electrical Engineers, Savoy Place, London. The conference was attended by over 240 delegates from 17 different countries including three from India.

The conference dealt with noise from the point of view of those who study its effects on man, those who make it, those who unwillingly suffer it and those who try to stop it. Twenty-five papers on various aspects were presented and discussed during the first four days of the conference; the last day was reserved for technical visits.

Opening Session

Welcoming the delegates, J. A. Ratcliffe, President of the Institution of Electrical Engineers, pointed out the increasing noise nuisance and the challenge of noise suppression. In an introductory survey lecture, D. W. Robinson (UK) said that there could be no quick and total suppression of noise. The noise problem today is like guerrilla warfare with new enemies, the sonic boom for example. The time dimension (the transient as well as the steady sound) has also added a lot to the complexity of the problem and the instrumentation needed. Another change pointed out by him was the increasing realization of the importance of psychological and environmental factors. For example, the degree to which the sonic boom might 'startle' would not necessarily correlate with loudness. The transistor radio next door and a dripping tap were other examples of irritants which might not rate highly on intensity scale alone. This may make it necessary to express acoustic noises of these kinds on two scales, as the reaction could not be expressed in a one-dimensional scale, however sophisticated.

Subjective Evaluation

The various sources of noise, such as road traffic, industrial machinery and aircraft are under constant examination and it has become just as essential to study the complexities of human reaction to them. Papers on subjective problems, such as evaluation of loudness and annoyance of noise were presented on the first day. S. S. Stevens (USA) dealt with the basic problem of the masking of one sound by another, such masking may be partial or complete. Practical methods for calculating the total loudness of a noise are based on the masking or inhibition that one part of noise produces on the other part. When a tone is masked by noise, the loudness function for the tone shows a discontinuity at the point where the tone is approximately as loud as the noise. A similar discontinuity has been found to exist in the brightness function for a visual target when it is masked by a bright surround.

Often when a person has adapted himself to a particular background noise, he finds an additional sound disturbing, if it exceeds a certain power level and this is a case which very often causes 'noise stress'. The determination of the influence of duration in the stresses to which human beings are subjected by noise is a difficult problem which has been with us for a long time. Papers on subjective study of some aspects of temporal influence of exposure time were contributed by F. J. Meister (Germany) and H. Gavini (France). The results obtained show that the intermittent stimulus is perceived with a loudness greater than that of the continuous one, although its intensity is lower.

A paper by H. Blaesser (Germany) described a transportable loudness analyser and computer for assessing subjective loudness. The method used is that proposed by Zwicker and accepted as one of the two methods to be standardized by the International Standards Organization (ISO Recommendation 675).

Annoyance of Noise

Not all noise annoys everyone equally and this, together with the problem of making effective

complaints, makes anti-noise laws difficult to frame. W. Hawel (Germany) presented some interesting results from research on psychoacoustics based on his definition of annoyance of noise according to which "any sound is annoying if, and only if, it is experienced by a person of reference as being inconsistent with his or her momentary intentions". The background of this definition is the hypothetical construction of a framework of five parameters — personality, situation, activity, quality of sound and the sound level itself. One is more sensitive to noise when in a bad humour or engaged in certain activity.

The results presented were derived from the statements of a subject as to how happy or annoyed he would be under certain conditions of noise, obtained by 72 possible combinations of these five variables. From the data so collected a multidimensional matrix has been derived which is suggested as a reasonable framework for field research. In another paper, W. Hawel described an 'annoyance level meter' explaining how this matrix of subjective effects could be realized in the form of an electrical network.

Aircraft Noise

Aircraft noise is measured as 'perceived noise level' in units of PN db. (perceived noise decibels). Maximum levels of 110-112 PN db. have been adopted for daytime operations and about 102 PN db. for the night. K. D. Kryter (USA) contributed a paper dealing with human response to aircraft noise, relating subjective 'noisiness' with measurement in PN db. The tests were carried out on a large scale with 125 listeners, 50 being out of doors and the remainder seated in a number of rooms in two houses. It was shown that subjective noisiness from an aircraft could be predicted within a range of 1-4 PN db. depending on the experiment. In another paper a detailed study of the basic concept, measurement and control of exposures of sonic boom was presented by H. H. Hubbard and D. J. Maglieri (USA).

A paper from a group of six German scientists based on the work at Frankfurt-am-Main airport with a system for automatic monitoring aircraft noise, in operation for 2 years, was presented. It consists of a central control room, six external monitoring stations located at the edge of residential areas and a monitoring vehicle. At any time when the sound level exceeds a certain predetermined value, a chart indicating the extent of deviation and the length of time it lasts is printed out. The record includes all important details, including flight numbers, weather conditions, airline and take-off directions. The equipment has shown its usefulness in analysing the noisy operation conditions. M. Bernard and P. A. Lienard (France) presented two papers on calibration and measurement techniques at high levels in difficult conditions of vibration and temperature in aerospace studies.

Machine and Industrial Noise

The spectra of noise radiated by machines may be specified in different ways depending on the purposes for which the data are required. If a single criterion is needed for comparing machines or to indicate roughly overall subjective effect, sound levels using one or more weighing networks may be adequate. If a sound attenuating enclosure or a resilient mounting is to be designed, or the total subjective effect of the machine when in a room with other noise producing equipment is to be calculated, rather more detail of the noise spectrum is needed in terms of the second pressure level in contiguous octave, half or one-third octave bands covering the audible range. A paper contributed by A. J. Ellison (UK) and C. J. Moore (Turkey) presented data on the acoustic noise radiation measured by a small electric machine. A polar diagram for such a machine shows a number of lobes and other features which depend on the shape of the machine, the way in which it vibrates and its size relative to measuring distance.

The morning session of the third day of the conference started with a paper dealing with noise in industry. Some aspects of control of noise in a chemical industry were discussed. Two papers dealt with specific technical problems and another with specification of noise limits for new plants and machines.

A practical and comparatively cheap method of reducing the noise from a large power transformer was discussed by R. S. Jackson, L. Jump and J. D. Lawrence (UK). The approach to the problem is to reduce the radiated sound energy by attaching panels to the ribs on the transformer sides and possibly also on the top. An attenuation of the order of 7 db. has been reported with 68 per cent of the transformer surface covered.

Road Vehicle Noise

With the increasing number and power of vehicles on the roads, the traffic is becoming a major source of noise and has, therefore, become a field of considerable interest for quite some time. Objectionable noise from motor vehicles is usually caused by violent acceleration in low gear. W. Denby (UK) discussed the results obtained with a simplified measuring procedure compared with the method using a 10 m.p.h. maximum approach speed standardized by International Standards Organization (ISO Recommendation 362) for potential use at vehicle inspection stations and roadside checks. The results obtained by the two methods are reported to be in fair agreement.

R. Martin (Germany) described some results of comparative sound level measurements of motor vehicles carried out with a number of lorries on a roller test stand. The measurements were taken with a moving microphone at a constant speed and constant distance around the contours of the vehicles. The observations were also taken with different engine speeds and engine loads in each case. The results obtained yielded some useful information regarding the direction of maximum noise emission, resonance of mufflers and the disturbances of the sound field due to interference effects with relation to the influence of different engine speed and engine load conditions.

Ambient Noise

The low frequency noise of underground trains in London has been the cause of interference in telephone conversation in offices and to make it acceptable an entire building would have to be mounted on springs. The 5000-ton auditorium of the new Odeon cinema near Marble Arch had been put on rubber mountings at a cost of £ 15000 to keep the rumble out. The new BBC broadcasting house extension is also facing a problem of ambient noise from underground trains.

A paper by C. L. S. Gilford (UK) described the techniques used to measure background noise in sound and television studios and the design requirements for ensuring that it remains below an acceptable level. Another contribution on a similar aspect came from J. Dunsbee and F. Billingsley (UK) who drew attention to the predominance of traffic as a source of ambient noise and the difficulty of correlating ambient noise with a simple description of the locality.

Among the papers presented on the fourth day were those on noise control in the design of air-conditioning plant in a hospital ward, noise produced by hydraulic systems, details of sound transmission from one part of a building to another, and noise from water installation units in buildings.

Technical Visits

The last day of the conference was devoted to visits to several institutions specializing in studies in acoustics. The participants had a choice of going on anyone of the following visits: (i) National Physical Laboratory, Teddington, and London airport (Heathrow); (ii) the Building Research Station, Garston, and Standard Telecommunication Laboratories, Harlow; and (iii) the Institute of Sound & Vibration Research, the University of Southampton.

Concluding Remarks

The work on noise currently in hand at various laboratories in Britain covers a very wide range of problems, from industrial deafness to sonic booms. The British attitude towards noise problems in recent years can be judged by the following facts. In 1960 an official committee headed by Sir Alan Wilson was appointed to examine the nature, sources and effects of the problem of noise and to advise what further measures can be taken to mitigate it. The committee presented a comprehensive report [*Noise* (HMSO, London), 1963, 2056] to the British Parliament in July 1963 and also suggested some more practical amendments to the ' Noise Abatement Act ' which came into force during 1960 in UK.

This conference was the second of its kind to be held in England, the first being ' The Control of Noise ' held in June 1961, at the National Physical Laboratory, Teddington. During 1966, Britain was the host of two international conferences on aircraft noise held in London. The newly formed British Acoustical Society has been busy arranging over half a dozen meetings and symposia on various aspects of noise problem, during the session 1966-67 and still the British feel themselves to be ' lagging behind ' in this field. This may probably be due to the fact that many other advanced countries are taking still more practical and stringent steps against noise.

Codes have been drawn up in a number of countries specifying minimum noise reduction standards for houses and for working places. In USA industrial deafness is a subject for industrial compensation and large sums are paid out. In UK although occupational hearing loss is not compensable as yet under the ' Workmen's Compensation Act ', hearing aids are made available to the deaf free of charge. At a school near London airport experiments are in progress, where a classroom has been provided with acoustic windows, which close automatically when the roar of a passing jet aircraft exceeds a certain value.

So far, little awareness has been shown (in these or other ways) towards the noise problem in India. The present-day studies confirm that the price of peace and quiet is increasing in the modern world, and any further delay in correctly assessing the magnitude of future noise problems in a rapidly developing country like India is bound to have serious after-effects.

A New Approach to Chemotherapy & Radiotherapy of Cancer*

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AN ideal chemotherapeutic agent should have maximum action on the diseased tissue and no or little action on the host tissue. Unfortunately, however, it has so far not been possible to obtain a completely safe chemotherapeutic drug. A large number of potent anticancer drugs have been discovered in recent years, but all these damage the normal cells also.

Chemotherapy of cancer began in 1941 as an offshoot of surgery. In those days castration was an accepted mode of treatment to control cancer of prostate. Dr Charles Huggins, a surgeon, introduced the use of synthetic oestrogens as a means of chemical castration in the treatment of cancer of prostate. Since malignancy is not restricted to particular organs alone, it was necessary to have a cytotoxic agent which would interfere with cancerous growth wherever it occurred. With this object in view, cytotoxic substances like nitrogen mustards and other bifunctional substances such as Busulphan (Myleran) were discovered, and which proved of some use as palliative remedies.

The use of antimetabolites as a means of controlling cancer was first investigated by Sidney Farber in 1948, using folic acid antagonists[1]. Since then a number of compounds having antagonistic properties against such essential metabolites of nucleic acids as purines[2,3], pyrimidines[4,5], vitamins[6] and glucose[7] have been tested. The main drawback of the antimetabolites tested so far has been that they interfered with the normal processes also, and as such exhibited toxic effects. The margin of safety between the therapeutic effectiveness and toxicity was extremely narrow. To make matters worse, the malignant cells, which originate spontaneously, are not really foreign to the host. They are a part of the host. The malignant cells, therefore, are unable to elicit adequate immunochemical response. In the control of malignant growths, unlike chemotherapy of bacterial diseases, it is not merely sufficient to use cancerostatic drugs and leave the final mopping up of the system free of the diseased cells, to the defence mechanism of the body. We have to use carcinolytic drugs and the treatment has to go on till the last cancer cell is wiped out. This is obviously a tall order and involves continuation of treatment over protracted periods. Under the circumstances, it is all the more imperative that the drug has to be absolutely non-toxic and should cause no harmful side effects even after prolonged administration.

A drug will be effective and at the same time non-toxic, if it interferes with a property which is specific for tumours and which constitutes an essential feature for its maintenance. Unfortunately, however, in spite of the sustained efforts, no clear-cut differences (i.e. presence in one and absence in the other) between the normal and malignant tissues have yet come to light. Most of the differences that have so far been discovered are of a quantitative nature. One of the striking differences between normal and malignant tissues is the active cellular proliferation accompanied by high rate of synthesis of nucleic acids in neoplastic tissues. This high rate, however, is not a characteristic solely of neoplastic growth. Normal tissues are also known to exhibit active nucleic acid synthesis without any evidence of neoplastic transformations. Conversely, there are tumours like the 'minimum deviation tumours' where the rate of nucleic acid synthesis is comparable to normal tissues. The difference between the normal and malignant cells lies in the fact that whereas normal regeneration comes to a stop after a while, the tumour continues to grow apparently without any control whatsoever.

Rationale for HMP Interference

To maintain the rapid rate of synthesis of nucleic acid, two things are essential: (i) a continuous flow of precursors, and (ii) an unrestricted supply of energy. In the biological system, the energy is usually generated in the Krebs' tricarboxylic acid cycle through the stepwise degradation of metabolites into carbon dioxide and water. Pyridine nucleotides have an important role in this connection in the hydrogen transport system, and thus indirectly participate in the energy production via the tricarboxylic acid cycle.

Two of the quantitative differences between normal and malignant cells which could be exploited with advantage in the chemotherapy of cancer are: (i) the low pyridine nucleotide (PN) levels and (ii) acceleration of hexose monophosphate (HMP) pathway in the tumour tissue[8]. Rapid HMP results in accelerated production of ribose-5-phosphate which is the starting material for the biosynthesis of purines, pyrimidines and nucleic acids. Acceleration of HMP thus appears to be conducive to uncontrolled growth. Our studies have shown that acceleration of HMP, although not an essential condition for the initiation of malignancy, is necessary for the maintenance of rapid cellular proliferation. Further, since the operation of HMP in normal tissues is much less than in malignant tissues, interference of HMP was anticipated to damage malignant cells preferentially and leave the normal cells comparatively untouched[8].

The Embden-Mayerhof (EM) and HMP pathways for the metabolism of carbohydrates are presented in Fig. 1. From among the intermediates of HMP pathway only antimetabolites of

*Based on a series of invited talks given by the author at the Indian Institute of Science, Bangalore 12.

†The work reported here is the result of a close collaborative effort of the author's group with that of Dr B. D. Tilak, while he was at the Department of Chemical Technology, University of Bombay.

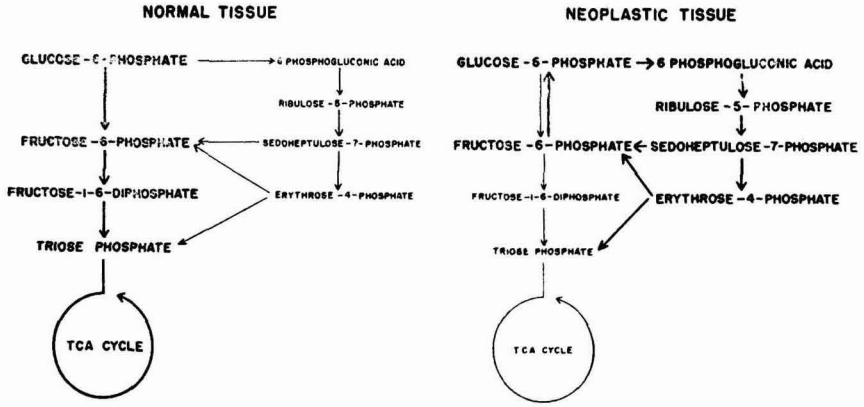


Fig. 1 — Embden-Mayerhof (EM) and HMP pathways for the metabolism of carbohydrates in normal and neoplastic tissues [A 30 per cent slowing down of TCA cycle and an acceleration of HMP pathway takes place in most of the cancers seen in the clinic]

6-phosphogluconic acid, sedoheptulose-7-phosphate and erythrose-4-phosphate were considered. Antimetabolites of ribose-5-phosphate, glucose-6-phosphate and fructose-6-phosphate were not considered because these would interfere with EM and other normal pathways also and may prove to be toxic[9].

6-Phosphogluconic acid is known to exist predominantly as a gamma-lactone. There is some evidence to show that enzymatically produced 6-phosphogluconic acid may be present as a delta-lactone. It was, therefore, decided to prepare antimetabolites of both the gamma-lactone and also the delta-lactone. In Fig. 2 are given the possible structures suggested for the proposed antimetabolites. Furan, pyrrole and thiophene structures were considered as antimetabolites for gamma-lactone, whereas thiapyran and oxathiane derivatives were considered for preparing antimetabolites of delta-lactone. Eighty compounds have so far been synthesized and their anticancer properties against transplantable Yoshida sarcoma (ascites) in rats and solid fibrosarcoma in Swiss mice investigated[9]. Yoshida sarcoma is a very rapidly growing tumour and kills the animals on the 4th or at the most on the 5th day after transplantation. The compounds to be tested were usually injected intraperitoneally 24 hr after the transplantation of the Yoshida sarcoma (ascites) cells. Solid fibrosarcoma is a comparatively slow growing tumour, it kills the transplanted animals by about the 25th day. In the chemotherapeutic screening, the compounds were injected subcutaneously near the tumour mass. The treatment was started on the 6th or 7th day after transplantation. The criteria of designating the compound active or inactive was as follows. If the survival of Yoshida sarcoma bearing rats in treated animals was more than double that of controls, then the compound was considered active and worthy of further investigation. Whereas in the case of solid fibrosarcoma, if the weight of tumour in treated animals is less than half of the controls on the 25th day, then also the compound was classified as active and worthy of further investigation. Some of the results are presented in Tables 1-5.

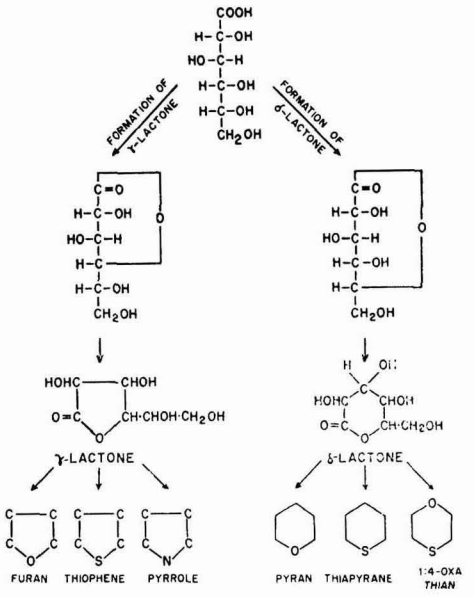


Fig. 2 — Possible structural antimetabolites of gluconic acid

It will be seen that compounds with six-membered heterocyclic rings and furan and pyrrolidine derivatives were inactive (Tables 1 and 2) against both the Yoshida (ascites) sarcoma and solid fibrosarcoma. Among the thiophene compounds tested, thiophene-2,5-dicarboxylic acid (TDA), 2,5-dimercaptomethylthiophene (MMT), thiouronium derivative of 2,5-dimercaptomethylthiophene (TUMMT) and 2,5-dicarbethoxy-3,4-dihydroxythiophene (DICETOL) were found to be effective against Yoshida (ascites) sarcoma and also against transplantable fibrosarcoma. With TUMMT treatment for ten days only, the Yoshida sarcoma transplanted animals survived their normal life-span without any trace of malignancy. The corresponding controls died by the 5th day after

TABLE 1 — ANTICANCER PROPERTIES OF THIAPYRAN AND THIOXAN DERIVATIVES

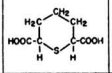
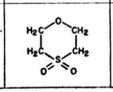
NAME	STRUCTURE	YOSHIDA SARCOMA RATIO OF SURVIVAL E/C	FIBROSARCOMA RATIO OF TUMOUR WTS. C/E	ACTIVITY
1. CIS-TETRAHYDRO-THIOPYRAN-2:6-DICARBOXYLIC ACID		1·0	1·0	INACTIVE
2. 1:4-TETRAHYDRO-THIOXAN-1:1-DIOXIDE		1·0	1·2	INACTIVE

TABLE 2 — ANTICANCER PROPERTIES OF FURAN AND PYRROLIDINE DERIVATIVES

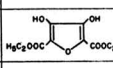
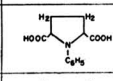
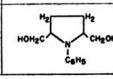
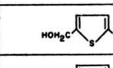
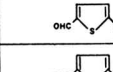
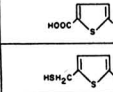
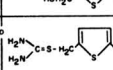
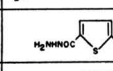
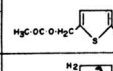
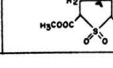
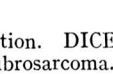
NAME	STRUCTURE	YOSHIDA SARCOMA RATIO OF SURVIVAL E/C	FIBROSARCOMA RATIO OF TUMOUR WTS C/E	ACTIVITY
3. 3:4 BIS (HYDROXY)-2:5 BIS CARBETHOXY-FURAN		1·0	1·0	INACTIVE
4. 2:5 BIS (CARBOXY)-N-PHENYL PYRROLIDINE		1·2	1·4	INACTIVE
5. 2:5 BIS (HYDROXY-METHYL)-N-PHENYL-PYRROLIDINE		1·0	1·2	INACTIVE

TABLE 3 — ANTICANCER PROPERTIES OF 2,5-SUBSTITUTED THIOPHENES

NAME	STRUCTURE	YOSHIDA SARCOMA RATIO OF SURVIVAL E/C	FIBROSARCOMA RATIO OF TUMOUR WTS C/E	ACTIVITY
6. 2:5(BIS) DIHYDROXY-METHYLTHIOPHENE		1·2	1·3	INACTIVE
7. 2:5(BIS) CARBOXALDE-HYDE THIOPHENE		1·0	1·0	INACTIVE
8. 2:5(BIS) DICARBOXY-THIOPHENE		3·0	2·6	ACTIVE
9. 2:5(BIS) MERCAPTO-METHYLTHIOPHENE		2·0	1·5	ACTIVE / INACTIVE
10. THIOURONIUM COMPOUND OF 2:5(BIS) CHLORO-METHYLTHIOPHENE		>4	2·0 TOXIC BY S.C.	ACTIVE
11. DIHYDRAZIDE OF THIOPHENE 2:5-DICARBOXYLIC ACID		1·2	1·4	INACTIVE
12. 2:5 DIACETOXYMETHYL THIOPHENE		1·0	1·3	INACTIVE
13. 2:5 DICARBMETHOXY-5-DIOXYTETRAHYDRO-THIOPHENE		1·7	1·4	INACTIVE

transplantation. DICETOL gave the best results with solid fibrosarcoma. The tumour weights in the treated animals were one-eighth of those seen in the control group.

While studying the metabolism of DICETOL it was suspected that the thiophene ring ruptures, resulting in an open chain compound. Open chain compounds of the type which were postulated to be formed in the body, such as thiodiglycollic acid (TDGA), and its higher homologues, were synthesized and tested for their anticancer properties

TABLE 4 — ANTICANCER PROPERTIES OF 3,4-SUBSTITUTED 2,5-DICARBOXYTHIOPHENE DERIVATIVES

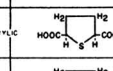
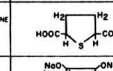
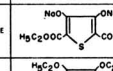
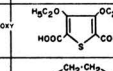
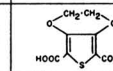
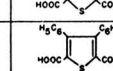
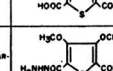
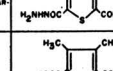
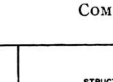
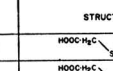
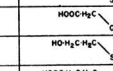
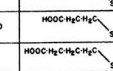
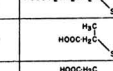
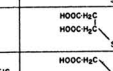
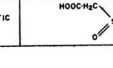
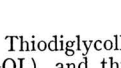
NAME	STRUCTURE	YOSHIDA SARCOMA RATIO OF SURVIVAL E/C	FIBROSARCOMA RATIO OF TUMOUR WTS C/E	ACTIVITY
14. TRANS TETRAHYDRO THIOPHENE 2·5 DICARBOXYLIC ACID		0·9	0·8	INACTIVE
15. CIS TETRAHYDROTHIOPHENE 2:5 DICARBOXYLIC ACID		1·0	1·1	INACTIVE
16. 2·5 DICARBETHOXY-3·4 DIHYDROXY THIOPHENE (DICETOL)		Toxic by I.P	7·5	ACTIVE
17. 3·4 DIETHOXY 2·5 DICARBOXY THIOPHENE		1·0	1·0	INACTIVE
18. 3·4 (DIMETHYLENEDIOXY) 2·5 DICARBOXYTHIOPHENE		0·9	0·9	INACTIVE
19. 3,4 DIPHENYL 2:5-DICARBOXYTHIOPHENE		1·5	1·0	INACTIVE
20. DIHYDRAZIDE OF 3·4 DIMETHOXY-2·5-DICARBETHOXYTHIOPHENE		1·5		INACTIVE
21. 2·5 DICARBOXY-3·4-DIMETHYLTHIOPHENE		1·0	1·1	INACTIVE

TABLE 5 — ANTICANCER PROPERTIES OF OPEN CHAIN COMPOUNDS

NAME	STRUCTURE	YOSHIDA SARCOMA RATIO OF SURVIVAL E/C	FIBROSARCOMA RATIO OF TUMOUR WTS. C/E	ACTIVITY
26. THIODIGLYCOLLIC ACID		>50	1·7	ACTIVE
27. DIGLYCOLLIC ACID		2·5	1·1	ACTIVE / INACTIVE
28. THIODIGLYCOL		>45	1·4	ACTIVE
29. THIODIPROPIONIC ACID		>45	2·5	ACTIVE
30. THIODIBUTYRIC ACID		1·7	1·0	INACTIVE
31. THIODILACTYLIC ACID		2·0	1·3	INACTIVE
32. EVAN ACID		2·5	1·2	INACTIVE
33. SULPHONYL BISACETIC ACID		1·0	0·9	INACTIVE

(Table 5). Thiodiglycollic acid (TDGA), thiodiglycol (TDGOL) and thiodipropionic acid (TDPA) showed good anticancer properties. These three compounds were able to completely annihilate the Yoshida sarcoma cells with only 10 days treatment. The treated animals survived their natural life-span without any trace of malignancy. The corresponding Yoshida sarcoma transplanted control animals died within 10 days (Fig. 3). Such spectacular results were not obtained with solid fibrosarcoma. It is believed that in solid tumours, because the tumours are avascular, the drug does not readily come in contact with malignant cells and hence the chemotherapeutic response is slow. To get over this difficulty of avascularity which is of a generalized nature, combination of radiation and chemotherapy are tried. The rationale for this approach is discussed in succeeding paragraphs.

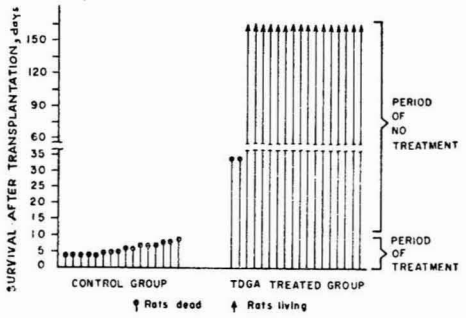


Fig. 3 — Effect of TDGA on survival of Yoshida sarcoma (ascites) bearing rats [The treated animals lived their normal life-span without any trace of malignancy]

Handicaps in Radiotherapy of Cancer

By virtue of the fact that malignancy is characterized by rapid and unrestrained growth, the multiplication of neoplastic cells far exceeds that seen in the stromal cells and blood vessels. Vascularity and the supporting stroma cannot cope up with the rapid and explosive cellular multiplication of the neoplastic cells[10]. One, therefore, finds that the tumour mass consists entirely or mostly of neoplastic cells without adequate blood vessels flowing through it. The entire tumour mass has thus to obtain its nutrients and oxygen from the periphery. This is schematically shown in Fig. 4. The peripheral cells are usually the first to come in contact with the flow of nutrients and oxygen from the surrounding spaces. Since these are rapidly multiplying, they 'plunder' most of the nutrients and oxygen for their own proliferation and allow very little to trickle inside, with the result that a sort of a diminishing concentration gradient is set up from the periphery to the centre of the tumour mass. As the tumour gets bigger and bigger, the peripherally situated cells utilize the entire supply of nutrients and oxygen and a region of anoxia and starvation is produced in the central area of the tumour. This is probably the reason why necrosis is invariably seen in the centre of the tumour mass.

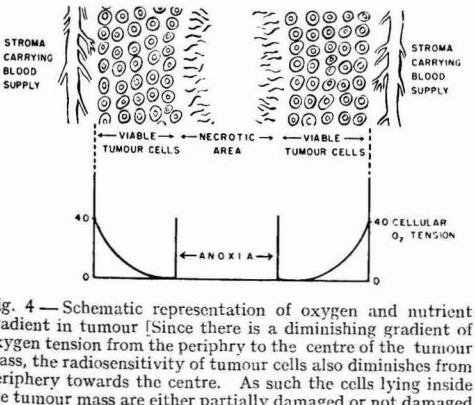


Fig. 4 — Schematic representation of oxygen and nutrient gradient in tumour [Since there is a diminishing gradient of oxygen tension from the periphry to the centre of the tumour mass, the radiosensitivity of tumour cells also diminishes from periphery towards the centre. As such the cells lying inside the tumour mass are either partially damaged or not damaged at all with radiation exposures]

Radiation Sensitivity of Tumours and Effect of Oxygen

The biological effects of radiation are known to be mediated in two ways: (i) effects brought about by direct 'hits' on some important cell constituents, and (ii) those produced by indirect action mediated through free radicals formed as a result of action on water molecules. In practice, although direct effects are seen to some extent, it is the indirect effects that predominate. It is now well established that the primary effects of radiation are as shown in the reaction sequence given below and result in the formation of H and OH radicals.

$$H_2O \xrightarrow{\text{Knocking off electrons}} H_2O^+ + e^- \quad ...(1)$$

$$H_2O^+ \xrightarrow{\text{Ionization}} H^+ + OH \quad ...(2)$$

$$H_2O + e^- \xrightarrow{\text{Capture of electrons}} H_2O^- \quad ...(3)$$

$$H_2O^- \xrightarrow{\text{Ionization}} H + OH^- \quad ...(4)$$

H and OH radicals are formed in the vicinity of tracks of ionizing radiations. Since H and OH radicals are highly reactive and have affinity for each other, their close proximity usually results in their recombination to form water as shown in Eq. (5).

$$H + OH \longrightarrow H_2O \quad ...(5)$$

In the presence of oxygen, however, hydrogen radicals combine with oxygen to form perhydroxy radicals.

$$H + O_2 \longrightarrow HO_2 \quad ...(6)$$

Since hydrogen radicals are removed, the danger of recombination disappears and oxidizing radicals like OH and HO_2 can exist in irradiated medium for some time. There is sufficient evidence to suggest that most of the radiobiological effects are mediated through the sequence of events shown above.

Radiosensitivity of tissues depends to some extent on oxygen tension inside the cell. It also depends on the state of mitotic activity of the tissue. Actively dividing cells appear to be more sensitive to radiation damage than the resting cells. This does not necessarily mean that resting cells are insensitive to radiation damage. Cells which have been irradiated in the resting stage and then caused to proliferate often show a great deal of damage at their first division. Malignant cells are usually rapidly dividing and hence radiation damage manifests in these much more readily. It is this property which has been exploited in radiotherapy of malignant diseases. In routine radiotherapy scrupulous care has to be taken to reduce the normal tissue dose and at the same time increase the tumour dose. It is with this object in view that rotation beam radiation therapy and other radiation devices have come into vogue.

Deschner and Gray[11] have shown that the radiosensitivity increases with increase in partial pressure of oxygen up to 40 mm. of Hg or so. Beyond this the radiosensitivity does not increase with increase in partial pressure of oxygen. This relationship of radiosensitivity of cells to partial pressure of oxygen is shown in Fig. 5. Since most of the cells, even those situated at the venous end, have a partial pressure of 40 mm. of Hg or more, their radiosensitivity is optimum.

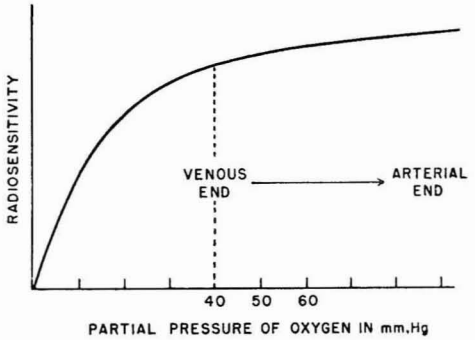


Fig. 5 — Relationship between radiosensitivity and oxygen tension

If a comparatively large tumour is irradiated, only the peripheral cells, which have an oxygen tension round about 40 mm. of Hg, will be radiosensitive. The cells lying inside, away from the periphery, will have comparatively less oxygen and hence their radiosensitivity also will be diminished. If such a tumour is irradiated, only the peripheral cells will be damaged and the cells lying inside the tumour mass will be damaged partially or not at all. This would mean that although the tumour is exposed to adequate radiation dose, it may not be possible to eradicate the entire tumour mass completely. On discontinuation of radiation treatment, the cells which are lying inside, away from the periphery, would burst into mitotic activity, and the malignant growth will recur. This is probably one of the reasons why disappointing results are obtained in radiotherapy of some tumours. One way of getting over this difficulty is to increase the oxygen tension of cells lying inside and thus make them radiosensitive.

Gray *et al.*[12], Churchill-Davidson *et al.*[13] and Sanger[14] tried this by putting the animal or the patient under 3-4 atmospheres of oxygen. Since a gradient of oxygen is believed to exist from the periphery to the centre of the tumour mass, it was anticipated that by boosting up the oxygen pressure in the surrounding tissue, it may be possible to proportionately increase the intracellular oxygen tension in the cells of the tumour mass. By adopting this procedure, these workers obtained interesting results. But the process of putting the patient in a closed chamber each time radiation is to be delivered, and increasing oxygen pressure to 3-4 atmospheres, irradiating the tumour while the patient is under the pressure and slowly releasing the pressure, required 3-4 hr and was fraught with certain hazards to the patient. An alternative procedure to increase the oxygen tension inside the tumour mass has been evolved in our laboratory and its practical application has met with considerable success.

Increasing the Radiation Sensitivity of Tumours

The uptake of oxygen and its utilization in the cell for metabolic process takes place through the Krebs' tricarboxylic acid (TCA) cycle and through the hexose monophosphate (HMP) oxidative pathway of glycolysis. In malignant tissue it is well known that the respiration and TCA cycle are impaired to about 30 per cent and the HMP pathway is accelerated. Any substance which interferes with the HMP pathway will, therefore, interfere with the utilization of oxygen by tumour cells.

Combined action of DICETOL and radiation was, therefore, studied on transplantable fibrosarcoma in Swiss mice. A large number of mice were transplanted with fibrosarcoma (solid). After about eight days, mice having same tumour sizes were divided into four groups: (I) the control group with no treatment whatsoever; (II) DICETOL treated group received, starting on eighth day, DICETOL for a period of five days at a dose of 1 mg. twice a day (total 9 mg.) given subcutaneously; (III) radiated group, animals in this group received on the 12th day one irradiation of 42 rad. X-rays on the tumour; (IV) animals in this group received treatment of DICETOL for 5 days between 8th and 12th day followed by radiation on the 12th day. Radiation was given immediately after the last DICETOL injection; and (V) in the fifth group radiation was given on the 12th day, followed by DICETOL treatment for succeeding 5 days. Rate of tumour growth was recorded. In one experiment the animals were observed till their natural death, whereas in another experiment the animals were killed on the 25th day after tumour transplantation, and tumour weight recorded.

The effect of combined action of DICETOL and radiation is shown in Fig. 6. It will be seen that when DICETOL is given first followed by radiation

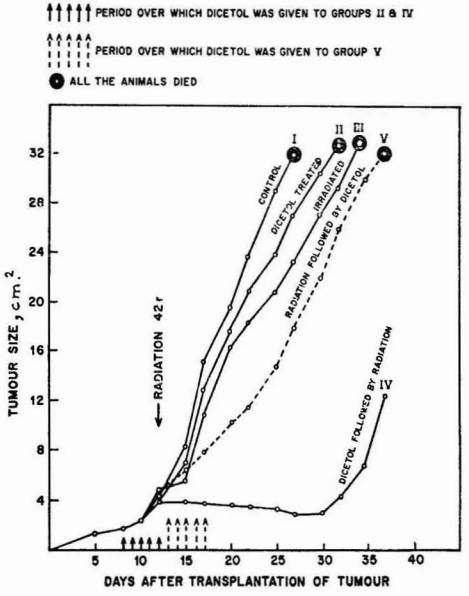


Fig. 6 — Combined action of DICETOL and radiation on tumour growth [Fibrosarcoma in Swiss mice; sustained inhibition of tumour growth in group IV]

the tumour growth is markedly inhibited. Neither DICETOL nor radiation alone was effective to the same extent in inhibiting the tumour growth. In Fig. 6 one finds that most of the control group animals died by 26th-28th day after tumour transplantation. Those receiving either DICETOL treatment or the radiation exposure died by the 32nd and 34th day (average) respectively. While the animals receiving DICETOL followed by radiation exposure lived for much longer periods. Both radiation and DICETOL are anticancer agents, but the result seen with group IV are not due to additive action because in group V, where DICETOL was administered after radiation exposure, no inhibition of tumour growth was seen. This suggests that administration of DICETOL before radiation exposure potentiates radiosensitivity of tumour mass.

Since there is a fairly wide margin of safety between therapeutic effectiveness and toxicity, it is felt that pretreatment with DICETOL before radiotherapy may be helpful in increasing the efficacy of radiotherapy in the control of malignant growths.

Toxicity Studies

Acute and chronic toxicity studies showed that TDA, DICETOL and TDGA could be given respectively 15, 30 and 50 times the daily dose in one instalment without any side effects. Administration of ten times the therapeutic dose for over 15 days did not materially alter the morphology of liver, spleen, kidney or gastro-intestinal tract. The only abnormality seen was the complete disappearance of glycogen from the livers of DICETOL treated animals.

Since the margin of safety appeared to be fairly wide, DICETOL and TDGA have been tried in advanced and incurable cases. This choice of the clinical material automatically restricted the correct evaluation of their chemotherapeutic properties. Even so, subjective improvements were seen. Life expectancy was enhanced. The growth of the tumour appeared to be slowed down, pain disappeared and the patient felt better. No toxic side effects were seen and blood picture remained normal even after prolonged administration of compounds. While no spectacular cures are claimed, there is sufficient evidence to show that as long as the treatment was given there was definite arrest of tumour growth. This improvement was unaccompanied by any obvious toxic side effects. It is anticipated that combination of these drugs with either radiotherapy and/or intermittent use of the cytotoxic drugs might lend a longer lease of life to cancer patients.

Summary

Although acceleration of HMP is not an essential prerequisite for the initiation of malignancy, it is essential for the maintenance of rapid growth in most of the rapidly growing tumours. In an attempt to preferentially interfere with the tumour growths, over 80 antimetabolites of HMP pathway intermediates were synthesized and screened for anticancer activity. The results of the screening tests are reviewed in this paper. Seven of these antimetabolites tested, viz. thiophene-2,5-dicarboxylic acid (TDA), 2,5-dimercaptomethylthiophene (MMT), thiouronium derivative of 2,5-dimercaptomethylthiophene (TUMMT) and 2,5-dicarbethoxy-3,4-dihydroxythiophene (DICETOL), thiodiglycollic acid (TGDA), thiodiglycol (TDGOL) and thiodipropionic acid (TDPA), have shown anticancer activity in experimental chemotherapy of cancer; with four of these, viz. TUMMT, TDGA, TDGOL and TDPA, complete cures of Yoshida sarcoma have been achieved. Since the margin of safety between therapeutic effectiveness and toxicity is fairly wide, two compounds, DICETOL and TDGA, were tried clinically in advanced and incurable cases of cancers, and tumour growth appeared to be arrested as long as the treatment lasted.

One of the major handicaps in radiotherapy of cancer is the poor vascularity of tumour mass, which renders the tumour cells comparatively deficient in oxygen and, therefore, insensitive to radiation damage. Increased availability of free oxygen in the tumour mass is achieved by interfering with the utilization of oxygen through HMP pathway. A combination of pretreatment with antimetabolites of HMP pathway followed by radiation exposures has been shown to increase the radiosensitivity of tumour cells considerably.

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Hydrogasification—An Efficient Method for the Exploitation of Low Grade Indian Coals

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INDIA draws her energy requirements mainly from non-commercial sources. At present, there is a great imbalance in the pattern of energy consumption in the country with heavy dependence of the domestic sector on non-commercial fuels like cowdung, firewood, charcoal, etc. According to the estimates of the Energy Survey of India Committee[1], the total domestic energy demand will reach 317 million tonnes coal equivalent (mtce) by 1980, of which 248 mtce may be non-commercial fuels. There is thus an urgent need to find suitable substitutes based on commercial fuels in order to conserve the forest wealth and the valuable cattle manure. Of the commercial energy sources, hydro-electric power and petroleum do not hold much promise due to their limited availability in the country. Therefore, the only promising source for commercial energy appears to be the vast reserves of low grade coals (estimated at 155,000 million tonnes). Domestic coke manufactured from these coals by carbonization has certain drawbacks like lower efficiency of utilization, ash disposal problem, etc. These problems mainly associated with the physical form of coal could be circumvented if solid fuel is converted into gaseous fuel. A gaseous fuel has several advantages over coal. It could be easily stored, could be economically transported by pipelines through long distance grids (at a cost 12 per cent that of electric energy), and it gives rise to no ash problems in combustion. In India, the supply of coal gas has not begun except to a limited extent in Bombay and Calcutta. But there is an immense potential for the use of coal-based gaseous fuels, especially in the urban areas.

In producing a gaseous fuel from coal, the main considerations are cost, quality of gas and thermal efficiency of the gasification process. None of the present-day coal gasification processes meets all these requirements. Gaseous fuels with a heating value of about 450 B.t.u. per standard cubic feet (scf) are derived from coal carbonization plants or steam-air/oxygen gasification plants. In the latter case the processes result in very low thermal efficiencies due to the highly exothermic combustion reactions. Lurgi pressure gasification process was an important development among efforts towards achieving total gasification of coal. But the gas from a Lurgi unit has a low calorific value (400-450 B.t.u./scf) and needs enrichment with petroleum products to come up to the standard of domestic gas. An additional and serious drawback of this process is the requirement of costly tonnage oxygen. Various investigations have been initiated for the production of high heating value gas (1000 B.t.u./scf) from coal, the ultimate aim being the efficient utilization of low grade coals. These researches have considerable significance to countries like India where natural gas resources are limited and the proper and efficient utilization of vast deposits of low grade coals is important. The investigations have proceeded mainly in two directions: (1) catalytic methanation of synthesis gas ($CO+H_2$) produced by steam-oxygen gasification of coal; and (2) direct high pressure hydrogenation of coal or coke to methane.

The first process is technologically in a more advanced stage. But it is a two-step process (gasification and methanation), involving large exothermic heats of reaction, whereby as much as 20 per cent of the potential heat of feed gases is lost. On the other hand, coal hydrogasification for producing methane could be carried out in a single step. The exothermic heat of reaction between coal and hydrogen does not exceed 10 per cent of the potential heat of reactants and theoretical thermal efficiencies approaching 90 per cent are attainable. In addition, direct coal hydrogasification processes completely dispense with oxygen, which may account for as much as 40 per cent of the cost of gas production in the conventional gasification processes like Lurgi. Hydrogasification of coal thus offers immense potentialities for the efficient utilization of low grade coals in the country. The principles of, and the recent developments in, the hydrogasification of coal have been reviewed in this article.

Much of the earlier work on the hydrogasification of coal has been due to the pioneering investigations of Dent[2,3] at the Gas Council Laboratories, UK. His work has demonstrated the feasibility of carrying out the reaction between hydrogen and carbon in coal at reasonable rates and of sustaining the reaction autothermally with moderate preheat of the feed hydrogen. Research work on similar lines leading to an understanding of the kinetic and technological problems connected with the process has been undertaken at the Institute of Gas Technology and the Bureau of Mines, USA, and the CSIRO Laboratories in Australia. Two excellent comprehensive reviews on hydrogasification of coal have recently been published[4,5].

A knowledge of the thermodynamics and kinetics of the hydrogasification process and a thorough understanding of the technological problems involved are essential for the design and operation of commercial scale reactors. Before considering these problems, it is worth while to consider various basic hydrogasification processes and the limitations imposed by thermodynamics.

Raw Material and Energy Requirements of Ideal Processes

Channabasappa and Linden[6] evaluated the theoretical process requirements and ideal thermal

efficiencies of the following three basic processes for the conversion of coal to methane:

(1) Gasification of coal with steam and oxygen to produce synthesis gas and subsequent methanation of the synthesis gas over a catalyst — The ideal thermal efficiency is 75·4 per cent and three atoms of carbon are required for producing one mole of methane.

(2) Partial hydrogasification involving partial gasification of coal with hydrogen and utilizing the residual char for hydrogen production by steam-oxygen gasification followed by water-gas shift conversion and CO_2 removal — The ideal thermal efficiency is 90·5 per cent and the requirement of carbon is 2·5 atoms per mole of methane.

(3) Complete hydrogasification of coal using excess hydrogen to methane — Hydrogen is produced by steam reforming of a part of the product gas. The ideal thermal efficiency is 87·9 per cent and 2 atoms of carbon are required per mole of methane.

Thermodynamic Limitations

A study of material and energy requirements of these three basic processes has shown that the direct hydrogasification processes have definite advantages over the synthesis gas methanation process. The hydrogasification processes have ideal thermal efficiencies approaching 90 per cent and require less of carbon per mole of methane. An additional advantage is the single stage operation of the hydrogasification process compared to separate gasification and methanation steps in the synthesis gas methanation process. But these apparent advantages are largely offset by equilibrium limitations imposed by thermodynamics. Though high equilibrium methane concentrations can be obtained (Fig. 1) at moderate pressures and temperatures, the gasification rates are very low. The rate of reaction between carbon and hydrogen can be augmented substantially by increasing the temperature of operation. This would result in lower equilibrium methane concentrations, unless the pressure is also increased. For example, at 650°C., 80 mole per cent methane can be obtained at 100 atm., but a pressure of 250 atm. would be necessary to attain this equilibrium methane concentration at 760°C. Therefore, to obtain reasonable rates of gasification and high methane concentrations in the product gas, the hydrogasification reactor has to be operated at high temperatures and pressures. Effective hydrogenation of coal requires pressures in the range 30-200 atm. at 500-900°C. and coal reaction times of 30 min. or more.

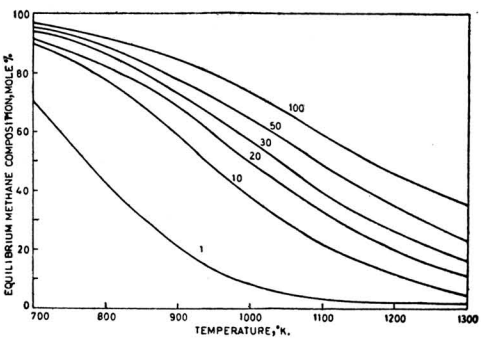

Fig. 1 — Equilibrium composition diagram for hydrogasification of carbon

Kinetics of Hydrogasification

Experimental studies on the kinetics of reactions have demonstrated the technical feasibility of generating methane by pressure hydrogenation of carbonaceous materials, but the existing knowledge of the mechanism of the process is very incomplete. An understanding of the actual mechanism of many reactions occurring in hydrogasification is made difficult by the complexity of coal structure and composition. However, it is possible to get data of practical value from empirical procedures.

Kinetic studies of coal hydrogasification have shown that the process may be taking place in two stages. The first stage is characterized by high gasification rates and involves the pyrolysis and hydrogenolysis of the more reactive coal constituents. Hiteshue *et al.*[7] have shown that the rate of methane formation in the first stage is controlled by hydrogenolysis of the volatile matter in coal and the completion of the first stage reactions is marked by the non-formation of liquid products. Wen and Huebler[8,9], from a kinetic study of coal char hydrogasification, concluded that two simultaneous reactions are occurring differing in their rates considerably. The more rapid reaction is associated with the carbon in the volatile matter and the slower one with carbon structure. For the initial rapid reactions, reaction rates are proportional to the amount of unreacted carbon remaining in particles as well as the effective partial pressure of hydrogen gas. The rate constant for small conversions of carbon was found to be 2 (atm. hr)$^{-1}$. Feldkirchner and Linden[10] found that the initial reaction rates are independent of temperature.

The second stage of reaction is characterized by the relatively slow reaction between the residual carbon structure and hydrogen. Blackwood[11] and Birch *et al.*[12] have expressed the rates of methane formation in carbon-hydrogen reactions by the first order rate expression.

$$r = KP_H$$

where r is the rate of methane formation; K, the first order rate constant; and P_H is the partial pressure of hydrogen. Data on integral char hydrogasification obtained at the Institute of Gas Technology, Chicago, also conform to the same type of first order rate equation. This expression is valid when the carbon-hydrogen-methane equilibrium is not too closely approached. In fact, the order of the reaction varies from 2 to 1, higher orders than unity being obtained at lower pressures[13].

At low methane partial pressures and under conditions where external diffusion to carbon surface is not a controlling factor, the rate constant K, expressed as moles of methane formed per gram of carbon in the bed/min./atm. hydrogen pressure, is represented by[14]

$$K = 17{\cdot}7 \exp (35600/RT)$$

The first order rate constant K is a function of both temperature and reactivity of coke. The reactivity of coke decreases with the degree of gasification. As more and more carbon is gasified, the rate constants for different coals tend to approach each other. This is due to the increasing similarity of different cokes as graphitization proceeds.

Mosely and Paterson[15,16] have concluded from char hydrogasification studies at temperatures in the range 600-1000°C. and pressures up to 600 atm. that though the initial rate of hydrogenation is very large, it rapidly decreases to a steady value and this decrease is independent of the extent of carbon gasification, depends upon time and temperature, and is related to volatile matter content. The rate of methane formation is directly proportional to hydrogen pressure. This leads to the conclusion that all the carbon, both fixed and volatile, can be hydrogenated at the initial high rate if temperature and pressure are sufficiently high.

Problems Confronting Commercial Processes

The basic problems in the design of hydrogasification reactors have been considered by Linden[5]. These concern with high pressure and high temperature operation of the reactor, control and utilization of exothermic heat of reaction, the agglomerating tendency of coals and coal pretreatment conditions and the economic production of hydrogen.

Materials of construction — Some major problems connected with the technology of the hydrogasification process are yet to be solved satisfactorily. At present there are very few metals which withstand the combined action of high pressures and temperatures in the presence of hydrogen as required in a coal hydrogenation reactor. High pressure vessels made of austenitic steels show satisfactory performance at moderate temperatures. But the strength of these metals falls rapidly at temperatures above 400°C. due to the setting in of creep or plastic flow of the metal. Hydrogen diffuses into the metal, combines with carbon to form methane which develops pressure, causing fissures at the grain boundaries. Therefore, the mechanical design of hydrogasification reactor is complicated. The design of the reactor should be based on the actual life period, determined from stress to rupture tests. However, with the present-day advances in high pressure technology and with the advent of new materials of construction like tantalum, problems encountered in the construction and operation of commercial scale reactors can be overcome.

Coal pretreatment — Many coals show a tendency to agglomerate under the conditions prevailing in a hydrogasification unit. This tendency can be overcome by a relatively mild pretreatment of coal at 300-500°C. The optimum conditions for bituminous coals[17] are fluidized pretreatment in air and nitrogen for about 1 hr at a maximum temperature of about 315°C.

Temperature control — As the carbon-hydrogen reaction is highly exothermic, adequate measures are necessary for the control of reaction temperature; increase in reaction temperature has an adverse effect on the equilibrium methane yield. Proper utilization of the exothermic heat largely determines the overall thermal efficiency of the process. The heat released is of the order of 21 kcal. per mole methane formed. Several reaction systems for hydrogasification have been proposed for the control and utilization of the exothermic heat of reaction. A complete analysis of these systems has been given by Linden[5]. Gasification can be done with hydrogen alone or hydrogen-steam or oxygen-steam mixtures. Gasification with steam-hydrogen mixtures can also be attempted. The purpose of steam addition is to absorb the exothermic heat of reaction between carbon and hydrogen by the endothermic steam-carbon reaction. Additional hydrogen is produced by steam decomposition, reducing the external hydrogen requirements. Von Fredersdorff[18] has shown that a large heat deficiency exists if total hydrogen requirement were to be met by steam decomposition alone.

Hydrogen production — The source of hydrogen and its cost of production form two important factors in the overall economics of the hydrogasification processes. Efforts have been made to utilize the inactive residual chars from hydrogasification reactors for hydrogen production and to produce supplemental hydrogen in the system itself by steam decomposition. At present there are three methods of producing hydrogen from coal or chars:

(i) Coal or char is reacted with steam and oxygen in a fluidized bed to produce synthesis gas which is then shifted to give hydrogen.

(ii) Steam-iron process — Coal or char is used to raise steam and generate producer gas. The Fe-FeO (5 : 95) mixture is converted to a Fe_3O_4-FeO (80 : 20) mixture in an oxidizer by steam oxidation producing hydrogen. The oxides of iron are reduced in a reduction cell with producer gas to form the FeO-Fe mixture, thus completing the cycle.

Katell and Faber[19] estimated that the total operating cost of hydrogen production for the first two processes for a plant of 30 million scf capacity per day is of the order of Rs 2.85 per thousand scf. The purity of hydrogen in the first process is 96·9 per cent, whereas it is not less than 99·8 per cent in the steam-iron process.

(iii) The Texaco partial oxidation process — The main advantage of this process is its versatility. Feeds ranging from methane and petroleum stocks to coal can be used in this process. A feed system delivers precisely controlled quantities of fuel, oxygen and other reactants into a refractory-lined reactor where the fuel is burned to produce hydrogen and carbon monoxide. When solid fuels are used, they are fed as suspension in water, which is delivered by a pump to the preheater where water is vaporized and the fuel preheated. With coal, a suspension type gasifier is used.

Of the above three processes the steam-iron process has definite advantage over the other two as oxygen is completely avoided and the purity of hydrogen is higher.

Commercial Hydrogasification

A commercially successful hydrogasification scheme should combine the following features:

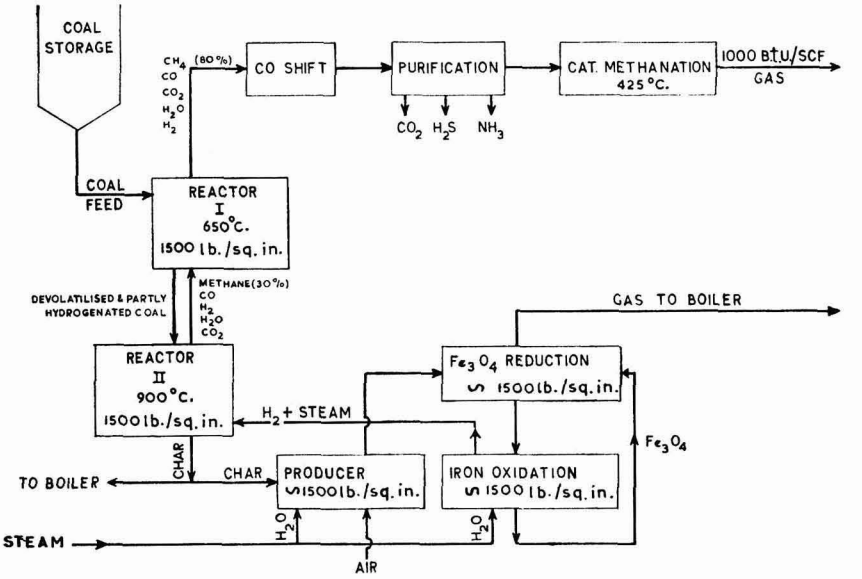

Fig. 2 — Two-stage hydrogasification scheme combined with steam-iron process

high methane content ; product gases, the best means of control and utilization of exothermic heat of reaction and the most economical means of hydrogen production. The mode of contacting coal and gases is of importance in determining the rate of gasification and the methane content of the product gases. If the flow is cocurrent, the highest available hydrogen partial pressure and temperature will be used to accomplish the easy first stage reaction and the potential for high gasification rate of the less reactive residual char is lost. Therefore, countercurrent flow of feed gases and coal is preferable. A fluidized bed is obviously the best means of controlling temperature as it has the most desirable heat transfer characteristics. But a unique feature of a fluidized bed reactor, a disadvantage in this case is the absence of axial temperature gradient. A controlled temperature gradient along the bed is desirable to achieve the highest overall reaction rate. As the gases flow through the coal bed, the methane content will decrease. Since the value of the equilibrium constant for the reaction $C+2H_2 = CH_4$ decreases with increase in temperature, the maximum allowable temperature at the inlet will be higher than that at the exit. The highest overall rate will be obtained when the temperature distribution approaches closely the optimum temperature progression. Such a controlled temperature distribution is not possible in a fluidized bed.

The control of exothermic heat of reaction is simplified by using hydrogen-steam mixtures instead of hydrogen alone in gasification. The introduction of steam serves two purposes. Endothermic steam decomposition reaction acts as a heat sink for the exothermic carbon-hydrogen reaction and simultaneously additional hydrogen is produced. Also, the construction of the reactor is simplified by the elimination of internal heat transfer surfaces.

All these desirable features have been combined in a two-stage hydrogasification process in conjunction with steam-iron process for hydrogen production, visualized by the Institute of Gas Technology (IGT), Chicago[20]. A flow diagram of the hydrogasification process, based on the IGT process, is shown in Fig. 2. The scheme combines the advantages of countercurrent flow with those of fluidized bed operation. There are two reactors, one operating at 900°C. and the other at 650°C. The high temperature reactor receives the less reactive coke from the first stage reactor. The coke particles are kept in a fluidized state by steam-hydrogen mixture coming from a steam-iron unit. The steam-carbon reaction is sufficiently fast at this temperature to utilize the exothermic heat generated by the carbon-hydrogen reaction and considerable amount of additional hydrogen is produced. It has been estimated that the external hydrogen requirement can be reduced to 70 per cent of the total by steam decomposition. The product gases from the high temperature reactor, which contain about 30 per cent of methane, are contacted with a moving bed of pretreated coal countercurrently in the low temperature reactor. The countercurrent operation and the lower temperature of the first stage reactor make it possible to obtain high concentration of methane in the product gases. The product gases from the low temperature reactor are upgraded in respect of calorific value by catalytic methanation after necessary purification and the adjustment of

CO-H_2 ratio. The residual char from the second stage reactor is used for producer gas generation and steam raising.

The advantages claimed for this scheme are complete elimination of oxygen, efficient control of exothermic heat of reaction by steam decomposition and generation of additional hydrogen in the system.

Comparative Study of Plant and Production Costs

The main features and the relative efficiencies of the three processes, viz. (i) Lurgi gas purification-catalytic methanation, (ii) gasification with hydrogen using residual char for hydrogen generation, and (iii) steam-hydrogen gasification followed by purification and catalytic methanation, are presented in Table 1 (ref. 21).

The capital investment for a plant producing gas with 90 billion B.t.u. heating value per day has been reported by Benson and Tsaras[21]. The cost of production with coal costing Rs 30 per ton and oxygen Rs 40 per ton is given in Table 1.

The relative costs of various domestic fuels worked out taking into account their combustion efficiencies come to (in Rs/million B.t.u.): charcoal, 27·50; firewood, 28·50; leco, 25·10; kerosene, 29·50; LPG, 60·00; LTC coke (Rs 125/ton), 20·70; briquette coke (Rs 165/ton), 27·30; and electric power (10 paise/unit), 37·50. Compared to the cost of the above fuels, the cost of high B.t.u. gas obtained by the gasification processes comes to: Lurgi gas methanation process, 13·75; partial hydrogasification process, 8·10; and hydrogasification combined with steam-iron process, 5·0 Rs/million B.t.u.

These are only relative figures and emphasize the advantage of converting solid fuel energy into gaseous fuels. The production of gaseous fuels would involve large initial investments for the plant and for building efficient distribution systems. However, the total investment cost compares favourably with that of thermal power plants. The estimated cost of a thermal power plant in India is about Rs 12,500 per million B.t.u./day (Rs 1000 per kWh)[22] against the estimated figure of Rs 7500 for a plant producing high B.t.u. gas[21]. The maximum plant efficiency of a power plant based on coal is about 40 per cent, whereas practical plant efficiencies approaching 70 per cent can be attained in hydrogasification plants.

TABLE 1 — RELATIVE EFFICIENCIES OF THREE IMPORTANT COAL GASIFICATION PROCESSES

(Basis: Production of gas with 1 million B.t.u. heating value)

	Methanation process	Partial hydrogasification process	Hydrogasification: H_2 from steam-iron process
Coal required, lb.	145	125	102
Oxygen required, lb. (99 per cent pure)	114	39	nil
Heating value of product gas, B.t.u /scf	1000	987	1000
Thermal efficiency, %	55	69	78
Economics			
Plant investment, Rs million	675	490	300
Cost of gas, Rs/million B.t.u.	9·65	6·00	4·1

Summary

The various thermodynamic, technological and operational aspects of the hydrogasification of coal and fuels for producing high calorific value gas for use as a domestic and industrial fuel are discussed. The economics of production of gas by these main gasification procedures, viz. (i) Lurgi gas methanation, (ii) partial hydrogasification, and (iii) hydrogasification combined with steam-iron process, are considered.

Acknowledgement

The author is thankful to Dr R. Vaidyeswaran for many helpful suggestions in the preparation of this paper and to Dr G. S. Sidhu, Director, Regional Research Laboratory, for his permission to publish the paper.

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REVIEWS

ISOBARIC SPIN IN NUCLEAR PHYSICS edited by John D. Fox & Donald Robson (Academic Press Inc., New York), 1966. Pp. xiv+896. Price $ 9.00

The book under review presents the proceedings of an International Conference on Isobaric Spin in Nuclear Physics, held at Tallahassee, Florida, in March 1966. This was the first conference on this subject, which is now recognized to have a bearing on many aspects of nuclear structure and nuclear reactions. Judging by this book, the objective of bringing together active scientists in this field in order to compare techniques, ideas and results has been achieved with marked success.

There were five sessions in each of which some five to eight papers were presented and discussed. Topics of fundamental importance, such as charge dependence of nuclear force, isobaric spin conservation in beta-decay, isobaric spin dependence of the nucleon-nucleon interaction, isobaric spin and analogue spin, and isobaric spin and the optical model, figured during the various sessions and the authors are of worldwide reputation in these fields. In addition, there are some 30 contributed papers which discuss the properties of individual nuclei.

This book, which runs to some 900 pages, is invaluable for those actively engaged in work on nuclear structure and nuclear reactions.

B. V. THOSAR

LA DIFFUSION DANS LES SOLIDES by Y. Adda & J. Philibert (Institut National des Sciences & Techniques Nucleaires, Saclay, and Presses Universitaires de France, Paris), Vol. 1, Pp. xvii+666; Vol. 2, Pp. xvii+667-1268. 1966. Price 212 fr.

The book under review forms part of a series on nuclear sciences and experimental techniques. Based on a course of lectures delivered by the authors at Quebec and Buenos Aires, each chapter is well illustrated by a number of sketches, photographs and tables. At the end of each chapter, a number of references to books as well as original papers are given.

Two special features of this treatise are: (i) wherever possible the topics under discussion are first analysed theoretically and next in terms of experiments; and (ii) a number of practical examples are given, however, collecting the detailed mathematical derivations in full, appropriately in appendices to each chapter. This reviewer noted sixteen of them in Chapter III.

Though primarily intended for metallurgists, the first eight chapters and, in the opinion of this reviewer, also Chapters XIV, XV and XVII would be of interest to research workers studying non-metals. Indeed other chapters too will interest the latter, for solids do include non-metals and an underlying unity in the basic laws governing the behaviour of metals and non-metals (subject always to refinements depending on the individual cases) might yet exist. After all, nature is indivisible.

The range of topics covered in this 'heavy' treatise—heavy both in quality and quantity—may be understood by scanning through the titles of the above eleven chapters, to start with. (In any case shortage of space will allow only that). The titles are: Introduction to the diffusion phenomena, in general (I); A broad survey of crystal defects (II); Solutions to Fick's law (III); Methods of preparing specimens and following the kinetics of diffusion (IV); Refinements to Fick's law from thermodynamic principles (V); Considerations of random atomic movements (VI); Correlations between atomic jumps (VII); Influence of pressure (XIV), temperature (VIII), as well as temperature gradient (XV); and Diffusion coefficients, rheological theory and applications to metals (XVII). The authors show that through rheological observations one can measure diffusion constants much lower (by an order of 100-1000) than by any other method including radioisotope techniques (3×10^{-17} cm.^{2}/sec.).

The authors give experimental results for metals and alloys, with and without chemical concentration gradient and for intermetallic phases in the last three chapters (IX to XI) in Vol. 1. Diffusion phenomena occurring in grain joints and crystal surfaces are discussed in the first two chapters of Vol. 2. Chapters XVI and XVIII, which could have been consecutive, deal with diffusion in the presence of an electric field and in halogen compounds. Chapter XIX gives an account of diffusion in oxides. The omission of any reference to the work of Prof. J. Benard is conspicuous here. An excellent compilation of tables giving valuable data on error function, diffusion constants, etc., constitutes Chapter XX.

The book ends with a list of references arranged in alphabetical order and a number of useful exercises. The publication is strongly recommended to any solid state science laboratory. It is printed in excellent art paper with no misprints. The authors are to be congratulated for their lucid style and practical approach. Finally, this reviewer cannot resist a word of appreciation for their keen aesthetic sense, e.g. on page 9 they have stressed in a picturesque manner how the interest of immediate practical utility and ease of interpretation run in opposite directions. How true indeed!

A. VISWANATHAN

INDUSTRIAL CHEMISTRY: Part I — METALLURGY by R. K. Das (Asia Publishing House, Bombay), 1966. Pp. 147. Price Rs 8.00

The book under review, written by an experienced teacher in chemistry, has well followed the much desired dictum 'discourage memorizing and encourage understanding'. Meant primarily for the three-year degree course in chemistry, this book could be used as an introductory exercise for students of chemical engineering though not for metallurgy students.

Part I of the book dealing with metallurgy has been divided into 12 chapters. The first chapter introducing the metals in general discusses in some detail metallic bonds and alloys, electronic structure, and some physical characteristics. The remaining eleven chapters are devoted to the occurrence, extraction, properties and uses of the metals sodium, magnesium, aluminium, iron and steel, copper, nickel, zinc, tin, lead, gold and silver. Being a text-book for Indian students, extraction processes undertaken in India have been stressed, though the general practices have been included, taking care to stress the up-to-date methods.

The book is lucidly written and would meet the fond hope of the author if it succeeds in engendering original thinking and expression. The book in its 147 pages includes 23 simple line diagrams, a number of flow sheets, a few useful tables, and an appendix. It is moderately priced.

A. A. KRISHNAN

INDUSTRIAL CHEMISTRY — INORGANIC AND ORGANIC by D. M. Samuel (Royal Institute of Chemistry, London), Monographs for Teachers Series Nos. 10 and 11, 1966. Pp. 46 and 34. Price 7*s*. 6*d*. and 6*s*. respectively

These publications, the 10th and 11th in the series of monographs on various aspects of chemistry by the Royal Institute of Chemistry, London, provide a very concise and elementary account of industrial inorganic and organic chemistry.

The monograph on industrial inorganic chemistry deals with the subject matter under two main subheads, non-metals (and their compounds) and metals (and their compounds). Non-metals dealt with are inert gases, hydrogen, boron, carbon, silicon, nitrogen, phosphorus, oxygen, sulphur and halogens. The metals discussed are lithium, sodium, copper, beryllium, magnesium, zinc, cadmium, mercury, calcium, barium, aluminium, titanium, germanium, tin, lead, arsenic, chromium, manganese, iron, cobalt and nickel.

The monograph on industrial organic chemistry deals with the heavy organic chemicals of industrial importance. The subject matter has been distributed under two heads, aliphatic (paraffins, olefins, acetylene, halogen compounds, alcohols, ethers and epoxides, aldehydes and ketones, carboxylic acids and derivatives, esters and nitrogen compounds) and aromatic compounds (aromatic hydrocarbons, nitro and amino compounds, sulphonic acids, phenols, alcohols, aldehydes, ketones and acids, and dyestuffs).

The level of treatment is such that what is commonly available in the text-books of inorganic and organic chemistry has been omitted and recent trends in the manufacture of the important chemicals have been reported. Actual production figures in UK have also been reported wherever possible.

The basic aim with which these monographs have been prepared is to introduce the subject of industrial chemistry at the ordinary 'O' level, so that those students who enter the chemical industry after their school education are exposed to recent developments in manufacturing processes. Hence they are also expected to serve as guides to the teachers of secondary schools in selecting and presenting the subject without having to overburden the course with greater details on industrial chemistry.

Although they serve the above purpose well, it is felt that at least some of the processes dealt with should have been presented in simple flow charts in order to impart the 'feel' of industrial chemistry.

S. ZAHED HUSSAIN

THE MÖSSBAUER EFFECT AND ITS APPLICATION TO CHEMISTRY by V. I. Gol'danskii (D. Van Nostrand Co. Inc., New York), 1966. Pp. 119. Price $ 4.95

The Mössbauer effect is one of the greatest discoveries of our times. It has no longer remained merely a curiosity in nuclear physics but its importance to widely diverse areas such as solid state physics, metallurgy, chemistry, biology and even geology has now been clearly realized.

Prof. Gol'danskii's monograph illustrates in a very lucid and concise manner the many diverse applications of the Mössbauer effect to chemistry and thus satisfies the long-felt need of chemists and chemical physicists for a book of this type. The first three chapters describe briefly but adequately the theory underlying the discovery, and give a clear account of the observable parameters, such as the chemical or isomeric shift in the Mössbauer line, the quadrupole splitting of the line in the presence of an electric field gradient in the molecule and also the Zeeman splitting of the line due to internal magnetic fields. An exhaustive survey of the data on Mössbauer effect in iron and tin compounds is given in the later chapters. The importance of this type of work for understanding molecular structure and the nature of chemical bonding in these compounds is the main theme; however, the use of these experiments for problems of chemical kinetics, radiation chemistry and physical chemistry of polymers has also been illustrated using a few selected examples.

Prof. Gol'danskii is one of the pioneer workers in this field. The monograph reflects the varied chapters of the work of the Russian scientist in this area. This book is invaluable to research workers in this field as it forms an excellent review of the subject and gives data of the Russian work which is otherwise not easily accessible. The book is also inspiring for those not initiated into this kind of work. Although Mössbauer effect has been discussed in several international conferences, only a few monographs exist on this subject and most of them are mainly written for the physicists by the physicists. This monograph is a valuable addition which the teachers and research workers in inorganic chemistry should find particularly useful.

The title of the book is a bit misleading, because it also contains two excellent articles on the use of nuclear quardupole resonance in chemical crystallography written by two other Russian authors, G. K. Semin and E. I. Fedin. The main features of NQR spectroscopy and the details of the apparatus used for this kind of work have been

discussed and the importance of this technique in ascertaining bond character, the non-equivalent sites in crystals and for the study of crystal imperfections and thermal motions in solids have been illustrated. Compilation of NQR data given in these articles enhances the value of this review for persons working in the fields of both NQR and Mössbauer effect.

C. R. KANEKAR

COMPILATION OF MASS SPECTRAL DATA by A. Cornu & R. Massot (Heyden & Son Ltd, London, and Presses Universitaires de France, Paris), 1966. Pp. xv+617. Price £ 14.10; $ 42.00

This is a compilation of mass spectral data of some 5000 compounds, studied over a period of years at the Laboratory of Mass Spectrometry, Centre of Nuclear Studies, Grenoble. The data listed include: (first line) name of compound, ten strongest peaks, molecular formula and index category; (second line) reference number (source of spectrum), molecular weight, reference value (height of base peak/height of a reference peak of a reference standard; this value is useful for the calculation of absolute peak heights) and relative abundances (of the ten peaks listed). The book is divided into four sections, each section representing a different index category. Thus, Section A is by reference number, Section B by molecular weight, Section C by molecular formula and Section D by fragment ion values (including the molecular ion). The compilation covers a wide variety of organic compounds and the different ways of indexing used greatly facilitate the identification and analysis of listed compounds.

The book must find a place in all laboratories using mass spectrometry. It is well produced.

SUKH DEV

MODERN ASPECTS OF POLAROGRAPHY edited by Tomihito Kambara (Plenum Press, New York), 1966. Pp. iii+245. Price $ 10.00

This volume containing thirty-two papers by recognized authorities on polarography gives a bird's-eye view of the research trends and activities in this fast developing branch of physical chemistry. It is a special issue in honour of Prof. Isamu Tachi, the leading polarographist of Japan who retired from Kyoto University in November 1962. Since polarography embraces a variety of physico-chemical phenomena, the topics treated cover a wide spectrum including adsorption, catalysis and kinetics at the electrode-electrolyte interface, the double layer structure and morphology of the waves, organic polarography in relation to structure and free energy, polarography in non-aqueous media, polarography with carbon paste electrodes, a.c. polarography and new instrumentation, clinical and industrial applications, etc. The great diversity of interests in these papers makes it difficult to arrange them in any logical sequence and, therefore, none has apparently been attempted.

It is difficult to pick and choose from this colourful bunch of communications. The papers by Brdicka and Nemec, Breyer, Biegler and Bauer, Kolthoff and Khalafalla, Kuta, Maironovskii and Frumkin, Shinagawa, Nezu, Muromatsu and Oka will particularly hold the interest of those devoted to an understanding of the mechanism and kinetics of redox reactions at the micro-electrode. Delahay's paper on the coulostatic method breaks new ground on the application of this elegant technique to the study of adsorption and electrode kinetics. Zuman's review paper is an able presentation of the relation between polarographic behaviour and structure in respect of organic compounds. The book will excite the interest of not only the fastidious electrochemist but also of the organic chemist, biochemist and discerning analytical chemist. The attractive get-up and printing are also consistent with the material presented.

P. R. SUBBARAMAN

AN INTRODUCTION TO COMPUTER PROGRAMMING by Henry Mullish (Gordon & Breach Science Publishers, New York), 1966. Pp. xi+244. Price $ 5.00 (paper); $ 14.50 (cloth)

Once in a while one comes across a book that makes a departure from the oft-beaten tracks. This book is a unique one. It is different because it is so forthright and introduces the subject more in the style of 'do-it-yourself' which gives a feel for programming to a beginner in computer sciences. Even in the type, size and presentation the book is different. The treatment is lucid, easy to follow and is based on a number of problems such that the whole framework is problem-oriented. There are a number of quizes after every few chapters which help the student in assimilating whatever he has learnt up to that time.

The author brings the reader straightaway into the midstream with a short introduction of a few pages which picturizes a typical computer centre. The programming language used is Fortran II, which is a right choice, considering that most of the modern computers are Fortran-oriented. Further, it can be argued that familiarization with any particular popular programming language can set up a broad base for the student to make diversions into other programming languages such as Algol. The number of problems covered have variety and encompass different topics, wherein the problems could be tackled with the help of digital computers.

Problems such as solving of simple quadratic equations, computation of simple and compound interest mortgage amortization, electoral sampling problems, racetrack problems, and simple statistical analysis problems, and solution of functions are some of the illustration examples. The author then takes the reader into slightly more interesting areas such as Do-Loops, sub-routines and matrix algebra. It is surprising that Boolean algebra has been introduced at the very end which should have been covered in earlier chapters.

The treatment of the entire text, although non-rigorous and non-mathematical, still holds the interest of the reader up to the end and brings home the basic concepts of computer programming very vividly. Since the book is primarily concerned with computer software, the machine organization and peripheral equipment have been treated minimally. On the whole, the book is an excellent

contribution to the art of computer programming; particularly for those interested in learning computer programming, on their own, it would be of invaluable help.

P. K. PATWARDHAN

MODERN OPTICAL ENGINEERING: THE DESIGN OF OPTICAL SYSTEMS by Warren J. Smith (McGraw-Hill Book Co. Inc., New York), 1966. Pp. 476. Price $ 15.00

This modern treatise on the design of optical systems and related subjects is remarkable in the manner in which the available information is condensed and presented with the matured knowledge of the author. The text is adequately illustrated with neat diagrams, useful equations and informative tables which makes the book valuable for anyone interested in optical instruments.

After giving the general principles briefly in the first 16 pages, the main subject is introduced in chapters on image formation (first order optics), and aberrations and is later developed in chapters on stops and apertures, optical computation and design of optical systems (two chapters). The methods of image evaluation are treated separately in a short but very interesting chapter. One of the chapters is devoted to prism and mirror systems and another to the basic optical devices like telescopes, microscopes, range finders, anamorphic systems, fibre optics, etc. It also has two useful chapters on the eye and colour, and radiometry and photometry. The remaining two chapters cover optical materials and coatings, and optics in practice; a practical man may find many useful hints in these chapters. A collected bibliography in classified form is given in 19 pages as a guide for further study.

It is but natural that in a work of this range and magnitude some topics are dealt with either in a passing manner or are left out altogether. The reader does not find information on binocular, stereoscopic or projection systems, not to say of less popular subjects of opthalmic and optomedical systems. Specialized systems used in phase contrast, interference, incident light and polarized light microscopy and similar techniques are also not covered in any details.

The book is primarily intended for reference by practising optical designers which purpose it serves adequately. The underlying mathematics has rightly not been discussed from the scratch. Only important equations are given, many of which are fully illustrated with worked out examples. In some cases systematic procedures for the design of lens systems are given which will be of benefit to the beginner. The articles like optical specifications and tolerances, optical mounting techniques, and the analysis of unknown optics indicate the intimate knowledge of the author of the optical designers' problems. The book, therefore, can be regarded as a must for an optical designers' library.

On the whole, the book is considered as a noteworthy contribution on the subject of its title, which has only a very few books of this type.

RAM PRASAD

HIGH PRESSURE MERCURY VAPOUR LAMPS AND THEIR APPLICATIONS edited by W. Elenbaas (Philips Technical Library, Eindhoven; *Distributors in India*: B.I. Publications, Bombay), 1965. Pp. xi+303. Price Rs 44.00

The book deals with several aspects of the mercury high pressure lamp, both fundamental and applied. Each topic is written by a specialist in the field. Chapters III and IV dealing with the shapes, sizes, fittings, output lumen and lighting applications will be most useful to the lighting engineer. High luminous efficiency is the main advantage of the HP mercury lamp, but one of its drawbacks is the colour of the light. Certain methods of colour correction are described and the use of the lamps primarily for street lighting, yard lighting in rolling mills, hangars and for floodlighting are illustrated. There is an interesting section on the discharge, its start, its maintenance, its failure, temperature rise and the role of the outer envelope.

The earlier chapters refer to the scientific aspects of the problem, viz. the electrical discharge, composition of light, luminous efficiency and the use of the fluorescent material. The chapter on luminescence and fluorescent materials is a welcome feature of the book.

Chapter VI refers to a variety of applications of high pressure mercury vapour lamps for scientific and medical purposes. The ultraviolet emission lamps with quartz or special quartz envelopes which are not needed for ordinary lighting purposes find other uses, particularly in photo printing, copying, photochemical reactions, sterilization and fluorescent analysis.

The last chapter refers to the possible improvements in the performance of high pressure discharges in the directions required for different purposes. A notable development is the use of metallic iodides as traces in the discharge tubes which suppresses the mercury light but produces lines of the metal atoms and ions that improve luminous efficiency and offers scope for better colour rendering.

The book is intended to bring into forefront the value of high pressure discharge lamps, particularly the mercury lamp, its applications and its potentialities. Well illustrated with scientific and technical data in the form of drawings, graphs, tables and photographs, the book will provide a reading without strain. It will serve the purpose for which it is intended, valuable for the scientific worker, the lighting engineer and even more valuable to the applied physicist and the scientifically minded engineer.

C. RAMASASTRY

DESIGN, OPERATION AND TESTING OF SYNCHRONOUS MACHINES by G. C. Jain (Asia Publishing House, Bombay), 1966. Pp. xiv+676. Price Rs 75.00

The book under review is a well laid out book dealing with three aspects of synchronous machines: design, performance or operational aspect, and testing and commissioning. Each part is covered in detail and, in fact, the material contained in the book makes it quite suitable for use both by an advanced student and a practising engineer.

Although most of the information contained in the various chapters of the book is already well known, it has been compiled in a systematic manner and the book is, therefore, quite useful. The author starts with the basic aspect of the synchronous machines and goes on to the mechanical constructional aspects. The treatment in this chapter is, however, too brief and some more details of mechanical design should have been given. The author then goes on to armature windings and discusses the cause, effect and means of suppressing the time harmonics in the voltage waveform. The chapters on armature reaction and reactances are well written and should be of great use. Factors involved in the computation of open-circuit and short-circuit characteristics from the designer's viewpoint and methods of computing them from design and experimental data, have been explained. The author also deals with the theoretical aspects of the behaviour of synchronous machines under steady state and transient conditions. The transient and sub-transient reactances have been thoroughly discussed. These chapters are very well presented and the latest techniques in machine analysis have been explained. The chapter on 'Excitation system of synchronous machines' is particularly well presented and contains valuable information.

On the whole, the book is very good and, but for a few slips and printing mistakes and some occasional repetitions, is very well presented.

The price of the book appears to be prohibitive, compared to many already established books of foreign publication.

This book is undoubtedly a valuable addition to the reference books in the field.

M. SEN GUPTA

TECHNICAL REFERENCE BOOK ON VALVES FOR THE CONTROL OF FLUIDS (Pergamon Press Ltd, Oxford), Second Edition, 1966. Pp. 342. Price 40*s*.

This book is a commendable effort by a manufacturers' organization to bring together most valuable technical data for the users, on the products manufactured by their members. It is a model for other similar organizations to follow to earn the goodwill of the designers and users of the respective specialized items.

The present book supplies essential technical guidance and data on the use of valves for the manipulation of flowing solids, liquids and gases. It also provides detailed information on the valves manufactured by individual producers in Great Britain. The book is divided into three parts, viz. Technical reference, Buyers guide to valves manufactured in Great Britain for the control of fluids, and Trade names and marks.

The technical reference part contains a glossary of valves and valve parts, guide to valve selection, valves for automatic process control, materials of construction, five-language (English, French, German, Italian and Spanish) glossary of valves and valve parts, graphical symbols for pipes and valves, valve installation and maintenance, valve end connections, flow rate and friction in pipes, valves and fittings, material specification, valve standards, steam tables and, lastly, conversion tables.

In Part 2, a guide to manufacturers of different types of valves and information on individual manufacturers are provided. Part 3 includes trade names and trade marks and an index.

Mr W. R. Blakeborough, Chairman of BVMA, in his foreword to this book has written, "A valve can only perform its duty satisfactorily if it has been selected correctly to meet the service conditions. Manufacturers are often asked to supply valves without being given details of the use to which they will be put in service." The information provided in the book helps in specifying by the customers their requirement and supply of the right type of valve by the manufacturer to ensure that the valve supplied will give satisfaction in service and the type chosen will be the most suitable and economical. In these processes of specifying and supplying valves a comprehensive format for giving customer requirement would have been of great value.

N. R. KULOOR

RESEARCH IN ELECTRIC POWER by Philip Sporn (Pergamon Press Ltd, Oxford), 1966. Pp. xvi +64. Price 7*s*. 6*d*.

The author discusses the indispensable need for research in electric power, the specific fields which call for research and the manner in which the vast research programme could be accomplished.

While tracing the history of growth of the electric power industry in USA, the author has projected for the year 2000 an increase of 6·6 times generation, 6·2 times peak demand and 4·33 times total revenue per year, as compared to 1963. The lower figure for revenue indicates that the electrical energy should be supplied at a much lower cost than at present in order to maintain a steady rate of growth in the utilization of electrical energy; and this feedback relationship can be maintained only through constant research in various fields of electric power.

The author has stressed the need for research on problems like increase in conversion efficiency of coal, development of large sized units of 1000-1200 MW, a.c. transmission at 1000-1100 kV., long-distance d.c. transmission, new methods of switching and protection in distribution, etc. Among the important challenges indicated by him is the development of a.c. circuit breakers for high voltage systems capable of clearing faults in a maximum time of one cycle. However, the optimum interrupting time for circuit breakers continues to be a controversial question and many modern systems still seem to prefer breakers with longer breaking time and, therefore, less susceptible to trivial mechanical and other failures.

The author points out the dangers of centralizing the research agency in a large and diverse country like USA and outlines the various forms of cooperation and the areas in which the electric utilities, manufacturers, academic institutions and government could join hands in carrying out research programmes. He indicates that even if 75 per cent of the electric utilities were to spend only

about 0·5 per cent of their revenue, enough financial support would be available for carrying out an exciting research programme.

The lectures covered in the book are essentially intended to serve as a call for dynamic leadership of the electric power industry and bold financial support. Although the lectures are directed mainly towards the creation of the necessary leadership in the United States, the basic ideas contained in them would, by and large, find application in any progressive society.

S. S. MURTHY

THE WEALTH OF INDIA, RAW MATERIALS, Vol. VII: N-Pe (Council of Scientific & Industrial Research, New Delhi), 1966. Pp. xxviii+330. Price Rs 30.00 or 60*s*.

Volume VII of *Wealth of India — Raw Materials* has maintained the high standard associated with the other volumes in the series. It deals with 294 plant species, 4 animals and animal products and 3 minerals — a total of 301 entries covering in alphabetical order under the letters N to Pe. In the treatment of the plants the detailed description of the species is preceded by a general description of the genus, providing a very useful background for a comparative study. More or less a similar pattern has been followed in the case of animals also. Among the plants, fairly comprehensive accounts have been given of food-yielding species (*Oryza sativa*) and fodder-producing grasses (*Pennisetum* spp.). In addition, important plant products like tobacco and opium have also been described. Among the animals, oysters have ranked prominently as they ought to. In the minerals dealt with, petroleum and natural gas have rightly taken a prominent place. Some of these accounts are original contributions from experts like Dr K. Ramaiah on *Oryza*, Dr G. N. Gupta on *Ocimum* and Dr K. Veerabhadra Rao on oysters, while the rest have been compiled by the CSIR staff in consultation with authorities in their respective fields.

The volume contains several illustrations — 140 figures in black and white and 9 plates, of which 4 are coloured. The plates, particularly the coloured ones, are highly impressive. It also contains a good index giving common names in English and the Indian languages and also the regional and trade names.

On the whole, the treatment of the subject is very good, containing statistical data wherever available and necessary, and a high standard is maintained right through. The present volume is a very useful publication both to the research worker and the general reader alike.

P. S. RAO

PUBLICATIONS RECEIVED

MATSCIENCE SYMPOSIA ON THEORETICAL PHYSICS edited by Alladi Ramakrishnan (Plenum Press, New York), 1966. Pp. xiii+167. Price $ 9.50

SYMPOSIA ON THEORETICAL PHYSICS edited by Alladi Ramakrishnan (Plenum Press, New York), 1966. Pp. xi+236. Price $ 12.50

WORLD ECONOMIC SURVEY, 1965: Part I — THE FINANCING OF ECONOMIC DEVELOPMENT; Part II — CURRENT ECONOMIC DEVELOPMENTS (United Nations, New York), 1966. Pp. xiv+196. Price $ 4.50; Rs 27.00

ENGINEERING KINEMATICS by Alvin Sloane (Dover Publications Inc., New York), 1966. Pp. x+310. Price $ 2.25

MODERN ASPECTS OF ELECTROCHEMISTRY, No. 4, edited by J. O'M. Bockris (Plenum Press, New York), 1966. Pp. viii+316. Price $ 12.50

THE THEORY OF EQUILIBRIUM OF ELASTIC SYSTEMS AND ITS APPLICATIONS by Carlo Alberto Pio Castigliano; translated by Ewart S. Andrews (Dover Publications Inc., New York), 1966. Pp. lxiv+360+15 plates. Price $ 3.00

A SIMPLE APPROACH TO ELECTRONIC COMPUTERS by E. H. W. Hersee (Blackie & Son Ltd, Glasgow, and Gordon & Breach Science Publishers Inc., New York), Second edition, 1967. Pp. xi+261. Price $ 7.50

AXIOMATIC FIELD THEORY edited by M. Chrétien & S. Deser (Gordon & Breach Science Publishers Inc., New York), 1966. Pp. xi+516. Price $ 32.50

PARTICLE SYMMETRIES edited by M. Chretin & S. Deser (Gordon & Breach Science Publishers Inc., New York), 1966. Pp. xi+691. Price $ 35.00

INSTITUTE OF AGRICULTURE, ANAND, INDIA, SILVER JUBILEE SOUVENIR 1940-65 (Director, Institute of Agriculture, Anand), 1966. Vol. 1 — EDUCATION; Pp. 64. Vol. 2 — RESEARCH; Pp. ix+xxii+250. Vol. 3 — EXTENSION; Pp. 33

PRINCIPLES OF SCIENTIFIC & TECHNICAL WRITING by Jackson E. Morris (McGraw-Hill Book Co. Inc., New York), 1966. Pp. xvii+257

ADVANCES IN HETEROCYCLIC CHEMISTRY: Vol. 6, edited by A. R. Katritzky & A. J. Boulton (Academic Press Inc., New York), 1966. Pp. xv +468. Price $ 18.50

ADVANCES IN ATOMIC & MOLECULAR PHYSICS: Vol. 2, edited by D. R. Bates & Immanuel Eastermann (Academic Press Inc., New York), 1966. Pp. xi +484. Price $ 16.50

MIXING: THEORY AND PRACTICE: Vol. 1, edited by Vincent W. Uhl & Joseph B. Gray (Academic Press Inc., New York), 1966. Pp. x+340. Price $ 15.50

MICROWAVE SCANNING ANTENNAS edited by R. C. Hansen (Academic Press Inc., New York), 1966. Vol. 2, Pp. xv+400. Price $ 15.50. Vol. 3, Pp. xvi+422. Price $ 16.50

HYPERSONIC FLOW THEORY: Vol. 1 — INVISCID FLOWS by Wallace D. Hayes & Ronald F. Probstein (Academic Press Inc., New York), 1966. Pp. xv+602. Price $ 16.50

PEROXIDES, SUPEROXIDES AND OZONIDES OF ALKALI AND ALKALINE EARTH METALS by Il'ya Ivanovich Vol'nov; translated from the Russian by J. Woroncow (Plenum Press, New York), 1966. Pp. xiv+146. Price $ 9.00

ACHEMA JAHRBUCH 1965-67 (Dechema Deutsche Gesellschaft für Chemisches Apparatewesen e.v., Frankfurt-am-Main), 1966. Vol. 1 — EUROPEAN RESEARCH IN CHEMICAL ENGINEERING; Pp. R32 +1088. Vol. 2 — TECHNICAL DEVELOPMENTS IN CHEMICAL ENGINEERING; Pp. R53+683. Vol. 3 — GUIDE TO CHEMICAL ENGINEERING IN EUROPE; Pp. R14+623

NOTES & NEWS

Determination of molecular weights of macromolecules in impure systems

The most commonly employed techniques for determining molecular weights of macromolecules in impure systems are gel filtration and density gradient centrifugation. In gel filtration the separation of substance occurs on the basis of relative molecular size, and the elution positions of the separating components are correlated empirically with their molecular weight. In the light of the recent finding by scientists at the Universities of Tennessee, Knoxville, and Johns Hopkins, Baltimore, that the elution position of a macromolecule on gel filtration does not correlate with its molecular weight, but instead is a function of Stokes radius, the estimation of molecular weight by either the gel filtration or the density gradient centrifugation method is erroneous as it would mean determination of only one of the three independent variables (Stokes radius, sedimentation coefficient and partial specific volume) of the molecular weight equation

$$M = 6\pi\eta\ Nas/(1-\bar{v}\rho)$$

where M is molecular weight; a, Stokes radius; s, sedimentation coefficient; $\bar{v}$, partial specific volume; η, viscosity of the medium; ρ, density of the medium; and N, Avogadro's number.

Researches at the two universities have, therefore, led to a more reliable method of determining the molecular weight of macromolecules in impure systems which combines gel filtration with density gradient centrifugation technique. The third parameter, the partial specific volume, varies over quite a narrow range for most proteins.

The method can also be applied to studies of the structure of enzymes too labile to be purified without structural alteration, of gross conformational changes of proteins, and of the effects of genetic damage upon the structure of specific gene products. In the new method, a calibrated gel filtration column is used for estimating the Stokes radius of a macromolecule present in impure form. The sedimentation coefficient of the macromolecule is determined by the method of sucrose density gradient centrifugation as described by Martin and Ames [*J. biol. Chem.*, **236** (1961), 1372].

Knowing the partial specific volume, the molecular weight of proteins is calculated by the usual molecular weight equation [*Biochem. biophys. Acta*, **112** (1966), 346].

Conversion of olefins to aldehydes — A new method

A new method for the conversion of olefins to aldehydes by ozonolysis, utilizing dimethyl sulphide for the reduction of ozonolysis products (hydroperoxides) has been reported [*Tetrahedron Lett.*, **36** (1966), 4273]. As a typical example, 75 ml. of 0·1 mole of 1-octene in methanol is cooled to −30° and ozonized oxygen gas containing 65·2 mg. of ozone per litre is passed through the solution at the rate of 1·0 litre/min. During ozonolysis the temperature is gradually lowered to −60°. When one molar equivalent of ozone has been absorbed, the system is flushed with nitrogen and 0·136 mole of dimethyl sulphide added. The solution is then stirred at −10° for 1 hr at ice-bath temperature and for 1 hr at room temperature. The solvent is then removed by evaporation and the residue extracted with petroleum ether and water. The petroleum ether solution is washed with water, dried and evaporated; the residue on distillation affords heptanol in 75 per cent yield. Besides the rapidity with which dimethyl sulphide reduces hydroperoxides under mild and neutral conditions, it is highly selective. The other advantages of the reagent include high yields (65-95 per cent), easy removal of unreacted dimethyl sulphide, and easy purification of the products.

A new immunoprecipitation method

A new immunoprecipitation method using paper discs soaked with antigen or antibody, thereby eliminating the tedious procedure of cutting the wells in the agar, has been reported from the University of Tennessee, Memphis. The new method, which is simple, quick and relatively sensitive, can be applied with advantage to both qualitative and quantitative reactions, thereby making the determination of precipitating antibody titres in an antiserum very simple.

For the qualitative immunoprecipitation reaction, paper discs (6·25 mm. diam. and 1 mm. thick) soaked with antigen solutions or antisera for 1-3 hr are placed on the agar plate at the desired distances from each other. After diffusion of the components from the discs into the agar, and the development of precipitation bands is complete, the discs are removed. Agar is washed, stained and the precipitation bands are observed without background staining.

In quantitative precipitation reaction, paper discs soaked in antiserum for 1-3 hr are placed on the agar in the following way (from right to left) at equal distances from each other: (a) 0·1 or 1 per cent antigen solution, (b) antiserum+known amount of antigen, (c) antiserum, and (d) known amount of antigen as in (b). From the top to the bottom discs b and d contain decreasing amounts of antigen. With decreasing amounts of antigen from the top to the bottom, firstly a precipitation band on the right side of b (an antigen excess on disc b), then no band on either side of disc b (zone of equivalence), and finally a band on the left side of disc b (antibody excess on disc b) is observed. The antibody titre can, therefore, be easily calculated from the amount of antiserum required to precipitate a standard amount of antigen in the zone of equivalence [*Life Sci.*, **5** (1966), 1605].

Heat of reaction by ESR

Electron spin resonance spectroscopy has been applied for the

first time for measuring reaction heats. The heat of reaction for the formation of triphenylmethylperoxy radicals by the oxidation of triphenylmethyl radicals was found to be $-9{\cdot}0 \pm 0{\cdot}4$ kcal. per mole. This is the first time the heat of reaction has been measured for the reaction between a hydrocarbon radical and oxygen.

Triphenylmethyl radicals are formed in the lattice of triphenylacetic acid and triphenylmethyl bromide and iodide when irradiated with cobalt-60, and give out a symmetric ESR signal at a *g* value of 2·0024. But when oxygen or air is admitted into the crystal lattice the signal appears at a *g* value of 2·014, indicating the formation of triphenylmethylperoxy radicals. The conversion is 95 per cent complete in 30 min. The reaction is reversible and the equilibrium can be controlled by varying either the temperature or oxygen pressure. The heat of reaction is calculated from the temperature dependence of the equilibrium constant which in turn can be computed from the ESR signal intensities [*Chem. Engng News*, **44** (No. 23) (1966), 48].

Analyses of metals and alloys by gas chromatography

The application of gas chromatography for the quantitative analysis of certain metals, alloys, carbides, oxides, sulphides and salts has been reported [*Chem. Engng News*, **44** (No. 51) (1966), 32]. The samples are fluorinated by elemental fluorine and the fluorides determined by gas chromatography. A research gas chromatograph, modified to include a special stainless steel reactor-injector system with a polytetrafluoroethylene column (22 ft long and $\frac{1}{4}$ in. diam.) and a stainless steel thermal conductivity cell (with nickel filaments) have been used. The column is packed with 15 per cent Kel. F oil No. 10 (polytrifluoromonochloroethylene) on 40-60 mesh chromosorb T (polytetrafluoroethylene). The weighed sample on an electrically heated nickel element is introduced into the reaction cavity and fluorine gas admitted, after evacuating the cavity to remove air. The sample is electrically heated at red heat for 1 min. and the reaction products swept immediately into the column. During analysis care has to be taken to prevent the formation of oxyfluorides. The temperature of the reaction cavity has to be maintained above the boiling point of the least volatile fluoride to be examined. Using this technique quantitative methods have been developed for the estimation of U, S, Se, Te, W, Mo and Re [*Analyt. Chem.*, **38** (1966), 1860].

Isoprene unit in *s*RNA

An isoprene unit has been isolated for the first time from *s*RNA by Dr R. H. Hall of the Roswall Park Memorial Institute, Buffalo, New York. The isoprene containing nucleoside has been identified as N^6-Δ^2 (isopentenyl) adenosine from spectral evidence (IR, UV, NMR and mass spectra), and its identity established by synthesis [*J. Am. chem. Soc.*, **88** (1966), 2614]. This is the first naturally occurring compound with kinetic activity known to be an integral part of *s*RNA.

*s*RNA obtained from yeast was enzymically hydrolysed and the nucleoside isolated by partition chromatography, in an yield of 15 mg. of isoprenyl nucleoside from 60 g. *s*RNA. This nucleoside accounts for 0·1 mole per cent of the total nucleosides from yeast *s*RNA and 0·05 mole per cent in the nucleosides of calf liver *s*RNA.

It is probable that this compound may have the structure of the N^1 isomer in *s*RNA and rearrange to the N^6 isomer during the enzymic hydrolysis involved in the isolation procedure. The full significance of this nucleoside and its role in the biological activity of RNA are yet to be understood [*Chem. Engng News*, **44** (No. 23) (1966), 20].

Bacterial fixation of CO_2

A reductive carboxylic acid cycle for fixing carbon dioxide has been found in the photosynthetic bacterium — *Chlorobium thiosulphatophilum* — at the Dept of Cell Physiology, University of California, Berkeley, USA. The intermediates in the cycle, part of which reverses the Krebs citric acid cycle, have the carbon skeletons of a variety of amino acids. The new cycle converts four molecules of carbon dioxide into one molecule of a C_4 dicarboxylic acid, thus differing from the Calvin cycle for carbon assimilation by photosynthetic cells, which converts one molecule of carbon dioxide into the equivalent of one-third of a molecule of thiose phosphate. The other difference between the two cycles is that while the Calvin cycle provides amino acids via 3-phosphoglyceric acid, the new cycle provides a direct path to amino acids. The reductive carboxylic acid cycle absorbs energy supplied from the reduced ferredoxins, and adenosine triphosphate (ATP). In the cycle, ferredoxin acts directly in the carboxylation of acetyl coenzyme A to pyruvate, which with ATP gives phosphoenolpyruvate. This combines with another molecule of carbon dioxide to give oxalacetate. Succinyl coenzyme A, obtained through oxalacetate and ATP, reacts with ferredoxins and carbon dioxide giving α-ketoglutarate. To complete the cycle α-ketoglutarate gains another carbon dioxide molecule giving citrate via isocitrate. Citrate along with ATP gives acetyl coenzyme A. By single amination, the intermediates, α-ketoglutarate, pyruvate and oxalacetate, could give glutamic acid, alanine and aspartic acid respectively. This pathway has been identified by exposing suspensions of the bacterium to labelled carbon dioxide and identifying the products at various time intervals [*Chem. Engng News*, **44** (No. 17) (1966), 50].

Synthesis of the S-peptide portion of a natural enzyme

A significant portion (S-peptide) of a natural enzyme (beef ribonuclease A) has been synthesized, for the first time, by scientists at the University of Pittsburgh. The synthesized portion is found to compare well in its activity with the S-peptide from natural sources.

The first step in the synthesis of the S-peptide involves preparation of a tetrapeptide, *tert*-butyloxy-carbonylphenylalanyl-*γ*-*tert*-butylglutamylglutamine azide, followed by coupling of the tetrapeptide with the nonapeptide, histidylmethionylaspartylserylseryl-threonylserylalanylalanine *d*-sulphoxide to yield a tridecapeptides.

The decapeptide product is then purified by countercurrent distribution. The purified compound is freed of the *tert*-butyloxycarboxyl blocking group by treatment with trifluoroacetic acid. The tridecapeptide is further coupled with a heptapeptide to prepare a protected eicosapeptide which on treatment with trifluoroacetic acid liberates free eicosapeptide *d*-sulphoxide. Reduction of this free peptide with thioglycolic acid yields S-peptide.

S-peptide is finally purified by first combining with natural S-protein and then chromatographing the resulting partially synthetic enzyme on Amberlite CG 5 [*Chem. Engng News*, **44** (1966), 22].

A new technique for locating double bonds in fats

A microreactor developed at the Northern Utilization Laboratory of US Department of Agriculture, Peoria, enables rapid location of unsaturation in fatty esters and determination of the fatty acid contents of vegetative oils. Unsaturation is located by an ozonization method and the fatty acid contents via transesterification.

The existing methods involving preparation and separation steps are time consuming and require large samples, but with the present technique microlitre samples are reacted (with ozone) in the microreactor and the products injected directly into a gas chromatograph for analysis. The complete analysis is over in 1 hr.

The microreactor, made out of a soldering gun, consists of a copper-encased, $\frac{1}{8}$ in. outer diam. stainless steel U-tube, which fits between the poles of a soldering gun, replacing the gun's tip. A hypodermic needle is fixed to one end of the tube. On the other end is a glass connection and a septum through which the sample is introduced.

For locating unsaturation, 2-5 µl. sample is placed in the microreactor and a stream of ozonized oxygen is passed over it at room temperature. When the reaction is complete, the oxygen flow is shut off and helium is allowed to flow. The outlet needle is inserted on the reactor into the injection port of the chromatograph and the reactor is heated to 250°C. by activating the soldering gun. This decomposes the ozonide and volatilizes the product. The resulting aldehydic fragments are swept into the chromatograph. For the transesterification, used in measuring the fatty acid contents of triglyceride vegetative oils, 2 µl. of oil and 3 µl. of 2·7*M* sodium methoxide (in methanol) are introduced into the microreactor. The reactor is heated to 50°C. for 20-30 sec. and immediately formic acid is added. After removing the excess reagents from the resulting methyl esters (by heating the reactor to 100°C.), the temperature is raised to 250°C. and the esters are swept into the chromatograph in a stream of helium.

This is claimed to be the first method for quantitative determination of the position of unsaturation in complex mixtures, the earlier methods being limited to qualitative determination on a single compound [*Chem. Engng News*, **44** (No. 37) (1966), 21].

A method for isolating mammalian deoxyribonucleic acid

A method for isolating DNA from a variety of mammalian tissues using a small amount of deoxycholate has been described by Dr J. Philip Savitsky and Dr Frieda Stand of Montefiore Hospital and Medical Centre, New York [*Biochim. biophys. Acta*, **114** (1966), 419].

The method involves removing the mammalian tissues, immediately freezing them in solid CO_2 (−60°C.) and storing them in the frozen form. The frozen tissue is weighed and then thawed slowly (30 min.) in a volume of 6 ml./g. tissue of 0·04 per cent sodium deoxycholate + 0·10*M* NaCl + 0·05*M* sodium citrate (*p*H 7) in an ice bath. If the tissues contain much fibrous connective tissue (thymus, spleen, lung) it is necessary to treat the mixture in a Waring blender or Virtis mixer for 10-15 sec. The suspension is then gently ground at 0°C. in a glass-teflon homogenizer to break all the cells. The extent of homogenization required for any tissue is determined by microscopic examination and cell counts. The suspension is then centrifuged at 3000 r.p.m. for 10 min. The supernatant is poured off and the sedimented 'nuclear' fraction washed repeatedly with the same initial volume of the ice-cold 0·04 per cent sodium deoxycholate-saline-citrate solution till the supernatant wash fluid is clear. The supernatant wash fluid should not be even slightly viscous; development of viscosity during washings means that the concentration of deoxycholate is too high and the insoluble DNA-histone is dissociating. The final sediment is extracted vigorously with twice the initial volume of ice-cold 2*M* NaCl for 3 min. at 0°C. The mixture is centrifuged at 4000 r.p.m. for 15 min. The supernatant containing the extracted DNA plus protein is poured into a flask; an equal volume of chloroform-amyl alcohol (10 : 1) is added; the mixture is shaken thoroughly and centrifuged. A total of 10-12 of these deproteinization steps is performed on each DNA extract. The final aqueous DNA supernatant is carefully separated from the chloroform phase and filtered. Two volumes of ethanol are then rapidly added to the cold 2*M* NaCl + DNA solution. The precipitated white DNA fibres are gathered by winding on a glass rod and gently pressing the excess fluid out on the side of the beaker. The fibres are dissolved in NaCl solutions of varying concentrations and in standard buffers (*p*H 7) with shaking (30-60 min.) if necessary. The moderately viscous, clear solutions obtained are filtered and stored in aliquots frozen at −20° or −60°C. The final concentration of DNA in these solutions ranges from 100 to 300 µg./ml.

The method is more effective when frozen-and-thawed tissues are used as the starting material rather than fresh tissues.

Stimulation of activity of chicken liver dihydrofolic reductase by iodine

Six- to tenfold stimulation by iodine of the activity of chicken liver dihydrofolic reductase, the enzyme catalysing the triphosphopyridine nucleotide-dependent reduction of dihydrofolic acid to tetrahydrofolic acid, has been

observed. The sulphydryl groups of the enzyme are believed to be intimately involved in the stimulated activity. This idea is supported by the fact that the pretreatment of the enzyme with iodoacetamide which ties up the sulphydryl group completely abolishes the stimulation due to iodine. The activation of the enzyme was achieved by titrating 200 ml. of crude enzyme eluate with successive increments (0·05 ml.) of 0·016*N* iodine. After each addition of iodine, the activity of an aliquot of the enzyme preparation was determined in the standard assay mixture. At the time of the maximal stimulation (about seven times the initial activity) the enzyme solution was absorbed and eluted from a hydroxylapatite column. The active fractions were combined, precipitated with ammonium sulphate, and immediately desalted through a column of Sephadex-25. The activated enzyme seemed to remain stable.

The iodine is believed to react with the enzyme via a sulphydryl group, presumably through the formation of dihydrofolic reductase sulphenyl iodide and the interaction of this activated form of the enzyme with mercaptoethanol, glutathione and other sulphydryl compounds should yield a mixed disulphide, rather than reliberating the enzyme SH group.

When the iodine-treated enzyme was reacted with mercaptoethanol (10 mmoles) and passed through Sephadex-25, the original enzyme was regenerated. Evidence for this is that both iodine and mercurials activated the enzyme. When the iodine-treated enzyme was reacted with a similar concentration of glutathione, a deactivated enzyme was regenerated. However, it did not respond to iodine or mercurials, indicating that a new form of dihydrofolic reductase, possibly a disulphide derivative, is formed by the action of glutathione. The activation by iodine possibly takes place at a specific site distinct from the catalytic site [*Chem. Engng News*, **44** (No. 41) (1966), 24].

New high energy-density battery

A new high energy-density battery, with a porous lithium anode and an organic electrolyte has been developed by Electrochimica Corp., USA [*Chem. Engng News*, **44** (No. 47) (1966), 24]. The porous lithium anode is made by a special process to ensure that it has a correct degree of porosity to allow high current densities of the order of 100 amp./sq. ft of anode surface. The cathode is made of cupric chloride. The organic electrolyte which replaces the water systems of conventional batteries has a high degree of conductivity and good reversibility towards the electrode reactions. The battery has a theoretical energy density of 503 W. hr/lb.; the net energy density for a 6 amp. hr cell when discharged during 10 hr is 68-72 W. hr/lb. The corresponding values for silver-zinc and lead-acid batteries are 200 W. hr and 60 W. hr/lb. for theoretical energy density and 40-43 W. hr/lb. and 8-10 W. hr/lb. for net energy density respectively. While the temperature range of operation for silver-zinc and lead-acid batteries is 0-130°F., the new battery can operate in the range −40° to 160°F. with Faradaic efficiencies of about 80 per cent. Because of cheapness and abundance of lithium, the new battery may eventually replace the costlier silver-zinc batteries in many portable communication equipment. A rechargeable version of the battery is also under development for use in automobile power systems.

Pediatric Research

This new international journal of human developmental biology is the successor to *Annales Paediatrici* (Vol. 207). Sponsored by the American Pediatric Society, the European Club of Pediatric Research and the Society for Pediatric Research, this new bimonthly commenced publication in January 1967. The journal is intended to provide a medium for presentation of research communications dealing with behavioural, biochemical and structural aspects of human development and developmental biology as well as interpretative studies leading to improved understanding of both morbid and normal processes. The annual subscription for the journal is $ 18.00 for students, interns and resident physicians and $ 25.00 for others. Further details can be had from the Editor, c/o Department of Pediatrics, University of Florida College of Medicine, Gainesville, Florida, USA.

I.I.T. Journal of Mathematical and Physical Sciences

Sponsored and supported by the Indian Institute of Technology, Madras, this new journal, commencing publication in April 1967, will be devoted to critical reviews and short original papers in applied mathematics and theoretical physics. Manuscripts for publication may be addressed to anyone of the executive editors: Alladi Ramakrishnan, Warner Koch, P. M. Mathews, S. D. Nigam or S. K. Srinivasan. The annual subscription for the journal is Rs 60.00 or $ 10.00 for institutions and Rs 20.00 or $ 4.00 for individuals.

British Coal Utilization Research Association

The annual report of the association for 1965 presents an account of the research and development activities of the various divisions during the year. An important development has been the designing of cast iron undergrate baffles for reducing high ash pit losses produced during the burning of low rank washed coals on a vibrating grate. These blocks also prevent overheating.

Two boilers, one of these incorporating a single feed mechanism and a reciprocating de-ashing mechanism to remove ash and clinker, have been tested for the smokeless combustion of coal by 'trickle feed' method. The experiments have resulted in the introduction of the following modifications: modified method of introducing the overfire air; reduction in the size of the combustion chamber to increase the combustion rate per unit area and the relative size of the secondary heating surface. A rapid and continuous thermal conductivity method for the analysis of flue gases for automatic domestic boilers operating with on/off control has been developed.

The addition of fly ash to flue gases has been found to reduce the corrosion of alloy steel water tube

boilers at 745°C.; doubling the effective amount of ash has resulted in 70-80 per cent reduction in corrosion. Experiments using flue gas atmosphere have shown that the corrosion mechanism is the one in which complex sulphates act as a source of SO_3 which will be reduced to sulphide and oxide ions on the metal surfaces. The kinetics of SO_3 formation in the system SO_2-O_2-SO_3, in the presence of various contaminants like nitrogen dioxide acting as catalysts have been studied in static and floating systems up to 1000°C. and mechanisms in both systems elucidated.

Twelve different coals, covering a wide range of rank, have been examined for the weight loss due to thermal decomposition of size graded particles suspended in nitrogen in the temperature range 300-1000°C. and with heating times 30-100 millisec.; it has been found that swelling coals decompose initially much faster than non-swelling coals. No detectable difference was observed between the results obtained in the presence of nitrogen and oxygen.

The following three methods for rapid heating coal have been developed to enable the study of the nature and composition of the primary decomposition products of coal: conduction heating using a stainless steel gauze in which the fine coal is embedded and heated in a few milliseconds by a condenser discharge; radiation heating in about 3 millisec., achieved by a pulse of intense light applied to a small coal particle by means of a flash discharge tube; and feeding coal into a flame so that the carbonaceous products of coal combustion can be readily distinguished from those of the carrier flame. All the three methods involve different heat transfer conditions and the products of decomposition are markedly different. During the investigations on the porous structure of graphites, it has been observed that the heating of nuclear grade graphite brings about an irreversible change in the porous structure from that at the room temperature, resulting in narrowing and even closing of some previously open pores.

To study the behaviour of mineral particles at high temperature, an apparatus has been designed which enables closely graded particles (20-100 μ) of selected minerals to be injected into a flame under laminar flow conditions with residence times that can be varied over the range 10-80 millisec.; experiments are under progress on quartz, kaolinite, muscovite and calcite and the seed materials, potassium carbonate and sulphate, at temperatures 1830-2030°C.

A relative line intensity method, involving measurement of argon spectral lines from a high temperature spinning plasma has been developed to measure the temperatures in the range 5000-10000°C. By calibrating the emulsion using plasma as a light source and using a manually operated micro densitometer, accuracies in the range $\pm$ 9-20 per cent were achieved.

Based on the application of nuclear magnetic resonance a reliable automatic laboratory method has been developed for the routine estimation of moisture content of coals and cokes. A prototype automatic process chromatograph for the analysis of H_2, O_2, N_2, CH_4, CO_2, CO and C_2H_4 within a 10 min. cycle period and at the same time providing quantitative analytical data in a form that can be fed to a data logger has been built for use with p.f. flame test plant.

Announcements

▪ *The Second International Conference on Crystal Growth* will be held at the University of Birmingham, England, during 15-19 July 1968. Basic theory of crystal growth, nucleation, kinetics and transport processes of fundamental importance to crystal growth of metals and non-metals such as electrothermal deposition, and new techniques of crystal growth are the subjects on which contributions will be accepted. Details can be had from Prof. A. D. McQuillan, Dept of Physical Metallurgy and Materials Science, University of Birmingham, England.

▪ *International Association for the Study of Clays* — From June 1966, Comite International Pour l'Etude des Argiles (CIPEA), founded in 1948, has been renamed the Association Internationale Pour l'Etude des Argiles (AIPEA). The association will promote international cooperation in clay research and technology and organize meetings, such as the International Clay Conference and publish the results of clay research. The annual membership fee for individuals is 5 Swiss francs. The association will organize the 1969 International Clay Conference in September 1969 in Tokyo. Clay mineral structures, clay mineral genesis, clay water systems, clay organic compounds and industrial applications of clays are the subjects to be discussed in the scientific sessions. Information regarding AIPEA can be had from Prof. U. Schwertmann, Institut für Bodenkunde der Techn. Universität, Engler Alle 19-21, 1 Berlin 33, Germany. Information regarding the conference can be obtained from the Organizing Committee, 1969 International Clay Conference, the Geological and Mineralogical Institute, Tokyo University of Education, Ōtsuka, Bunkyo-ku, Japan.

▪ *The Kalinga Prize* for the year 1966 has been awarded to Prof. Paul Couderc, French astronomer and author of a number of widely read popular books.

An honorary lecturer in Astrophysics at the Ecole polytechnique, Prof. Couderc has to his credit a number of publications in astronomy, physics and the philosophy of science. His twenty popular science books include *The expansion of the Universe* and *The wider Universe*, apart from one on relativity. Many of these have been translated into several foreign languages including English, Danish, Spanish, Italian, Greek, Hungarian, Portuguese and Japanese. Prof. Couderc has been the Secretary General of the French National Committee for Astronomy (1946-60), Vice-President of the Astronomical Society of France and Vice-Chairman of the Committee on Science of the French Radio and Television Network (1948-60). He was also a founding member of the French Association of Science Writers and an adviser to the Palais de la Découverte in Paris.

▪ *Prof. Dinesh Mohan*, Director, Central Building Research Institute, has been elected President of the Indian National Society of Soil Mechanics and Foundation Engineering for a term of two years (1967-69).

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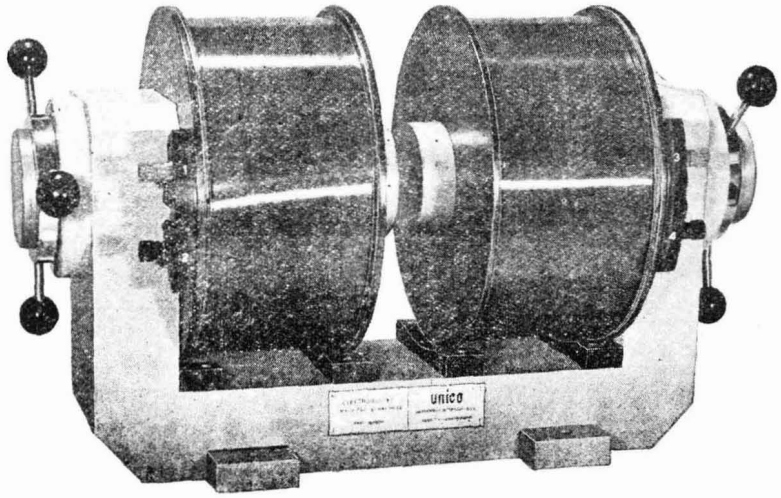

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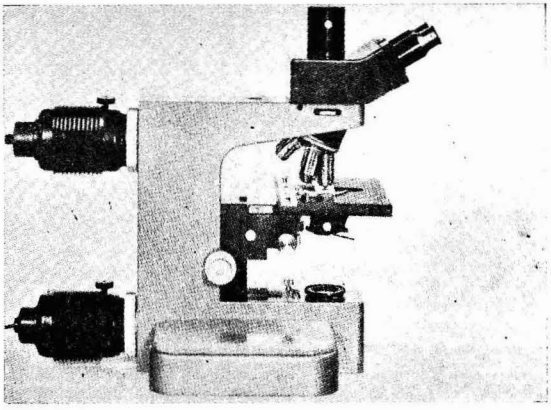

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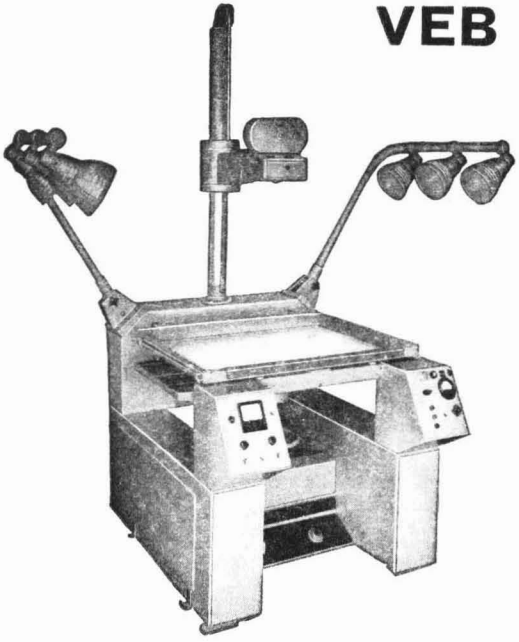

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