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IN THIS ISSUE

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MARCH 1959

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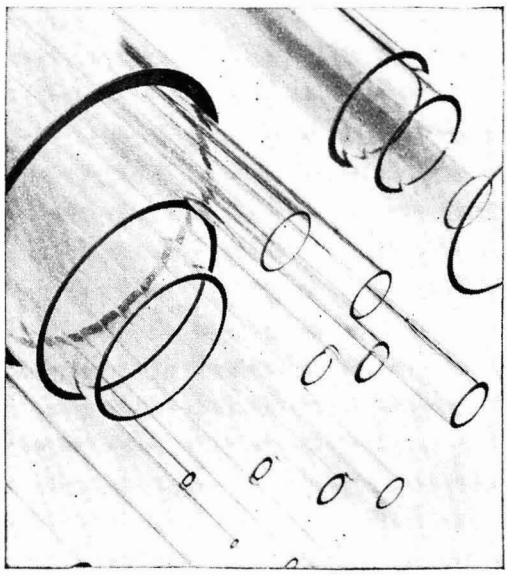

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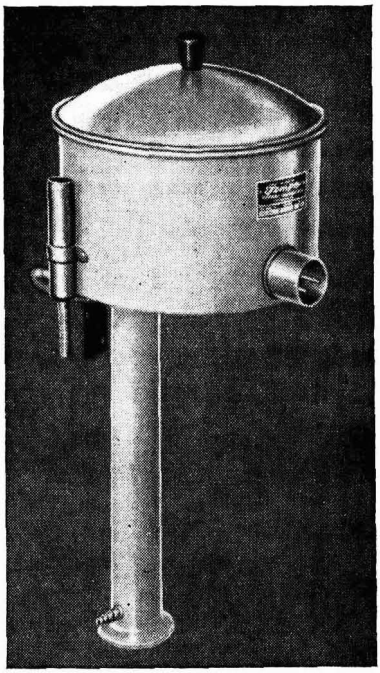

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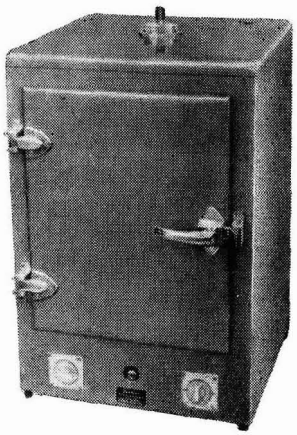

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INDEX TO ADVERTISERS

Current Topics

NATURE OF COAL — A SYMPOSIUM

COAL HAS BEEN THE PRIME SOURCE OF ENERGY FOR over two hundred years, and yet not much is known about the precise nature of coal. Attempts at unravelling the constitution of coal were initiated by Bone in U.K. hardly 30 years ago and a little later a micellar structure for coal was suggested by Bangham. It is only during the past few years that the studies on coal constitution gained impetus and different schools of workers in U.K., Holland, U.S.A., Australia, U.S.S.R. and India became actively engaged in research on the subject. In India, the Central Fuel Research Institute has been devoting its attention to the subject and has achieved certain significant results. It was, therefore, considered expedient by the workers at the Institute to assess the advances made in the field so far and accordingly a symposium on the ' Nature of Coal ' was organized at the C.F.R.I. during 7-9 February 1959. Distinguished scientists from abroad contributed twenty-one papers containing their findings. Nineteen papers came from the Indian workers. In a subsequent issue of this *Journal* a fuller account of the proceedings of the symposium will be presented.

Certain significant conclusions have emerged from the results of researches, though it is obvious that the last word on coal constitution is yet to be said. Studies so far carried out have revealed certain specific patterns in the coalification of vegetable matter. Petrologically two discrete constituents, namely vitrain and fusain, are known in coal: chemically parallel to these are ' disordered ' and ' ordered ' carbons in coal. The disordered fraction consists of alicyclic carbon and some methyl groups, the ordered part being the polycondensed aromatic nucleus which remains little affected during geothermal changes till the coal attains 90 per cent carbon content. The evolution of coal from peat—a sol—to anthracite, apparently takes place in steps of dehydration, decarboxylation and demethylation followed by dehydroxylation. These steps, however, concern the ' disordered ' carbon, petrologically corresponding to vitrain. The alicyclic bodies are confined to vitrain and almost absent in fusain. A significant result of great industrial potential arising from the studies at the Central Fuel Research Institute is the identification of the alicyclic carbon of coal as the coking constituent. By manipulation of this entity in coal, it seems possible to achieve fundamental changes in the property of coal. For instance, it is claimed that by mixing chemicals containing alicyclic structures such as quinine, pitch, etc., a non-coking coal may be transformed into a coking coal.

IRON & STEEL INDUSTRY

THE COMMISSIONING OF THE FIRST BLAST FURNACE at Rourkela (Orissa) and Bhilai (Madhya Pradesh) by the President of India during the first week of February 1959, following close on the heels of expansion programmes undertaken by the Tata Iron & Steel Co. Ltd, the Indian Iron & Steel Works, and the Mysore Iron & Steel Works, stands out as a landmark in the history of iron and steel industry in India. It marks a step further towards the fulfilment of the production target of six million tons of ingot steel by the end of the Second Five-Year Plan. With the Durgapur (West Bengal) plant also going into production by 1960-61, the target for iron and steel would be reached, the shortage of steel in the country would be removed and the needs of the engineering and construction industries would be completely met.

Designed for an ultimate annual production capacity of two million tons of ingot steel, the Rourkela and Bhilai plants will be individually producing at present one million tons per annum. In addition to foundry iron, these plants will be producing a wide range of products: the Rourkela plant will turn out sheets, plates, strips and tinplate, and the Bhilai plant rails, sleeper bars, heavy and medium structurals and billets. The former will be producing steel not only by the open hearth process but also by the L.D. process. Both the plants will be processing the byproduct tar for chemicals, and the Rourkela plant in addition will be utilizing the surplus nitrogen

from the oxygen plant for the manufacture of nitro-limestone.

These developments, significant as they are from the point of view of achieving the targets set for steel production, are of considerable importance in other ways. The establishment of the new steel plants has provided valuable opportunities for the training of engineers, skilled technicians and operators. And, side by side with the establishment of the steel plants, many ancillary and supporting industries are springing up. New steel fabrication and refractories industries are being set up and the existing ones are being expanded and strengthened; heavy machine building, mining machinery and heavy forge plants are being established. All these developments together should give a fillip to engineering industries and enable the country to face the tasks of the Third Plan, with respect to heavy machine tool production, with confidence and reliance on internal resources of men, material and equipment.

Increased output and availability of iron and steel brings with it not only the problems of proper utilization of these metals but also problems concerning the supply of raw materials and their processing. In this context, the 'Symposium on Iron and Steel Industry in India' organized by the National Metallurgical Laboratory at Jamshedpur from 4 to 7 February 1959 was timely. A large number of distinguished scientists and technologists from India and abroad gathered to discuss many scientific and technological aspects of special interest to the Indian iron and steel industry. The present position and future expansion of the industry were discussed and the symposium specially focussed attention on processes for the production of iron and steel employing high or low grade iron ores in conjunction with non-metallurgical or inferior grades of coal and lignite.

A significant development in respect of these problems is the setting up of a low-shaft furnace pilot plant at the National Metallurgical Laboratory which was put into operation on 5 February 1959. The furnace, which is designed to produce 15 tons of pig iron per day, will carry out trials with low and high grade iron ores and inferior grade coals and lignite. The results of the trials will be important as they will indicate the possibilities of establishing steel plants in regions where iron ore and inferior grade coal or lignite are available. They will also indicate the feasibility of producing steel in small-scale units.

In this context the possibility of employing electric smelting processes for smelting of pig iron is of interest since such processes are not dependent on coking coal and permit the establishment of steel plants in areas where iron ore and cheap electric power are available. Tysland-Hole furnaces with a capacity of 100 tons pig iron per day are in operation at the Mysore Iron & Steel Works, and in view of the possibilities of setting up small-scale units, the adoption elsewhere of the direct reduction electric smelting process merits consideration.

Forty-seventh Indian Science Congress, 1960

PROF. P. PARIJA, VICE-CHANCELLOR, UTKAL UNIVERSITY, Cuttack, was elected General President of the Indian Science Congress Association for the year 1959-60. It has been decided that the Forty-seventh Indian Science Congress will be held from 3 to 9 January 1960 at Bombay under the auspices of the University of Bombay. The following office-bearers for 1959-60 were elected: Prof. M. S. Thacker, Dr K. S. Krishnan, Dr B. Mukerji, Dr D. N. Wadia, Dr D. M. Bose, Dr D. S. Kothari, Dr B. C. Roy, Dr Triguna Sen, Dr A. C. Joshi and Dr U. P. Basu (*Members of the Executive Committee*); Dr R. S. Krishnan, Dr V. R. Khanolkar, Prof. P. N. Bhaduri, Dr N. R. Tawde, Dr D. Chakraborty, Dr B. C. Kundu and Prof. Sachidananda Banerjee (*Members of the Council*); Dr A. K. Dey and Dr B. N. Prasad (*General Secretaries*); and Dr B. C. Guha (*Treasurer*).

The following Sectional Presidents were also elected: Prof. V. G. Iyer (Mathematics); Dr C. R. Rao (Statistics); Dr S. Parthasarathy (Physics); Dr Abani Kumar Bhattacharyya (Chemistry); Dr V. S. Dubey (Geology & Geography); Dr S. K. Pande (Botany); Dr H. D. Srivastava (Zoology & Entomology); Dr M. L. Chakravarti (Anthropology & Archaeology); Prof. A. R. Natarajan (Medical & Veterinary Sciences); Dr B. N. Singh (Agricultural Sciences); Dr A. Roy (Physiology); Dr D. Ganguly (Psychology & Educational Sciences); and Prof. N. N. Sen (Engineering & Metallurgy).

Dr Jnan Chandra Ghosh : 1894-1959

THE death of Dr J. C. Ghosh on 21 January 1959 is a grievous loss to the country. The loss is particularly severe to the Council of Scientific & Industrial Research, with which he was connected since its establishment in 1942 and to which he rendered valuable service. He was a Member of the Governing Body of the Council and of the Board of Scientific & Industrial Research. He was actively associated with this *Journal* as a member of its Editorial Board since its inception.

Dr Ghosh was born on 14 September 1894 at Purulia (West Bengal) and had his early education at Giridih (Bihar). In 1909 he joined the Presidency College, Calcutta, where he was a student of Sir P. C. Ray. He had a brilliant academic career and was awarded the D.Sc. degree of the Calcutta University in 1918. The same year he went to U.K. on a Palit Research Scholarship to work with Prof. Donnan at the University College of Science, London. On his return to India in 1921, he was appointed Professor and Head of the Department of Chemistry, University of Dacca. During his stay (1921-39) in Dacca, Dr Ghosh founded active schools of research in photochemistry, biochemistry and agricultural chemistry. In addition to being a brilliant research worker, Dr Ghosh was an excellent teacher, and his lectures were models of lucidity and contained a wealth of information.

Dr Ghosh was appointed Director, Indian Institute of Science, Bangalore, in 1939, which post he held till 1947. He had the foresight to realize that the country needed a large number of highly trained personnel for a fuller utilization of its resources, and accordingly he not only expanded the existing departments in the Institute but also established several new ones including those of Aeronautical, Internal Combustion, Power and High Voltage Engineering and Metallurgy. Towards the end of 1947 he was appointed Director-General of Industries and Supplies. This gave him an opportunity to give shape to his vision of developing industries in India.

In 1950 he became the first Director of the Indian Institute of Technology, Kharagpur, which he built up as one of the best institutions of its kind in the East. Dr Ghosh left Kharagpur in 1954 to accept the post of Vice-Chancellor, Calcutta University, in which capacity he initiated various schemes of development and reform including the setting up of a day home for the students.

Dr Ghosh's researches embrace various fields, viz. photochemistry, electrochemistry, technical gas reactions, catalysis and allied subjects, in all of which he made outstanding contributions. In 1918, while he was a Lecturer in the Calcutta University, he published papers on the abnormality of strong electrolytes — a problem that had baffled physical chemists for years. His most important piece of work in photochemistry relates to an extensive study of chemical reactions on the surface of certain inorganic colloidal photocatalysts under the influence of dextro and laevorotatory polarized light. In the field of techncial gas reactions, Dr Ghosh was a pioneer and he made valuable contributions to the development and improvement of Fischer-Tropsch synthesis. After 1939, Dr Ghosh was engaged in research mostly of an industrial nature which was directed to the production of a variety of industrially important products from indigenous raw materials.

DR J. C. GHOSH

In May 1955 Dr Ghosh was invited by the Prime Minister to join the Planning Commission as Member in charge of Education, Scientific Research and Health. His rich experience as a teacher, scientist, administrator and planner had a great bearing on the policy decisions of the Planning Commission on education, scientific research and other matters. Dr Ghosh was interested in all phases and sectors of educational development including primary, secondary, university and technical education.

Dr Ghosh was associated with the development and activities of various scientific and technical organizations of the country. Together with Dr S. S. Bhatnagar and Prof. J. N. Mukerjee, he was responsible for founding the Indian Chemical Society in 1924 of which he was the President from 1935 to 1937. He was elected General President of the Indian Science Congress held at Lahore in 1939. He was a Member of both the Council and Executive Committee of the Indian Science Congress Association for a number of years. He was the President of the National Institute of Sciences of India in 1943. His association with the Council of Scientific & Industrial Research has already been referred to. He was also

a Member of the Advisory Board of the Indian Council of Agricultural Research and of the Governing Body of the Indian Council of Medical Research. As a member of the All-India Council of Technical Education and as the President of the Association of the Principals of Technical Institutions in India, he was largely responsible for the shaping of technical education in the country. He was the President of the Indian Association for the Cultivation of Science from 1950 to 1954.

Dr Ghosh was a Member of the Indian Scientific Mission to U.K. and U.S.A. in 1944-45 and a Member of the Delegation to Empire Scientific Conference, U.K., in 1946. He represented India at the Fourth General Assembly of Unesco held at Paris in 1949 and at the United Nations Conference on Conservation and Utilization of Resources held at Lake Success in 1949. In September 1956 he attended the International Congress of Catalysis held at Philadelphia and presided over one of the sections.

Honorary Doctorates of several universities in India, including one by his Alma Mater in 1956, were bestowed on him. He was knighted in 1943. The Government of India awarded him the title of Padma Bhushan in 1954.

This account of the scientific life and career of Dr Ghosh gives rather an inadequate picture of the man himself. His life was one of selfless devotion to the cause of scientific research, technical education and industrial development of India. He was the most lovable of men and his outstanding characteristic was his capacity for inspiring affection. He showed an abiding interest in the welfare of his students and he was always referred to by them as their beloved *Master Mahashaya* (teacher). Many of his students have made a mark in the scientific field and are occupying important positions. His students, colleagues, friends and many others who were associated with him will always remember him with deep affection and regard.

K. P. Basu

Conference on Information Processing

An International Conference on Information Processing will be held in Paris from 15 to 20 June 1959 under the auspices of the United Nations Educational, Scientific & Cultural Organization.

The main subjects for discussion at the conference will be: (1) Methods of digital computing; (2) Logical design of digital computers; (3) Common symbolic language for digital computers; (4) Automatic translation of languages; (5) Collection, storage and retrieval of information; and (6) Pattern recognition and machine learning. Each of these six subjects will be the theme of a number of papers by specialists from various countries which will then be discussed in plenary sessions. Seventy-four papers have been tentatively accepted for the conference as recommended by an international screening committee and others were suggested as subjects for study by symposia.

Concurrently with the conference, and scheduled not to conflict with its plenary sessions, symposia will be held on the following subjects: (1) Relationship between digital and analogue computing; (2) Use of computers for weather prediction; (3) Automatic programming; (4) Numerical analysis on computers; (5) Influence of very large memory designs and capabilities on information retrieval; (6) Logical organization for very high speed computers; (8) Linear programming; (9) Logical organization of very small computers; (10) Programming procedures; (11) Switching algebra; (12) Error detection and correction; and (13) Machine translation.

Popular evening lectures on the principles and the applications of electronic calculation have also been planned. An international exhibition of information processing equipment entitled 'Auto-Math 59', the first of its kind to be organized, will be held at the Grand Palais in Paris.

Summaries of Addresses of Presidents of Sections, Forty-sixth Session of the Indian Science Congress, Delhi

FLOW OF REAL FLUIDS

THE mathematical approach to the theory of the flow of real fluids formed the subject of Dr M. Ray's presidential address to the Section of Mathematics (A). The derivation and limitations of the equations of motion and equations of state for real fluids are discussed, and solutions recently obtained for some simple and special cases, e.g. Poiseuille flow through a circular pipe when the coefficient of viscosity (μ) is constant and the Prandtl number (σ) is unity; unsteady flow with suction on an infinite plate; theory of the boundary layer on a flat plate; and laminar motions in plane wakes, have been considered.

The Reynolds number $\left(R = \frac{\rho UL}{\mu}\right)$ and the Prandtl number $\left(\sigma = \frac{\mu C_p}{K}\right)$ (where L the characteristic length, U the representative velocity, ρ the density, μ the coefficient of viscosity, K the coefficient of heat conduction and C_p the specific heat at constant pressure), play an important role in the theory of flow of real fluids. Equations of motion of real fluids are obtained by considering the fluid as a continuous elastic medium so that a system of strain and stress is set up at every point. Stress components are taken as linear functions of strain components and the usual method for finding the equations of motion of an elastic body is applied. The equation of continuity is obtained from the law of conservation of mass and the equation of energy from the law of conservation of energy. These are

$$\frac{D\rho}{Dt} + \rho\Delta = 0$$

and $$\rho\left\{\frac{DE}{Dt} + p\,\frac{D}{Dt}\left(\frac{1}{\rho}\right)\right\} = \frac{\partial}{\partial x_\alpha}\left(K\,\frac{\partial T}{\partial x_\alpha}\right) + \Phi$$

where Δ is the dilatation, T the absolute temperature, D/Dt the usual hydrodynamical operator and Φ the dissipation function. The equation of state is $p = R\rho T$, where R is the gas constant.

In terms of enthalpy $i = C_p T$, the equation of energy reduces to

$$\rho\,\frac{Di}{Dt} = \frac{Dp}{Dt} + \frac{\partial}{\partial x_\alpha}\left(\frac{\mu}{\sigma}\,\frac{\partial i}{\partial x_\alpha}\right) + \Phi$$

These equations are highly non-linear and exact solution of very few problems could be found. The simplest case is the solution for one-dimensional steady flow where we have the well-known equation

$$i + \tfrac{1}{2}u^2 = \text{constant} \quad \ldots\ldots\ldots (1)$$

Illingworth showed that the closed solution for the Couette flow under the gravitational force between parallel flat plates in relative motion can be found in the form

$$i + \tfrac{1}{2}\sigma u^2 = au + b \quad \ldots\ldots\ldots (2)$$

where a and b are constants. Ray found the solution for the Poiseuille flow through a circular pipe when μ is constant and σ is unity in the form

$$i = i_1 + i_0 e^{-\alpha t} J_0(Kr) - i_1 e^{-2\alpha t} + \tfrac{1}{64} e^{-2\alpha t} K^4 r^4 \omega_0^2 (1 + \tfrac{1}{9}K^2 r^2 + \ldots.) + \ldots.$$

where suffix zero indicates value at the centre of the mouth of the pipe, i_1 corresponds to hydrostatic temperature and the constants are given by

$$K^2 = \alpha^2 + \frac{\alpha}{\mu}\rho_0\omega_0,\ J_0(Ka) = 0$$

a being the radius of the tube.

Solution of the problem of unsteady flow with suction on an infinite plate has also been worked out. From the equation of continuity we have

$$\rho = \frac{\partial \Psi}{\partial y},\ \rho V = -\frac{\partial \Psi}{\partial t}$$

and changing the independent variables (t, y) to (t, Ψ) the equations can be much simplified. The solution is

$$i = i_0 + cerf\,(n) - \frac{u_1^2}{2}\{crf\,(n)\}^2 - \frac{16}{3\pi}V_2^1 f$$

where $$f = \int_0^\eta e^{-\eta^4}\left(\int_0^\eta e^{-\frac{1}{2}\eta^4} d\eta\right) d\eta$$

where y is given in terms of η.

The case when Reynolds number is very large leads to the boundary layer theory of Prandtl. For flow over a surface Prandtl assumed that rates of change in the direction parallel to the surface of the

velocity components and their derivatives as well as of the temperature and its derivatives are all small compared to the rates of change normal to the surface. With these approximations Prandtl simplified the equations which, though still non-linear, are easier to handle.

The most important case is the boundary layer on a flat plate. Crocco discovered that when σ is unity, equation (1) is true, no matter what the pressure distribution is but when pressure is constant, equation (2) is true with $\sigma = 1$. He also found the velocity distribution and showed that when $\rho\mu =$ constant, the ultimate equation reduces to the well-known Blasius equation for the corresponding problem in incompressible fluid. Von Karman and Tsien used Mises's transformation to arrive at the same result.

Laminar motions in wakes and jets are another type of problems which can be discussed from boundary layer theory. Toose found a closed analytic solution for a laminar jet behind a cylindrical obstacle taking μ proportional to T. The problem of plane wake has also been worked out.

Taking $u=u_1(1-u_o)$, $i=i_1(1-i_o)$

where suffix unity denotes the value at the edge of the wake and quantities with suffix zero are small, we get

$$u_o = \frac{A}{\sqrt{x}} e^{-\eta^2}, \quad i_o = \frac{B}{\sqrt{x}} e^{-\sigma\eta^2}$$

with $\Psi = 2(\mu_1\rho_1 u_1 x)^{1/2}$, η, A and B being constants. η is also given in terms of y.

'AMOUNT OF INFORMATION' & STATISTICAL INFERENCE

THE presidential address of Prof. A. Bhattacharyya to the Section of Statistics (B) deals with some uses of the 'Amount of Information', a concept originally introduced by Karl Pearson and given new significance by Fisher by putting in conjunction with his principle of Maximum Likelihood (M.L.) in the theory of (point) estimation. The address details how subsequently workers examining this quantity from different points of view have discovered new and important uses for it.

Pearson applied the principle of Maximum Likelihood (M.L.) to get the 'most probable' value of the correlation coefficient from a bivariate normal population and also obtained for its large sample standard error [the population Deviations (S.D.) of the variables being known] an expression identical with the reciprocal of the 'Amount of Information' regarding this parameter. In collaboration with Filon, Pearson found out the Standard Errors (S.E.) of the estimates of a large number of frequency constants, involved in various frequency curves, using the theory of information throughout. However, these S.E. are valid for M.L. estimates only. Realizing this limitation Edgeworth investigated the problem and proved that the M.L. estimates have minimum (asymptotic) variance thus anticipating the later work of Fisher; he also gave a proof of the above result which anticipated the work of Rao and Cramer about the lower bound of variances of unbiased statistics. Wilks in collaboration with Daly considered the problem of shortest average confidence intervals from large samples (which is connected in an essential way with the method of maximum likelihood) and extended the result to the case of estimation of several parameters. Through a different method Wald also arrived at similar results and extended them to several parameters. Aitken and Silverstone considered the problem of unbiased statistics with minimum variance. Bhattacharyya extended the results of Aitken and Silverstone and gave a more general method of deriving such statistics. Closely related with the above problem is the problem of determination of the lower bound of the variance of unbiased estimates. Rao and Cramer independently found a lower bound of the variances of unbiased estimates — the so-called Rao-Cramer inequality. Cramer also examined the problem of the simultaneous estimation and found some bounds for the concentration ellipsoid. Bhattacharyya introduced certain generalized information coefficients and improved upon the Rao-Cramer inequality. Wolfourtz extended the Rao-Cramer inequality to sequential analysis and Seth did the same for Bhattacharyya inequalities.

The concept of statistical divergence has some relation with the quantity under consideration. Mahalanobis developed the concept of generalized distance. An expression of general applicability has been given by Bhattacharyya. An alternate method of finding the distance between two statistical populations of the same form but differing in the values of the parameters is due to Rao. Though different from the classical quantity introduced by Fisher, it is worth mentioning the work of Solomon Kullback and his associates who derived many interesting and useful results from their studies by considering a different quantity called 'Information'.

ELASTIC WAVE PROPAGATION IN FLUIDS

THE presidential address of Dr A. K. Dutta to the Section of Physics (C) gives a connected account of the work carried out in recent years on elastic

wave propagation in fluids. The anomalous experimental results obtained and the theoretical interpretations advanced by several workers have been discussed in detail with reference to his own findings.

Experimental verification of some of the unexpected and peculiar phenomena observed in the case of elastic wave propagation in fluids, e.g. flow of the medium, has not been possible using sound waves because of their very long wavelength. Velocity determination in liquids was restricted in the beginning to the case of water only for obvious reasons. The advent of ultrasonics made possible the experimental determination of the velocity and attenuation of the short wavelength elastic waves in fluids. In such experiments involving h.f. piezoelectric oscillations of quartz, a strong quartz-wind, that is a flow of the medium, was also noticed, along with the propagating waves. The experimental results, however, were, in many cases, not in accordance with the theoretical relations. A constancy of the velocity value in any gaseous medium, under definite conditions of temperature and pressure, was expected in view of the Newtonian relation

$$V^2 = \frac{dp}{d\rho} = \frac{\gamma p}{\rho}$$

It has been observed that the velocity of the waves in gases shows a dispersion, changing from a lower value to a higher value, at a particular critical high frequency. Also, attenuation in most of the liquids is, generally, much larger than that calculated by Stokes' relation. The departures in some particular cases, like benzene and carbon disulphide, are much too large compared to other liquids, whose known physical properties are not so divergent as to give rise to the observed differences in the departures of absorption. Thus modification of the earlier theories became necessary.

A relaxation mechanism proposed by Herzfeld and Rice, Kneser and Rutgers to explain the dispersion and anomalous absorption observed in gases envisages that the molecules get some of their vibrational states excited by the energy of the elastic wave, provided the frequency of vibration is comparatively small, that is, the time period is large. When, however, the time period is too small, so that the energy cannot be assimilated, the vibrational states are not excited. This theory of relaxation mechanism explains the anomaly in the case of gases more or less satisfactorily. Dutta and Ghose and Kneser considered that the same relaxation mechanism would serve to explain the anomalous absorption in the case of the liquids also. On a critical analysis of the data, however, it became evident that it was not so. A new theory proposed by Eckart and supported by Rosenhead on the basis of experimental results of Liebermann explains the anomalous absorption as due to a second viscosity coefficient or bulk viscosity coefficient, which had so far been not taken account of in hydrodynamic equations on the ground that the bulk viscosity property is not expected in the case of the liquids. Eckart proposed that the flow of the medium is a second order effect due to bulk viscosity and when the velocity of the flow could be determined, this coefficient could be known and, thus, also the absorption associated with it. Rosenhead attempted to show that on this basis Liebermann's experimental results could explain the anomalous absorption.

Further theoretical work on these lines by Markham, Piercy and Lamb and Nyborg has shown that the flow is not necessarily linked up with the second viscosity coefficient. It could be associated with any other form of absorption also and thus the new postulate of this extraordinary viscosity was unnecessary. Nyborg has also shown that the flow would require a superposition of the waves and an elementary wave form would have no associated flow. It indicated that an elementary wave form, even if strongly absorbed, should not give rise to a flow. Therefore, for an elementary wave, any particular type of absorption mechanism which could give rise to flow and hence to observed anomalous absorption, could not be considered. A different theory, supported by some experiments, has been proposed by Dr Dutta who considered the mechanism of propagation from the standpoint of intermolecular forces. The theory developed by him led to the conclusion that, working with an optical analogy, a wave group generated in the liquid medium could be obtained for elastic waves. The correct nature of absorption mechanism, however, could not be explained on this theory also. It became necessary to undertake more detailed experimental study on the nature and character of absorption.

Measurement by Dutta and Samal of the heat energy developed in a double-window thermostatic chamber, as a result of comparatively small length of the ultrasonic beam, has shown that the absorption coefficients, obtained by this method of procedure, were peculiarly different from the absorption coefficients obtained by other methods. Experiments on these lines have pointed out some curious effect of thin partitions of material on the nature and properties of the wave system passing through it. This has, since, been studied critically by a different procedure. Radiation pressure and the intensity of flow on cellophane discs suspended in the field, with auxiliary partitions interposed, have been

measured. From these observations has emerged the curious finding that imposition of a number of thin partitions cuts off the propagating elastic waves by unequal steps; the transmitted energy through the third partition remains unaffected and it continues through the fourth partition without any attenuation. The total energy, thus, passing through four partitions is about 50 per cent of the value without partitions. For a strongly absorbing liquid like benzene, although the fourth partition does not affect the transmitted energy through the third one, the amount of energy passing through is only about 30 per cent of the unrestricted beam. From this it can be concluded that the elastic beam consists of a system of non-homogeneous waves with a main core of the homogeneous group and the liquid itself is a contributory factor in the creation of this non-homogeneity of the wave system. It has also been determined by a study of the diffraction spectra of the sound-beam-grating, which is unobstructed or transmitted through a number of partitions, that the whole group of the associated non-homogeneous group lies within a close range of frequency, so that they jointly contribute to the intensity of the spectra, with only an extra-broadening effect. It appears that the anomalous absorption is caused by a gradual spreading of the waves which contributes to the flow of the liquid and is lost to the beam. It has also been observed that the flow of the beam, studied with the help of a suspended single cellophane disc, does not bear a constant ratio with the vibrational energy, obtained from the difference of intensity through a double cellophane and a single cellophane disc. The ratio decreases rapidly to an almost negligible value from a single to a three-partition system. When the ratios for different liquids are measured, it is observed that a strongly absorbing liquid like benzene shows a much higher percentage of flow in relation to vibrational energy, compared to the percentage for a liquid with a lower absorbing power. These observations link up the flow of the medium with the superposition of the non-homogeneous group of waves, and when the non-homogeneous group is eliminated after three partitions, the flow of the liquid also tends to vanish. This is in good accord with the theoretical prediction of Nyborg and appears to explain the inconsistencies observed in both the mechanism of flow and anomalous absorption.

The mechanism of the propagation of elastic waves in a liquid medium appears, thus, to be of a very peculiar nature and of a completely different character than visualized by earlier workers. The experimental observations and their explanations presented harmonize all aspects of elastic wave propagation in a liquid medium.

DEVELOPMENTS IN HIGH POLYMER SCIENCE

IN his presidential address to the Chemistry Section (D), Prof. S. R. Palit has dealt with some of the recent advances in the field of high polymers with particular reference to the contributions made by Indian workers. Tracing the growth of polymer science, reference was made to the pioneering work of Emil Fischer on polypeptide synthesis, synthesis of oxytocin by du Vigneau who got the Nobel Prize for his work in 1955, Sangar's work on the giant insulin molecule and to contributions of Staudinger and Todd. Technical production of butadiene and its polymerization to synthetic rubber by Lubedev was also referred to. In the industrial front many technically important high polymers, namely plastics, resins, rubbers and fibres, bakelite, ureas, melamines, alkyds, epoxy resins, polystyrenes, polymethyl methacrylates, etc., have made their appearance.

The process of polymerization takes place by the two fairly distinct mechanisms: polycondensation and addition polymerization. The process of formation of commercially important polycondensates like bakelites, ureas, melamines, alkyds, maleics, nylons (polyamides), terylene (polyesters), epoxy resins, etc., is well understood. The development in 1946 of the linear polycondensate of terephthalic acid and glycol, the 'Terylene' or 'Dacron' of commerce, was a great stride forward. This polymer has been lately developed under the trade name 'Mylar' in the form of films. Gold and silver can be vacuum deposited on mylar film without affecting its transparency and many decorative effects on textiles and upholstery are possible.

In the field of polycondensates interesting work has emanated from Indian researchers. The finding that an insoluble polycondensate containing acidic or basic groups can be titrated in suspension to obtain information about the molecules including information on faults (laecherstellen) in its three-dimensional structure and sometimes its D.P. (degree of polymerization), has opened up new avenues of investigation. Bakelite type mouldings from molasses, oil seed cake and agricultural wastes have been developed in the laboratory and their commercial possibilities need study.

Researches on addition polymerization in India have been mostly limited to kinetics of polymerization. Spreading properties of macromolecules on water, physical chemistry of polyelectrolytes including their chromatic interaction with dyes, viscosity of polymer solutions, quantum mechanical calculation by localization approximation of the energetics of the propagation reaction are other fields of study engaging the attention in India.

Initiation, propagation and termination, the three steps in the mechanism of chain polymerization, have been investigated. In initiation, the ' cage effect ', i.e. the preferred reaction of the radical pair formed in the solvent cage before they diffuse out, is the problem of current interest. Lately much work has been directed towards determining the efficiency of utilization of the free radicals formed by the decomposition of the initiator. The propagation step, namely the growth of the active centre, has been investigated under intermittent illumination by the rotating sector technique to get the absolute values of the propagation rate. In the termination step, the question which is widely debated currently is whether termination occurs by disproportionation or by combination. The experiments brought to bear on this problem are based on either some kind of end groups analysis or of molecular weight distribution. In contrast with initiation, propagation and transfer, the termination reaction involves two units both of which are highly polymeric.

Recently some new developments in the field of high polymers are reported which relate to (i) graft and block polymers; (ii) living polymers; (iii) synthesis of protein analogues; (iv) application of radioelements; (v) trapped free radicals and (vi) stereospecific polymers. Besides these, a few interesting novel polymers which are under various stages of development are: polyvinyl fluoride in the form of films; hard polycarbonates; synthetic wool fibres; and organic polymers of high melting point.

NATURE & ORIGIN OF ANORTHOSITE ROCKS

THE presidential address of Dr S. C. Chatterjee to the Section of Geology and Geography (E) was devoted to a discussion of the problem of anorthosite rocks, with particular reference to anorthosite rocks of Bengal. The subject is dealt with in two parts: the first part briefly reviews the various views advanced by different earlier workers on the nature and origin of anorthosites and in the second part, the results obtained on Bankura (Bengal) anorthosites have been discussed, in the light of the recent and new geological and geographical evidences. Dr Chatterjee arrives at the conclusion that while it is possible that the anorthosite bodies in other countries may be of metasomatic origin the Bankura anorthosite mass was originally igneous in origin.

The anorthosite rocks, a group of supposedly igneous rocks composed mainly of plagioclase feldspars, posed no problem till Bowen's experiments revealed that the melting temperature of the plagioclase feldspars is about 1400°C. and that the rocks do not show any evidence of contact effect. Bowen, therefore, postulated that the anorthosites were formed not from a molten magma of the same composition but from a gabbroic or basaltic magma from which plagioclase crystals were precipitated at a certain temperature and that these plagioclase crystals settled towards the bottom of the magma chamber under the influence of gravity. The residual magma formed granitic rocks overlying the anorthosite mass. Later it was suggested by Grout that the plagioclase feldspars had floated up towards the top of the magma reservoir near Pigeon Point in Minnesota. Mathias has recently advocated the flotation of feldspars in a South African anorthosite. Another view is that the anorthosite rocks are due to the metamorphism of calcareous and argillaceous sediments and metasomatic transformation of these rocks by the influx of alkalies, etc. This view has been supported by Prof. Ramberg of Chicago University and recently by Prof. Tom Barth of Oslo University. Prof. Michot of France believes in a dual origin for the anorthosites of Madagascar.

A large anorthosite body in the northern part of the Bankura district south of the Raniganj coalfield, occupying an area of about a hundred square miles, has been studied by Dr Chatterjee. The intrusion probably occupies a much larger area beneath older rocks since there are outlying patches of anorthosite rocks in the neighbourhood. The intrusion appears to be sheet-like in structure and consists of a mass of plagioclase crystals with more or less ferro-magnesian minerals. The feldspar crystals lie with their largest faces parallel or sub-parallel and in a vertical plane. The rocks have a well-developed planar and linear parallelism in many outcrops. The igneous origin of this anorthosite body is proved, by many structural and microscopic characters. There are intrusive dykes of anorthosite in the gneissic country rocks and inclusions of gneiss in the main anorthosite mass. Under the microscope the plagioclase feldspars appear to be mainly labradoritic in composition. The prevalence of Carlsbad twins relict ophitic texture, protoclastic marginal granulation, etc., indicates that the rocks had formed from a magma of anorthosite-gabbro composition. While the rocks of this area may be primarily magmatic in origin, they have undergone regional metamorphism by which olivine in olivine norite has developed reaction rims of hypersthene, hornblende and garnet. The rocks have also undergone cataclastic and hydrothermal metamorphism seen by the abundant development of epidote, scapolite, calcite, etc. The anorthosites are cut by numerous dykes and veins of a dark coloured granulitic gabbro or norite which seem to be

due to segregation of basic minerals in the magma and subsequent intrusion.

Recently experiments in the system anorthite-diopside with water vapour, carried out by Yoder, have shown that in the presence of water vapour under considerable pressure, anorthosite magma may remain molten down to ordinary temperatures, and variation of pressure may cause alternate precipitation of plagioclase and diopside. Anorthositic magmas may not, therefore, show contact effect on the intruded rocks. In view of these results of experiments and the field and laboratory evidence, it is believed that the anorthosite mass of Bankura was originally igneous in origin. This does not rule out the possibility that certain other anorthosite bodies in other countries may be of metasomatic origin.

ECOLOGICAL FACTORS & PLANT DISTRIBUTION

DISCUSSING some of the fundamental aspects of the relation between ecological factors such as environment, adaptation, etc., and plant distribution in the light of the recent researches carried out in India, Prof. R. Misra, in his address to the Section of Botany (F), expressed the view that experimental investigations into the role of these ecological factors will ultimately solve most of the existing anomalies concerning the distribution of plants. Prof. Misra felt that Indian workers are mostly engaged in describing the vegetation of the country and apply to it ecological concepts developed in other countries, and that an experimental analysis of Indian material would be more rewarding and would yield interesting results. To enable Indian workers to pursue investigations in this field, Prof. Misra pleaded for the establishment of a chain of field stations where plants can be grown under different environmental, soil, climatic and other conditions for carrying out specific studies.

The mechanism of plant distribution is a complex process which depends upon their adaptation and environmental characters. Experimental ecology, which is able to explain this mechanism, consists of two steps: (1) field observations wherein problems of distribution are formulated in order to explain the occurrence of plants in relation to environmental factors and associated phenomena and (2) cultivation of plant under controlled environmental conditions.

The distribution of rooted aquatic plants has been observed to be dependent upon the physical and chemical characters of the sub-stratum. This fact is supported by transplant experiments and chemical analysis of the plants and the soil. Decomposition of organic matter under sub-aqueous conditions plays important role in determining nutrient status and reducing conditions of the soil. Marsh plants have been shown to stand wide fluctuations in moisture content of the soil — many of them growing under water in the beginning and finally emerging as mesophytic plants. In case of seasonal ponds most of the species are distinct for the aquatic and the dry phases of the habitat. The latter have been shown to possess seeds which can germinate only after a period of embedding in mud under water. Diurnal extremes of temperature as found in September-October in northern parts of India also favour their germination. Since transplants have successfully grown on normal soil, it is clear that the distribution of those plants is controlled by the germination behaviour of the seeds.

Different mechanisms have been observed in the distribution of plants found on lime-rich soil (calciphytes). The calciphytic ecotype of *Lindenbergia polyantha* Royle is capable of accumulating calcium in the tissue. Some plants grow there not for the calcium but for higher *p*H value which immobilizes the toxic aluminium present in the soil. A metabolic interaction between calcium and phosphorus in the plant tissue is suspected in teak (*Tectona grandis* L.f.) which is generally found on soils rich in exchangeable calcium. The seeds of the non-calciphytic ecotype of *Euphorbia thymofolia* L. would not germinate in lime-rich soil. Finally plants like *Sida acuta* Burn. and *Anisochilus eriocephalus* Benth. are driven to lime-rich soils on account of their susceptibility to interspecific competition as they can be cultivated easily on any soil with weeding and protection management. The mechanism of distribution of plants is also related to soil nitrogen. Interaction between soil nitrate and light intensity has been demonstrated to affect the distribution of *Peristrophe bicalyculata* Nees. This plant is found in exposed habitat with low soil nitrate and under shade on nitrate-rich soil. In the latter case the plant is able to assimilate higher doses of nitrogen. Many other characters of the soil, such as porosity, erosion, deposition, water logging, etc., have been shown to control the distribution of species effectively. The adaptational features, both structural and physiological, are quite interesting.

Climatic and biotic factors are potent in the distribution of all the plants and vegetation types. The climax vegetation of India is mostly forest except for the high altitude Himalayan meadowlands. But on account of biotic interference, the forest has yielded to grassland at many places. A study of the bio-ecology of these grasslands has revealed a wide floristic flux in relation to the type and intensity of the biotic pressure.

The experimental approach to the study of ecology has been helpful in solving most of the problems of plant adaptation and distribution. The nature of the environment has also been revealed by experimental methods. Many of the syn ecological problems regarding community structure and organization have yielded to the experimental method. In India, ecological studies have so far been mostly confined to descriptive work. The introduction of experimental methods demands the establishment of a large number of field stations with facilities for controlling environmental conditions. Culture rooms, called 'phytotrons', have been established at the California Institute of Technology, wherein plants can be grown in any desired climatic and nutrient conditions. Realizing its utility in the solution of many botanical and agricultural problems, a chain of these units has been erected in the temperate countries. But no such station exists anywhere in the tropical region of the world. The installation of such a unit in India with facilities for collection of wild plants would go a long way in providing the much-needed impetus to ecological research in the country.

INLAND FISHERIES IN INDIA

ONE of the urgent and vital problems facing India today is the problem of augmenting food production to meet the needs of a rapidly increasing population. The present rate of food production is quite inadequate and new ways of increasing food production are being actively pursued. In this context, the presidential address of Dr B. S. Bhimachar to the Section of Zoology and Entomology (G) on the development and problems of inland fisheries in India is timely and opportune. Potentially, India is a very rich fishery country, with respect to both inland and marine fisheries, and the development of the vast fishery resources on a planned basis would go a long way in making up the gap in our food production and also in providing the much-needed protective foods and protein. Dr Bhimachar appealed to his fellow workers to 'take interest in fisheries research and to the administrators and planners to accord fisheries the high place it deserves in the national development programmes.

The inland fishery resources of India are large and varied. There are extensive river systems all over the country with a vast network of irrigation canals, reservoirs and tanks. There are large number of ponds, *jheels*, swamps and vast brackish water lakes and extensive estuaries. Potentially the inland fisheries of India are among the richest in the world but adequate attention has not been paid to develop them. There are no conservation measures in force on the capture of fish in rivers, lakes and estuaries, and fish culture operations are not sufficiently well organized. Large masses of fertile cultivable waters are at present lying fallow. In spite of these drawbacks, fish production from inland fisheries is appreciable, indicating the richness of the fisheries. At present India produces, from marine and inland water resources, a little over a million tons of fish per year and ranks eighth among the fishing nations of the world.

It is estimated that the production of fish from inland water resources is about a third of the total production and the national income from it is high. The inland fisheries have a significant and important role in the rural economy of the country and fish culture could provide the rural population with a subsidiary occupation and additional income. In this respect fish culture acquires the status of a cottage industry and every encouragement should be given to its development. In recent years there has been a widespread recognition of the need for the development of fisheries both by the Central and State Governments, and a large number of research and development projects are being implemented under the Five-Year Plan programmes. Extensive fisheries survey and research are, however, needed to develop the fisheries in the country on sound lines and many basic problems have to be tackled and solved such as cultural techniques and conservation measures which have a direct bearing on development problems.

The riverine resources of India are highly diversified. Many of the riverine resources such as the Brahmaputra river system and Mahanadi river system have not been fully exploited. A fuller utilization of the available resources would augment fish production in the country a great deal. The need for conserving riverine fisheries is becoming increasingly important and measures such as prohibiting destructive methods of fishing, fishing in certain sections of the rivers, capture of young and brood fish are coming into force, and sanctuaries are being established for providing protection to spawning fish. Introduction of suitable species of fish and acclimatizing them and reduction of pollution of rivers from factory effluents are other problems which need attention. The large number of reservoirs formed as a result of dams constructed across the rivers constitute the bulk of lacustrine fisheries in India and considerable work is being done in such reservoirs towards the development of fisheries. In some reservoirs, e.g. Mettur, about 400 tons of fish are harvested annually. Stocking the reservoirs with suitable fish, clearing them of submerged tree stumps to facilitate fishing and colonization of fishermen are some of the

problems which need attention. The construction of dams across rivers affects fisheries due to environmental causes and due to obstruction to the movement of fishes. The former problem necessitates a detailed investigation of the fish population in the area. To prevent obstruction to fish migration by dams suitable measures have to be taken to enable the passage of fish upstream, particularly in the lower reaches of the river. For instance, the proposed Farraka barrage across Ganga may affect the important *Hilsa* fishery unless suitable fish passes are provided.

One of the main features of estuarine fisheries in India is that their exploitation is unbalanced. Measures should be taken to avoid over-exploitation in such areas as Sundarbans, and in cases where the area is under-exploited such as the Mahanadi estuary, suitable steps should be taken to develop fishing. The problem of silting is a serious one in estuarine fisheries and periodic dredging has to be carried out. The practice of catching young and immature catches should also be strictly prohibited.

The yield of fish from impounded fresh water ponds in low lying deltaic regions hardly exceeds 500 lb. per acre in spite of the fact that these waters are highly productive. This has been attributed mainly to backward and wasteful methods of pond management practised. The methods of fish culture practised in brackish waters are far from intensive and the yields are of the order of 150-500 lb. of fish per acre. The layout of the fish farms in these areas has to be improved and selective stocking of fish has to be introduced to weed out uneconomic fish. The possibilities of fertilizing the brackish water ponds with cheap fertilizers have to be explored. Improved nursery pond management methods have been evolved and based on these, it is now possible to obtain high yields from nursery ponds and transport the catch over long distances with negligible mortality.

An assured supply of pure and quality fish seed is an essential prerequisite for the successful large-scale cultivation of fish. The present system of collection and distribution of fish has several drawbacks: the resources are limited to localized areas and transportation of live fish is expensive, and spawn collected from rivers contain several species of uneconomic fish. These problems have been overcome by the methods developed for the successful breeding of major carps in confined waters by injecting pituitary hormones. Large quantities of fish seed have been produced by this technique on a commercial scale in Assam and Orissa and the method can be employed in all parts of the country. A survey of the chemistry of pond soils has shown that the variability in the productivity of the ponds is largely due to differences in the chemical composition of the soils and not the dissolved nutrients. Since the growth of benthic algae, the food of the fishes, depends on the available soil nutrients, more attention has to be paid to these aspects.

A beginning for the reclamation of swamps for fish culture has been made in Orissa State and it would do well for other States to follow the example. There are instances in India where high production of fish has been achieved in sewage-fed tanks and sewage is also employed to manure fish ponds. The utilization of sewage for fish culture has to be explored more intensively.

Fisheries research and development plans depend largely on fisheries statistics. Though much progress has been made to collect statistical data for marine fisheries, so far it has not been possible to obtain data for the inland fisheries because of its highly dispersed character. Detailed surveys have to be undertaken to assess the water areas under capture and culture fisheries, the extent of present exploitation, the area now being used for fish culture, fisherman population, and fishing craft and gear.

THE NEOLITHIC PATTERN OF INDIA

IN his presidential address to the Section of Anthropology and Archaeology (H), Prof. V. D. Krishnaswamy attempts a fresh appraisal of the Neolithic culture in India on the basis of the excavations carried out during the last decade which have provided convincing proof of the existence of a distinct Neolithic pattern in India, contrary to the belief of some western archaeologists. Prof. Krishnaswamy states in conclusion that " we have evolved our own Neolithic pattern of India, partly influenced by a West Asian Neolithic culture, partly by the Harappan culture, partly by the Far Eastern Neolithic culture, and partly of autochthonous origin ". Further excavation in the various regions, especially in Eastern India, will provide a better understanding of the new pattern that is beginning to appear as a result of the research work that is being carried out on the subject.

The primary trait that sets the Neolithic culture apart from other Stone Age cultures is that of intentional food production as opposed to mere food-gathering for subsistence. The secondary traits are disclosed by pottery and smoothed stone tools. An analysis of the characteristics of tools, pottery and other implements collected from various sites during excavations points to the existence of four types (A, B, C and D) of regional Neolithic cultures in India.

Culture A, restricted to Western Madhya Pradesh and Western India, coextensive with the Deccan trap region, is chalcolithic in character and is characterized by parallel-sided ribbon flake blades, painted pottery and copper artefacts of post-Harappan phases of Western origin. Closer to the Karnatak region in the South, it absorbs the polished stone axes of the second culture (B) spread all over the South. The urban parallel-blade industry is further galvanized by the earlier hunting type of microlithic phase, characterized by the lunates and trapezes with steep retouch. This galvanization has become patent in the blunted backed blades, that persist side by side with ribbon flakes. It is interesting that such an impact did not take place in the later Harappan sites of the Kathiawar peninsula, just outside the (chalcolithic) neolithic cultural regions of Central and Western India.

Culture B, centred in Karnatak beyond the Deccan trap region, is characterized by pointed butt type of axe which apparently originated in the region itself. In its earlier phase, it is related to the post-palaeolithic flaking technique, arising in a microlithic milieu. Latterly, it got absorbed in the post-Harappan ribbon flake and the painted pottery and copper celt traits of culture A.

Culture C is restricted to Eastern India, with indications of three phases overlapping each other. The earliest phase is the rounded butt axe showing chipping, grinding and polishing, without any relationship with the pre-existing microlithic culture of the region as in the Karnatak and in Central and Western India. The second phase is characterized by faceted and square-cut tools involving a metallic technique of manufacture. Closely linked with this is the third phase of the copper hoards of the Gangetic basin and of Gungeria in Madhya Pradesh with tools similar to the types of the second phase. The origin of the first two phases appears to be located in the South-east Asia in Indo-China and Malaya in real archaeological complexes. The first phase shows great antiquity in South-east Asia and, therefore, the rounded butt type of axe has spread uniformly from South-east Asia to Chota Nagpur. The second phase, characterized by faceted square-cut tools, shows an irregular distribution in Eastern India. There are faceted tools of Malaya in Assam along with the shouldered hoe. In Bengal, Bihar and Orissa, the faceted type of tool is absent, but the shouldered hoe, the bar-celt and the rectangular chisel with quadrangular section are similar to those of Malaya, thus showing a maritime influence and even indicating the introduction into India of the plough for rice cultivation. This phase was closely followed by the copper hoards of the Gangetic basin and Gungeria which exhibit, in metal, the same type of tools as in stone (including the bar-celt) found in Chota Nagpur.

The fourth region (D) where indications of the existence of Neolithic culture have been obtained lies in Kashmir where pointed butt axes with hand-made buff and grey ware have been found. This culture was succeeded by the post-Harappan Jhangar culture characterized by black polished ware and shreds with incised geometric design.

VETERINARY RESEARCH & FOOD PRODUCTION

THE importance of the role of livestock in the building up of our country's economy, status of livestock in food production, improvement in quality and productive capacity of the livestock through research formed the subject of the presidential address of Dr P. G. Pande for the Section of Medical and Veterinary Sciences (I). It is an admitted fact that no country in the world has achieved self-sufficiency in food, both quantitative and qualitative, through the production of cereals alone. Integrated agriculture aiming at production of foods of animal origin, viz. milk, meat, eggs and other products, has much to commend and our land resources have to be apportioned for growing food crops and raising livestock. The present pattern of land utilization has to be reoriented simultaneously with the execution of the various plans of development in the field of animal husbandry so that the potential wealth of our livestock may be fully exploited for the development of our country's economy. Cattle in India hold the most strategic position as animal labour is a potent factor in the production of plant foods. In the ultimate analysis, it is the efficiency of animals that determines the country's capacity for food production.

The essential requirement for building up the productive capacity of our milch stock is the dissemination of superior genes from approved and pedigree bulls. With increasing use of the artificial method of insemination, the country could soon attain self-sufficiency in the matter of high quality stud bulls. The attainments of these targets would provide strong launching ground for achieving still higher targets of production in these fields.

Veterinary research in this country also has made some notable contributions to the nation's agriculture and food supply. Epizootics of rinder pest in cattle, buffaloes, sheep and goats, which formerly used to sweep over the country and take a toll of about two lakhs of animals annually, are gradually being brought under control by the use of goat tissue vaccine

developed for the first time in this country at the Indian Veterinary Research Institute, Mukteswar. An eradication programme now initiated in every State with the financial assistance from the Indian Council of Agricultural Research has made it possible to control rinder-pest incidence. Similarly a reliable vaccine against Ranikhet disease of poultry, also developed at the Indian Veterinary Research Institute, is being widely used in India and abroad for the control of this disease.

Research in veterinary sciences is largely confined to some of the central institutions. In a vast country like India with varying geo-climatic conditions, there is a need for organizing research on animal husbandry at all the three levels, i.e. Central, State and Regional. Every State should have a livestock research station to conduct investigations into problems of local importance, provide a feeder service to the regional and central institutes and undertake application of results of their own researches and those of the central institutes and their regional sub-stations. It is envisaged that a chain of research stations spread over the whole country will offer the only possible means of intensifying research and making available the results of researches for utilization in the field.

JUTE FIBRE — ITS NATURE & FORMATION

IN his presidential address to the Section of Agricultural Sciences (J), Dr B. K. Kar dealt with the physiological processes in the development of jute, the important bast fibre. The following aspects were discussed: (i) nature of vegetative growth; (ii) nature of flowering stage, including physiology of seed formation; (iii) nutritional aspects; and (iv) quality.

Studies in the growth and development of the root system *in situ* have indicated the differences in the adaptability of *Corchorus capsularis* and *C. olitorius* in different types of soils and under different environmental conditions. Fibre is laid in the stem by virtue of two processes of growth: activity of the apical meristem and the activity of the secondary cambium. The vegetative performance of a species is, therefore, dependent upon the activity of both the apical meristem and the cambium layers.

Growth in terms of height and basal diameter of the stem has been quantitatively estimated by determining the production of green matter and dry matter in the stem at different phases of growth and in different parts of the plant, and by studying the production and distribution of bark, wood and fibre contents. The growth and development of bark are among the most important features of the jute plant because they have a direct bearing on fibre development. The bark and wood show maximum development in the lower regions of the stem with gradual decrease up along the stem towards the apex. A correlated growth occurs between the wood and the bark, and a definite ratio between the two is observed at different stages of growth and at different heights of the stem.

The vegetative growth and the variations in associated growth components are greatly influenced by the reproductive phase. The flowering habits of *capsularis* and *olitorius* species are quite different. The occurrence of well-defined and quick flowering phase demarcates *capsularis* into phases of active vegetative and flowering periods showing corresponding variations of fibre growth. In *olitorius*, such clear demarcation is not possible as both the phases continue simultaneously over a long period. This relationship between the two phases enables the determination of the stage when the fibre yield is maximum, and the time of harvest. From practical point of view, therefore, the status of flowering in the two species has different connotations and should be taken into consideration in determining the maturity of a plant.

The nutritional aspects of the jute plant have been investigated from the point of view of (1) the growth habit of roots and their absorptive capacity, (2) the adjustment of application of fertilizer in relation to the nature of growth and (3) the kind of nutrients and their functions in physiological growth processes of the various quantitative factors. The jute plant has been found to respond significantly to nitrogen, and in whatever form it is made available, it stimulates vegetative growth. Nitrogen as ammonia produces a more significant response than other forms of nitrogen, and nitrate in association with Na, K and Ca has been found to be more effective in fibre production. The growth habit of root system in the two species has indicated that *capsularis* with its numerous fibrous roots absorbs nutrients more quickly than *olitorius* with its deep penetrating and less spreading fibrous root system.

It is not possible to judge the quality of a jute fibre, even approximately, on the basis of a single criterion as is possible in the case of cotton fibre on the basis of halo-length. Many physical characters of the fibre including the effect of setting process have been found to govern the quality of jute. Therefore, the problem of effecting improvements in the quality of jute should be tackled by cultivating selected varieties of jute which possess quick and uniform growth characteristics and which mature early.

TEACHING & RESEARCH IN PHYSIOLOGY

THE present status of teaching in physiology in medical colleges in India and a brief review of the research work being carried out on the digestive system and on nutritional problems formed the subject of the presidential address of Dr N. P. Benawri to the Section of Physiology (K). Since most of the entrants to a medical college eventually take up the practice of medicine and do not specialize in physiology, Dr Benawri was of the opinion that a highly specialized treatment of the subject was neither desirable nor useful at the undergraduate level. The questions whether the curriculum should contain subject matter which has no direct clinical application and whether the student should be taught only applied physiology were discussed, and a method of teaching which combines both theoretical and applied aspects was considered the best. Dr Benawri also stressed that physiology teaching should be correlated with other related disciplines such as anatomy, histology, biochemistry and pharmacology on the one hand and physics, chemistry and biology on the other.

The problems confronting the teacher of physiology are: should he exclude from his teaching, material otherwise useful, but of no clinical applicability? should the teaching be on a purely scientific level or purely applied level? Also, how much time the teacher should spend in exemplifying the fundamental principles of physiology? It is agreed by all that the main aim of teaching physiology to the medical students is to prepare them for the eventual practice of medicine. Such being the case, undergraduate teaching in the subjects has to be adapted to the needs of the majority of the medical students who would ultimately practise medicine. Though the utility of physiology for the ultimate understanding of medicine is unquestionable, too applied an approach is likely to confuse the student. A course which combines both theoretical aspects and clinical applications would, perhaps, be the best. The teaching of the subject should also be planned in such a way that it should be neither a mere recital of facts nor should it be overburdened with too much detail or too many examples. It is not only necessary to teach the basic concepts but also to briefly elaborate the manner in which they have been arrived at. On the experimental side, it is considered best that animal experiments of an elementary nature are carried out by the student himself.

Physiology teaching for a medical student has to be correlated with anatomy, histology, biochemistry and pharmacology on the one hand, and physics, chemistry and biology on the other. The present tendency is to treat biochemistry as a separate discipline which complicates the problem of planning a general course in physiology which includes physiological chemistry. There is also a growing tendency to merge histology with anatomy, but from the point of view of the medical student, histology is more a fundamental part of physiology than of anatomy. The student should in any event have a proper understanding of functional histology.

Research in physiology has gained impetus since Independence and the Indian Council of Medical Research has been providing more funds for the purpose. Excellent work is being carried out in different laboratories in the country on the digestive system and in the field of nutrition. Studies on gastric function have shown that potato meal is a better stimulant than alcohol or oat meal gruel of the gastric mucosa in Indian subjects. In the past a single nutritional deficiency was correlated with a particular clinical condition in malnutrition. Investigations on phrynoderma have revealed multiple nutrition deficiencies involving essential fatty acids, B-group vitamins and milk proteins. Studies on the amylolytic activity of the saliva of new-born infants have shown that the activity of the enzyme present was $\frac{1}{35}$ to $\frac{1}{40}$ of that in the adults. Investigations on the incidence of urinary calculi in subjects on rice and wheat diets have shown that total urinary output is higher in subjects on rice diet and that the concentration of calcium, phosphate and oxalate in a 24 hr sample of urine is much less in the case of subjects on rice diet.

PSYCHOLOGICAL THEORY & ITS APPLICATION IN INDIA

IN his presidential address to the Section of Psychology & Educational Sciences (L), Dr S. Jalota has reviewed the development of the psychological theory, the salient features of ancient Indian psychological concepts, and the present trends in the study of and research in psychology in India, with special reference to the work carried out at the Banaras Hindu University. Dr Jalota has pointed out that increased attention and encouragement should be given to teaching and research in psychology in the universities. He also stressed the urgent need for bringing out a research journal to serve as a medium for the publication of the results of researches carried out in the country in the field of psychology.

Psychological education and research in India have been influenced to a great extent by occidental way of thinking and the Indian workers have largely followed the western lead in much of their work.

The progress western countries have been able to make in the field of psychology is largely due to the ample facilities available for study and research. The Indian counterpart is handicapped by the lack of adequate facilities. Considerable work is, however, being carried out in certain fields, particularly in the measurement of intelligence, but the interest shown in the fields of animal, child and physiological psychology is limited. In the early years, individual testing employing Binet-type test was carried out at some universities. Group testing based on tests and norms evolved elsewhere was actively carried on for some time but in all these studies, the statistical analysis of the data was often neglected. Few attempts were made to evolve and use local norms, and there was no co-ordination in the work carried out.

Psychological tests were introduced in India first in the Indian Army during the last war to facilitate recruitment of the right type of personnel to the army. Such tests were also introduced by some industrial establishments, notably the Tata Iron & Steel Co. Ltd, to help them in their selection of personnel. Studies in animal psychology were taken up in certain universities, but there was no sustained or systematic programme of research. The first Bureau of Psychology in Uttar Pradesh was established at Allahabad which was followed by several others in different States. These were mainly engaged in preparing suitable tests and training of personnel for using and interpreting test data for guiding school population. The data collected, however, have not been analysed and no validation studies have been carried out.

Studies carried out at the Banaras Hindu University have pointed out the utility of modal-age-grade norms. Investigations on *difficulty values* have shown that the *unattempted items* may be considered 'wrong' from the point of view of difficulty value analysis and of *power*. Further, it has been found that *relative discrimination* study of sub-tests is as meaningful as the more laborious techniques by putting them in high, medium and low grades of discrimination ability. From tests carried out with vocabulary items with four alternatives, within the range of 25·60 per cent difficulty, it has been concluded that these tests can be of help only in assessing the general rather than the scholastic ability of the test subjects.

In national development programmes, high priority is given to the development of physical, engineering and other applied sciences, but these priorities cannot be rendered effective without an adequate programme for the development of the science of psychology. *Materials* and *machines* can do nothing without the skilled effort of *men*. In modern industry there is a large group of workers with varying abilities and specializations. The co-ordination of their efforts, and the supervision necessary for controlling the quality of their production, give rise to interpersonal contacts, competition, friction and conflicts. It is essential that such sources of conflict are discovered and set right. It is in the fields of industrial management and relations, and the motivation of the worker in industrial and agricultural spheres that the psychologists in India have a fertile field for research and the services that they can render in these areas can be of immense benefit to the nation.

POWER IN NATIONAL PLANNING

PRIOR to Independence, electric power generation and supply was generally confined only to some remunerative urban and industrial areas. With the initiation of the Five-Year Plans, the importance of electric power for integrated and balanced economic development of the country has been duly realized. In this context, Dr M. Datta's presidential address to the Section of Engineering and Metallurgy (M), in which he presented an overall national view of the present power supply position and trends in the generation, transmission and distribution of power, is timely. He has also attempted to visualize the future developments in India and has exhorted engineers of different disciplines, namely electrical, civil, mechanical and metallurgical, to pool their efforts in achieving the target set for power development.

From the low per capita annual power consumption (25 kWh.), even to attain a modest target of 100 units per head per year in the near future, Dr Datta feels the need for an installed capacity of the order of 12,000 MW. for providing cheap power, establishment of large power generating stations and construction of regional grids connected with the principal load centres by extra high voltage lines.

Indian resources for power development are sufficient for the foreseeable future. Water power potential is estimated at 40,000 MW. and low grade coal reserves at 40,000 million tons; the available nuclear power resources are encouraging. From a cursory examination of the economics of power generation, "it is obvious", Dr Datta says, "that for a considerable period emphasis shall be on pit-head coal-fired thermal power and hydrostations all over India except for a few nuclear power stations in places far remote from coal reserves and water power sites, because of their locational flexibility and/or for experimental purposes in regional grids where sufficient base load is available". To secure optimum

development and utilization of power potential, the need for co-ordinated planning and development of power on zonal basis has been realized and developments are taking place in cognizance of fairly well-defined eight power zones in India, details of which are stated in the address. After indicating the technological trends in steam and hydro power generation and transmission and distribution, emphasis is laid on rural electrification which is engaging active consideration in the country. For economy in rural electrification, transmission methods need to be looked into. Use should be made, as much as possible, of the same pole to carry high and medium voltage lines without the use of guard wires. Another suggestion is for the joint construction or use of poles by the Electricity Board and the Post and Telegraph authorities. Co-ordinated use of autorecloser with fuses gives satisfactory protection in rural power distribution. The ' hold closed ' type, which is the co-ordinated circuit recloser and operates very rapidly to clear a temporary fault before the fuse can blow off and holds closed when proper fuse clears the fault, holds promise in India. In our country, where large hydro power schemes have to be developed with long transmission lines, problems of system stability, voltage drops, etc., assume importance. The use of network analyser is imperative for the design and planning of power system. It is highly desirable to have more a.c. network analysers operating at higher frequency in the country for effective and efficient planning in relation to power.

In view of the rapid industrialization envisaged in the country, it is realistic to provide for an annual increase in demand of power at 20 per cent up to the end of 1966. For this increase in power, the development will largely devolve on the high voltage network, the low voltage network remaining substantially the same.

Atoms for Peace Award, 1958

PROF. GEORGE CHARLES DE HEVESY OF SWEDEN is the recipient of the Atoms for Peace Award for the year 1958. The first scientist to be honoured with the award was Prof. Niels Bohr in 1957. The award, instituted by the Ford Foundation, consists of a gold medallion and a cash prize of $ 75,000. The citation states that Prof. de Hevesy was given the award " for his basic contribution to the peaceful uses of atomic energy in the discovery and development of tracer techniques in chemistry, biology and medicine, using natural and artificial radioactive and stable isotopes and for his continued interest in these fields ".

George Charles de Hevesy was born in Budapest in 1885. He took his doctorate from the University of Freiburg in 1908. Working with Lord Rutherford at Cambridge, U.K., he succeeded in separating radium D from lead in 1912. In 1920 he joined the Institute for Theoretical Physics, Copenhagen, where, with the physicist D. Coster, he discovered the element hafnium. He also pioneered the activation of radioactive compounds within a system by neutron bombardment. He was awarded the Nobel Prize for Chemistry in 1943. Prof. de Hevesy has published more than 50 research papers and is the author or co-author of a number of text-books on radioactivity and its uses in chemistry, biology and medicine.

Opto-physical Measuring Instruments for Chemical Industry

W. NEBE
VEB Carl Zeiss, Jena

CHEMISTS in large industries and in research laboratories are continuously in search for methods to carry out analyses within the shortest possible time. Optical methods have come into the fore and have been largely adopted for this purpose during the last 20 years. To the classical methods of refractometry, interferometry, polarimetry as well as of photometry and of the spectral analyses, new provinces have been added, such as the extension of the spectral analysis of the visible and ultraviolet regions to the infrared region of the spectrum and the employment of photoelectric measuring methods in the field of photometry. For all these methods, VEB Carl Zeiss, Jena, have developed improved types of instruments which have become indispensable expedients for analytical chemistry.

For determining the refractive index of all kinds of liquids, the Abbe Refractometer and the Dipping Refractometer (reading to $[n]_D$ 0·0001 and 0·00002 respectively) are used for absolute measurements and the Laboratory Interferometer (reading to 2×10^{-7}) for comparison measurements. In addition to the most accurate determination of the concentration and purity of liquids, this interferometer is also used for quantitative analyses of gases (reading to 2×10^{-8} for the difference in refraction, corresponding to 0·0015 per cent benzol vapour in air). This work also includes the examination of the air for explosive or other gases detrimental to health, which is so important in every factory or laboratory.

In the province of the macro-molecular chemistry Schlieren-optical and interference methods are of late being introduced in conjunction with electrophoretic and diffusion techniques. For the observation and photographical recording the Macro-Electrophoresis Instrument is equipped with the universally applicable Schlieren Recording Instrument 80 (Fig. 1). In addition to its use for the registration of interference curves as well as of the gradients of the refractive index, etc., in stratified media, this Schlieren equipment is also available for the examination of currents, heat-conductivity, ultrasonics and mixing processes, etc., in gases and liquids, as well as for testing the homogeneity of glasses. By employing the Toepler Schlieren method it will be possible in this case to perceive deviations of light up to 2 sec. The specific demand for Schlieren apparatus for aerodynamical and other examinations led to the development of a Schlieren Recording Apparatus with a 300 mm. diameter of the object field.

The extensive literature published on this subject shows that the Pulfrich Photometer is the most commonly used optical instrument. This instrument is of a remarkable versatility, its applicability extending to all branches of chemistry: colorimetric determinations of concentration and absorption in the measurement of liquids, turbidity and fluorescence, especially of colloidal suspensions, evaluation of paper electrophoresis strips, etc. Spectrophotometric measurements in the visible region can also be carried out. The extension of the photometric analysis to the wavelength region 210-1000 mμ is accomplished by the Universal Spectrophotometer (Fig. 2). The assembly of this instrument from individual constructional elements makes it possible to achieve optimum results in whatever investigation it is employed. This applies in particular to the photoelectric measuring device which affords a variety of facilities and which permits measurements of the photo flux up to 1×10^{-13} without the use of an amplifier. Measurement is either made by the zero reading method through visual observation on the Electrometer (measuring equipment A), where com-

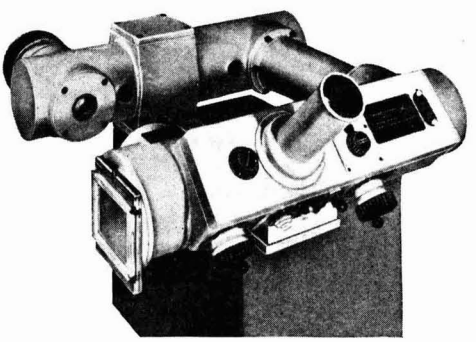

FIG. 1 — SCHLIEREN RECORDING INSTRUMENT 80

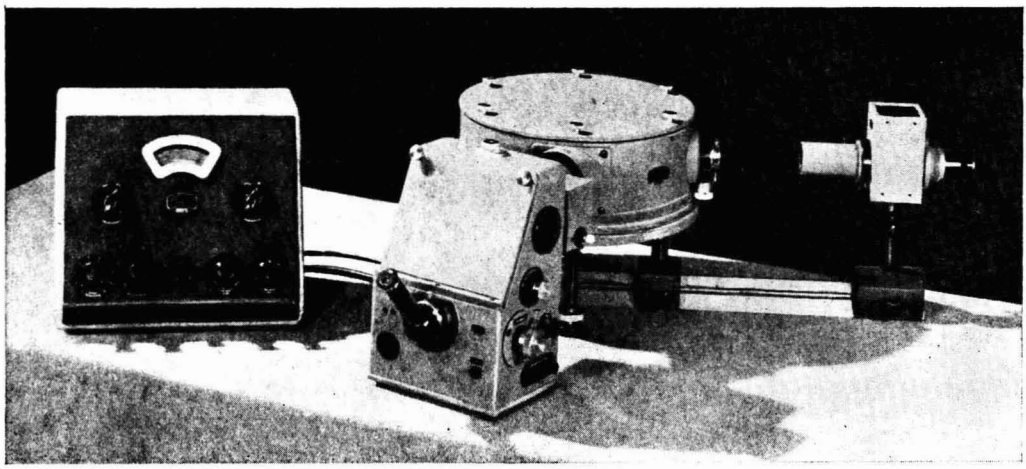

FIG. 2 — UNIVERSAL SPECTROPHOTOMETER

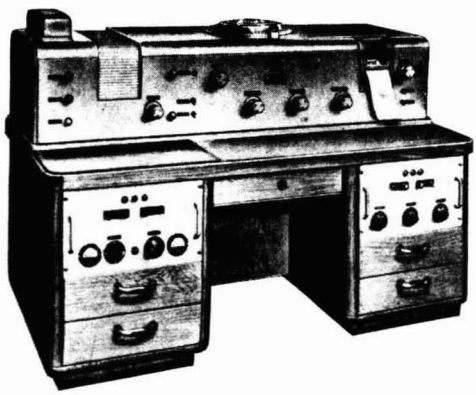

FIG. 3 — AUTOMATIC INFRARED SPECTROPHOTOMETER UR 10

pensation is effected by means of a potentiometer, the extinction values being directly read off the measuring scale, or one uses in the measuring equipment B a projection-electrometer in which the electrometer filament is projected on to a ground glass screen, thus doing away with the microscopic observation altogether. Finally, one may use the measuring equipment C which operates by the deflection method in conjunction with the photo-voltaic cell and scale galvanometer.

For the rapid specific analysis of alkalies and of some alkaline-earth metals, the Flame Photometer is the most suitable instrument. Its extraordinarily high sensitivity of detection, amounting to 1 mg./litre or still less, approaches the most accurate interferometric measurements of corresponding solutions. The indicating instrument in this case also is a scale galvanometer which reads to an accuracy of from 6 to 8×10^{-10} A./scale division and which has the advantage of occupying a minimum of space.

Investigations in the infrared region of the spectrum have been assuming, of late, considerable importance in the study of molecular structures as well as for purity tests and for qualitative and quantitative analysis of gases and liquids. The often unmethodical nature of infrared spectra calls for the provision of automatic recording instruments. VEB Carl Zeiss, Jena, have developed for this purpose an instrument which, by its all-automatic operation, high precision, convenient manipulation, and adaptability, meets extreme requirements for industrial as well as laboratory purposes. This instrument is known as the All-Automatic Infrared Spectrophotometer 'UR 10' (Fig. 3). By means of three built-in prisms, which automatically change their positions as soon as each of their measuring ranges is scanned, a total measuring range extending from 400 to 5000 $cm.^{-1}$ (25 to 5 $m\mu$) is covered. A programme dial-selector permits pre-setting of the desired spectral regions for registration purposes. Registration can be made fully automatic at an adjustable speed ranging from 4 to 400 $cm.^{-1}$/min. The instrument operates on the reliable double-beam intermittent light principle with optical zero balance and achieves a reproducibility of transmittance indication better than $\pm 0{\cdot}5$ per cent. The spectral resolution amounts to approximately 2 $cm.^{-1}$.

For the qualitative and quantitative emission spectral analysis in the visible and ultraviolet regions reliable optical recording and evaluating instruments

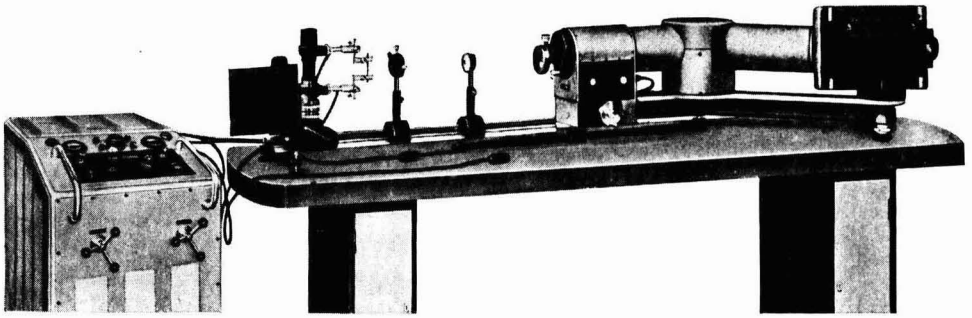

FIG. 4 — SPECTROGRAPH Q 24

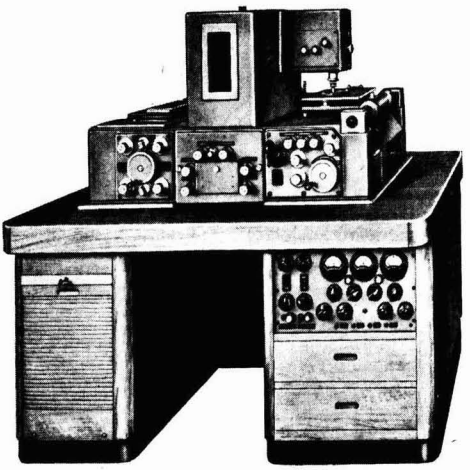

FIG. 5 — PHOTOELECTRIC RECORDING PHOTOMETER

are available. The Three-Prism Spectrograph, a glass-type spectrograph with a Foersterling set of prisms, covers the range from 360 to 100 mμ. Its resolving power varies between 3·6 mμ/mm. in the long-wave and down to 0·1 mμ/mm. in the short-wave end of its spectral range.

For the ultraviolet region from 200 to 500 mμ, the UV Spectrograph 'Q 24' with quartz prism is the most suitable instrument (Fig. 4). It achieves a dispersion of roughly 0·4 mμ/mm. at 200 mμ. By the provision of appropriate accessories for the excitation and evaluation of the emission spectrum, the application of the spectrograph is facilitated for numerous chemical analyses. Well-reproducible conditions of excitation are furnished by the 'HFO 1' Spark Generator or by the Intermittent Arc Producer. For evaluation purposes, the Spectrum Projector, the Abbe-Comparator, Rapid Photometer and the Photoelectric Recording Photometer (Fig. 5) are available.

Every one of the afore-mentioned opto-physical measuring instruments enjoys a reputation for giving rapid and reliable analytical results, a fact which makes for their approval on the part of the chemist who cannot be expected to deal with instrument details but must devote every attention to his analysis. The wide distribution of these instruments throughout the world is an adequate argument in favour of their quality and reliable performance.

Sampling of Leather

N. K. CHAKRAVARTI
Defence Research Laboratory (Stores), Kanpur

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The problem of selecting appropriate leather pieces, both from the point of view of design of experiments and of sampling inspection for acceptance, has been investigated. It is found that the simple criterion of low variance adequately achieves the objective that is sought to be achieved by the more elaborate criterion of correlation coefficient developed by Mandel and Mann[1]. This result points to the necessity of adopting certain experimental designs in preference to others when performing experiments on leather.

The problem underlying sampling inspection for acceptance has been defined and it is found that there are two theoretical approaches based on the two types of requirements that may be stipulated by the purchaser. The appropriate acceptance procedures have been developed.

INVESTIGATIONS have been undertaken from time to time by various research workers to evolve a scientific procedure for the sampling of leather. The purpose of such investigations has been to work out a procedure for sampling leather for acceptance inspection and also for working out suitable designs for carrying out experiments for testing the superiority or otherwise of different treatments that may be applied to leather.

Leather is a highly variable material, particularly so in the case of leather from areas in the immediate vicinities of backbone and flanks. This being so, if the uniform portions are not chosen while designing an experiment to test the efficacy of certain treatments, the variability of the experimental pieces of leather plays such a dominant role as to obliterate any real differences in the treatments in case they are not large enough. In acceptance sampling, the problem is to so select the sample pieces as to obtain a correct estimate of the lot quality.

In order to evolve a correct technique, data on uniformity trials are essential. Valuable work has been done in this direction by Mandel, Mann and co-workers[1-7] who have studied the variability of leather as follows.

From a side, i.e. half of a leather taken along the backbone, is cut as large a rectangular area as possible and it is divided into 21 rectangular blocks as shown in Chart 1.

These blocks represent different locations in a leather. Variations in different physical and chemical characteristics between different blocks within the same leather and between leathers at the same blocks are studied. This has been done in respect of split and unsplit leathers, hides of cow and steer, light and heavy, vegetable-tanned and chrome-tanned leathers.

Prior to the work of Mandel, Mann and co-workers[1-7] an extensive study with uniformity trial data does not appear to have been made for investigating sampling techniques applicable to leather. For acceptance sampling, the extant procedure, that of the Society of Leather Trades Chemists[8], is to sample from three fixed locations in the shoulder, butt and belly. Probably, according to the experience of leather inspectors, these locations would represent the types of variabilities to be expected in a leather. Moore[9] states that the skin was found to be the most significant influence in establishing the variability of data in experiments. Hence, he decided that all the comparisons of the several experimental treatments should be performed upon the same skin. The portion of the limed calf-skin behind the shoulder wrinkles, extending across the backbone, but excluding the bellies, had been found to be more

BACKBONE

11	12	13	14	15	16	17
21	22	23	24	25	26	27
31	32	33	34	35	36	37

CHART 1

reproducible for the work. This skin was divided into 36 blocks, 18 in each side. Since bilateral symmetry had been found to exist in this leather, 18 skins would permit each of the 36 variables to occur once in each position in a leather. Hence 18 skins were chosen as replicates. Beakbane and Robinson[10] have divided a skin into four quadrants and a latin square experiment was tried, the four quadrants serving as the four replicates. It was also found that the two sides of a leather were more or less similar and that the variation from block to block within a side was much more than the variation between the two pieces that would fall on one another if a leather were folded along the backbone (cf. Moore). This result has been used by Conabere and Hall[11].

A remarkable fact noticed by Mandel, Mann and co-workers in their investigations is that the variation from block to block within the same side is larger than the variation between pieces of leather obtained from corresponding blocks of different sides in a lot. They have also found large variations in the block variances. They have not, however, in any of their papers, tested whether the differences of the block variances are statistically significant. The investigation of the significances of the differences between the block variances is of fundamental importance for evolving a suitable sampling technique. Bartlett's method[12] for testing the significance or otherwise of the block variances can be used and the hypothesis of homoscedasticity tested.

Since variation from block to block within a side is larger than the variation from side to side for the same block (block variance), Mandel and Mann[1] thought that some blocks would be better than others for sampling purposes, and developed a criterion for determining these blocks. All the subsequent papers by them and co-workers[1-7] are based on this technique. These authors reject the criterion that the best sampling block should vary least from side to side, because they desire that the characteristic measured for any block in a side should bear some relationship to the average value of that characteristic for the side. They, therefore, adopted the following two criteria:

(i) The regression coefficient of block values on side averages should be relatively large, and

(ii) the scatter of the experimental points about the regression line should be small.

These two criteria, taken along with an additional criterion that a sampling block should be considered better than another, if it requires a smaller number of sample sides for an equal certainty in the final results, lead to a single criterion, viz. that the correlation coefficient of block values with side averages should be largest.

In the following sections the problem has been examined using the linear hypothesis set up.

Analysis

Let X_{ij} be the value of the characteristic under study in the ith block of the jth side, and let there be n sides and K blocks per side. Then

$$X_{ij} = m + p_i + h_j + e_{ij}$$

$$\text{where } m + p_i = \frac{\sum_{j=1}^{n} X_{ij}}{n} = \text{block average}$$

$$m + h_j = \frac{\sum_{i=1}^{K} X_{ij}}{K} = \text{side average}$$

$$\text{and } m = \frac{\sum_{i,j=1}^{nK} X_{ij}}{nK} = \text{general average}$$

$$\text{Also, } \sum_{i=1}^{K} p_i = 0, \quad \sum_{j=1}^{n} h_j = 0$$

$$\sum_{j=1}^{n} e_{ij} = 0 \text{ for all } i \text{ and } \sum_{i=1}^{K} e_{ij} = 0 \text{ for all } j.$$

$$\text{Let } E_j(e_{ij} \times e_{aj}) = 0 \text{ if } a \neq i$$

where E_j is the expectation when variation over sides is considered.

$$\text{The } j\text{th block variance} = E_j(h_j + e_{ij})^2 = \sigma_i^2 + \frac{\sum_{j=1}^{n} h_j^2}{n}$$

$$\text{The variance of the side averages} = \frac{\sum_{j=1}^{n} h_j^2}{n}$$

$$\text{The co-variance is } \sum_{j=1}^{n} h_j(h_j + e_{ij}) = \frac{\sum_{j=1}^{n} h_j^2}{n}$$

The correlation coefficient between the ith block values and corresponding side averages, ρ_i, is given by

$$\rho_i = \frac{\frac{1}{n}\sum_{j=1}^{n} h_j^2}{\sqrt{\left(\frac{1}{n}\sum_{j=1}^{n} h_j^2\right)\left(\frac{1}{n}\sum_{j=1}^{n} h_j^2 + \sigma_i^2\right)}} = \frac{1}{\sqrt{1 + \frac{n\sigma_i^2}{\sum_{j=1}^{n} h_j^2}}}$$

Hence the correlation increases as σ_i decreases and can be 1 only if $\sigma_i = 0$. ρ_i's are all equal if σ_i's are all equal.

From the data on averages and coefficients of variation reported by Randall *et al.*[6] in respect of tensile strength, stitch-tear strength, tongue-tear strength and bursting strength in both parallel and

perpendicular directions for both split and unsplit hides, we obtain the variances. By applying Bartlett's test, we find that some of them are significant while others are not. It, therefore, appears that it is not possible to decide about the significance or otherwise of block variance in respect of any characteristic and any lot of leather without making a thorough study of them.

Considering now their criterion (i), the regression coefficient is

$$\beta_i = \rho_i \frac{\sqrt{\frac{\sum_{j=1}^{n} h_j^2}{n} + \sigma_i^2}}{\sqrt{\frac{\sum_{j=1}^{n} h_j^2}{n}}} = 1$$

Hence, the slope of the regression line is always unity. The variations from unity are, therefore, to be ascribed to chance causes only. This criterion, therefore, is of no value.

Considering now their criterion (ii) the scatter about the regression line is given by

$$\sigma_i^2(1-\rho_i^2) = \left\{ \frac{\sum_{j=1}^{n} h_j^2}{n} + \sigma_i^2 \right\} \left\{ 1 - \frac{1}{\left(1 + \frac{n\sigma_i^2}{\sum_{j=1}^{n} h_j^2} \right)} \right\} = \sigma_i^2$$

Hence the scatter is directly given by the block variance.

Thus the block variance is the most important criterion, and correlation coefficient gives no further information. The method of Mandel and Mann thus reduces to choosing the most uniform blocks, the criterion that they seemed to reject.

Using the same data as used above for testing the significance of block variances, the block standard deviations and leather standard deviations calculated are given in Table 1.

TABLE 1 — BLOCK AND LEATHER STANDARD DEVIATIONS

(Standard deviations calculated at each of the 21 blocks of a leather[6])

Block No.	Tensile strength				Bursting strength		Stitch-tear strength				Tongue-tear strength			
	Perpendicular		Parallel				Perpendicular		Parallel		Perpendicular		Parallel	
	Split	Unsplit	Split	Unsplit	Split	Unsplit	Split	Unsplit	Split	Unsplit	Split	Unsplit	Split	Unsplit
1	67	56	103	99	22	17	20	26	29	22	10	10	8	16
2	66	34	129	123	29	26	18	18	25	16	12	6	13	9
3	67	49	98	74	17	20	15	14	13	14	8	6	6	7
4	52	33	65	73	18	14	15	9	14	11	10	6	6	7
5	39	45	58	51	15	13	14	10	16	11	7	6	7	7
6	50	51	63	61	23	14	13	11	11	10	5	6	6	6
7	62	53	55	60	13	14	16	9	14	11	12	10	7	7
11	63	55	119	107	26	23	23	22	22	21	16	18	15	20
12	57	42	76	89	21	17	26	18	28	20	12	14	16	15
13	72	87	73	81	22	23	17	19	11	16	17	16	13	11
14	48	53	107	71	21	22	16	23	14	12	11	17	9	8
15	45	43	99	71	19	19	15	11	14	12	10	9	7	7
16	54	67	72	68	18	22	14	14	12	10	8	8	7	8
17	66	66	79	72	16	27	15	12	21	22	6	7	7	7
21	51	70	63	74	18	20	21	21	31	29	16	18	20	19
22	73	60	75	64	26	14	20	24	28	29	18	14	16	15
23	53	62	82	93	28	24	17	24	19	17	13	11	14	16
24	53	51	88	85	25	28	15	15	31	13	14	8	10	8
25	53	59	105	55	13	13	19	12	21	26	10	9	10	9
26	60	66	122	111	26	19	15	27	23	31	9	12	10	9
27	89	63	106	86	18	11	20	17	23	23	13	10	10	9
Leather s.d.	33·59	26·10	42·85	36·17	11·62	11·20	7·38	6·79	8·71	7·28	5·92	6·41	5·75	6·27
Bartlett's χ^2	18·54*	26·94*	31·59	28·39*	46·25	36·71	18·37*	61·93	72·76	73·60	53·50	77·10	74·48	86·10

The block variances are all higher than the leather variances except in rare cases which are attributable to sampling fluctuations. This is as is expected from the relations: Block variance $= \frac{\sum_{j=1}^{n} h_j^2}{n} + \sigma_i^2 =$ leather variance $+ \sigma_i^2$.

*Not significant.

Discussion

It might be supposed, from the manner of formulation of the problem by Mandel and Mann, i.e. sampling with a view to assessing the side averages most efficiently, that this sampling scheme should be satisfactory for acceptance inspection. However, leather being a highly variable material, an average over an entire side does not represent any tangible quality characteristic. Hence the results obtained in respect of the blocks having the highest correlation with side averages cannot serve as a guide for acceptance purposes also.

Design of experiment

Till now, in experimental designs involving leather, a side has been divided into a number of blocks, rectangular or square, all of equal sizes, and these have been assigned to different treatments under comparison. The design has varied from simple randomized blocks and latin squares to balanced incomplete block designs and Youden's squares. Thayer *et al.*[13] prefer the use of Youden's squares to BIB designs, since, in such designs, variability in two directions can be taken account of.

The existence of bilateral symmetry can be made use of by assigning pieces of leather to blocks in such a manner that they may be expected to be nearly uniform. In this case, the pieces of leather in a block will, in general, not be all contiguous. It will, therefore, not be possible to use Youden's squares, but a BIB design can be used. Moreover, by using those locations of leather which are nearly uniform from side to side, a different type of design can be worked out. Here, the pieces of leather in a block will be contributed to by different sides, but at the same location. Instead of using different sides as replicates, different blocks can be used as replicates, and a BIB design worked out.

A study with uniformity trial data, if available, would have established the relative merits of these different types of designs.

Acceptance sampling

For various speciality products, it is not only the visual characteristics but also various physical and chemical characteristics of leather that are important. These have, of necessity, to be determined on a few samples chosen at random from a lot. For the manufacturer to be sure that he does not market a high proportion of goods that are deficient in quality, he has to assure himself that the raw material, i.e. the lot of leather, does not contain an undue proportion of unsatisfactory material. Because a leather is highly variable, the three sampling locations advocated by the Society of Leather Trades Chemists, though sampling from three representative portions of leather, does not appear to be fully satisfactory. For the same reason, an average value of a characteristic for an entire leather is also not satisfactory. Samples have to be drawn from all locations and the proportion satisfactory for the purpose at hand determined.

Two approaches are possible for tackling this problem: (i) To set up in advance a proportion of unsatisfactory material (in terms of blocks) that will be quite acceptable to the purchaser (AQL) and another percentage that is unacceptable to him (LTPD). The probability of acceptance of AQL quality leather is 95 per cent and that of LTPD quality is 10 per cent; and (ii) the purchaser may wish to determine, with a given confidence coefficient γ (the probability of arriving at the correct conclusion), the maximum proportion of unsatisfactory material that the lot of leather may contain.

The sampling techniques in respect of both the approaches depend upon the X_{ij}'s being normally distributed. Since there is a superimposition of many populations, i.e. of the distributions of the X_{ij}'s in the different blocks, the population of all the X_{ij}'s may be taken to be normally distributed. Let the mean of the distribution be m and s.d. be σ. The relevant techniques have been developed by the Statistical Research Group, Columbia University[14]. These will be indicated below.

Approach (i)

Let p_1^* = AQL
p_2^* = LTPD
L = lowest value of characteristic acceptable
N = the sample size, the samples being assumed to be drawn at random
$\overline{X}$ = the average of the sample values, and
S = s.d. of the sample values

The lot is acceptable if

$$(\overline{X}-K\cdot S)>L$$

and rejected if

$$(\overline{X}-K\cdot S)\leqslant L$$

where K is given by the following formulae.

Let K_ϵ be a normal deviate exceeded with probability ϵ $(0<\epsilon<1)$; i.e. K_ϵ is given by

$$\frac{1}{\sqrt{2\pi}}\int_K^\alpha e^{-t^2/2}.\,dt=\epsilon$$

Values of K_ϵ corresponding to the four values of 5 per cent (i.e. 100—95 per cent), 10 per cent, p_1^* and

p_1^*, i.e. $K_{0\cdot05}$, $K_{0\cdot10}$, K_1, K_2 are of particular interest.

$$\text{Then } K = \frac{K_{0\cdot05}K_2 + K_{0\cdot10}K_1}{K_{0\cdot05} + K_{0\cdot10}} \text{ and}$$

$$N = \frac{K^2+2}{2}\left(\frac{K_{0\cdot05}+K_{0\cdot10}}{K_1-K_2}\right)^2$$

Example — Let the characteristic under study be bursting strength (lb./in. thickness).

Let $p_1^* = 0\cdot02$
$p_2^* = 0\cdot06$
$L = 3\cdot00$ lb./in. thickness

Then $K_{0\cdot05} = 1\cdot645$
$K_{0\cdot10} = 1\cdot282$
$K_1 = 2\cdot054$
$K_2 = 1\cdot555$

$$K = \frac{K_{0\cdot05}K_2 + K_{0\cdot10}K_1}{K_{0\cdot05}+K_{0\cdot10}} = 1\cdot774$$

$$N = \frac{K^2+2}{2}\left(\frac{K_{0\cdot05}+K_{0\cdot10}}{K_1-K_2}\right)^2 = 88\cdot5$$

Hence 89 sample pieces are selected at random from the lot of leather and the bursting strength determined. Then the mean ($\bar{X}$) and standard deviation (S) of the 89 bursting strength values are determined. Suppose that it is found that

$\bar{X} = 4\cdot00$
$S = 0\cdot50$

Then $\bar{X} - K\cdot S = 4\cdot00 - 1\cdot774 \times 0\cdot50$
$= 4\cdot00 - 0\cdot887$
$= 3\cdot113$

Since $3\cdot113 > L$ which is 3·00, the lot of leather is acceptable.

If for some reason, the sample size N is definitely fixed, the sampling plan may be based either on AQL or on LTPD.

Choosing the AQL, the formula becomes

$$K = \frac{K_1 - \sqrt{K_1^2 - ab}}{a}$$

where $a = 1 - \frac{K_{0\cdot05}^2}{2(N-1)}$ and $b = K_1^2 - \frac{K_{0\cdot05}^2}{N}$

Example — Let us consider the same lot of leather as in the previous example and the same characteristic, viz. bursting strength. Suppose that the sample size is fixed at 100, i.e. $N = 100$. Also suppose that the mean and standard deviation, as determined from the 100 leather pieces drawn at random are found to be

$\bar{X} = 4\cdot05$
$S = 0\cdot55$

Let, as above, $L = 3\cdot00$

$$\text{Then } a = 1 - \frac{K_{0\cdot05}^2}{2(N-1)} = 0\cdot986$$

$$b = K_1^2 - \frac{K_{0\cdot05}^2}{N} = 4\cdot192$$

$$K = \frac{1}{a}\left(K_1 - \sqrt{K_1^2 - ab}\right) = 1\cdot788$$

whence $(\bar{X} - K\cdot S) = 4\cdot05 - 1\cdot788 \times 0\cdot55$
$= 4\cdot05 - 0\cdot983 = 3\cdot067$
$> L$

Hence the lot is acceptable.

***Approach* (ii)**

If m and σ are known, the exact proportion of unsatisfactory material would be

$$\int_{-\alpha}^{L} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(X_{ij}-m)^2}{2\sigma^2}} dx_{ij}$$

However, since none of m or σ are known, but are to be estimated from a sample, we can only know $\bar{X}$ and S, based on a sample of size N. Let

$$\frac{\bar{X}-L}{S} = K_0$$

Then the two limits of proportion defective (p) in the lot determined with confidence coefficient γ are

$$Kp = K_0 \pm K_{\left(\frac{1-\gamma}{2}\right)}\sqrt{\frac{1}{N} + \frac{K_0^2}{2(N-1)}} \quad \ldots\ldots \text{(A)}$$

Let the upper value of p be $\overset{\vee}{p}$ and the lower value $\hat{p}$. The maximum percentage of defective material is then $\overset{\vee}{p}$.

If now the limits $\overset{\vee}{p}$ and $\hat{p}$ are too wide, and it is desired to investigate whether a lower value for $\overset{\vee}{p}$ can be justified, it will be necessary to draw a larger sample and base the estimates on it.

Fix the value $\overset{\vee}{p}{}^*$ that is desired, then $K\overset{\vee}{p}{}^*$ is found. Now if N' be the sample size required, using the previous value for K_0, N' is determined as follows:

$$K\overset{\vee}{p}{}^* = K_0 - K_{\left(\frac{1-\gamma}{2}\right)}\sqrt{\frac{1}{N'} + \frac{K_0^2}{2(N'-1)}}$$

$$\text{or } \left(K\overset{\vee}{p}{}^* - K_0\right) = -K_{\left(\frac{1-\gamma}{2}\right)}\sqrt{\frac{1}{N'} + \frac{K_0^2}{2(N'-1)}}$$

$$\text{or } \frac{\left(K\overset{\vee}{p}{}^* - K_0\right)^2}{K^2_{\left(\frac{1-\gamma}{2}\right)}} = \frac{1}{N'} + \frac{K_0^2}{2(N'-1)}$$

Since N' will be large, we may replace $N'-1$ by N' without appreciably affecting the accuracy. Thus

$$\frac{(K\overset{\vee}{p}^*-K_o)^2}{K^2_{\left(\frac{1-\gamma}{2}\right)}}=\frac{1}{N'}\left\{1+\frac{K_o^2}{2}\right\}$$

$$\text{or } N'=\frac{K_o^2+2}{2}\cdot\frac{K^2_{\left(\frac{1-\gamma}{2}\right)}}{(K\overset{\vee}{p}^*-K_o)^2} \quad \ldots\ldots \text{(B)}$$

Now $(N'-N)$ additional samples are drawn at random, $\overline{X}$ and S recomputed and a revised value for K_o is found. Now all the quantities on the right-hand side of formula (B) are known. Hence, a revised value of $K\overset{\vee}{p}^*$, say $K\overset{\vee}{p}^{**}$, is computed, and $\overset{\vee}{p}^{**}$ may now be considered as the revised upper limit of unsatisfactory material in the lot, determined with a confidence coefficient γ.

Example — Suppose that a sample of 100 leather pieces has been drawn from a lot and that it has been found that in respect of bursting strength

$$\overline{X} = 4{\cdot}00$$
$$S = 0{\cdot}50$$

Let $L = 3{\cdot}00$

$$\text{Then } K_o=\frac{\overline{X}-L}{S}=\frac{4{\cdot}00-3{\cdot}00}{0{\cdot}50}=2$$

Let the confidence coefficient $\gamma = 0{\cdot}90$

Then $K_{\frac{1-\gamma}{2}} = K_{0{\cdot}05} = 1{\cdot}645$

$$\therefore \quad K\overset{\vee}{p} = 2\pm1{\cdot}645\sqrt{\frac{1}{100}+\frac{2^2}{2\times99}}=2\pm0{\cdot}286$$

$$\therefore \quad K\overset{\vee}{p} = 1{\cdot}714 \text{ and } K\hat{p} = 2{\cdot}286$$

$$\text{i.e.} \quad \overset{\vee}{p} = 0{\cdot}043 \text{ and } \hat{p} = 0{\cdot}011$$

Let $\overset{\vee}{p}^* = 0{\cdot}03$

Then $K\overset{\vee}{p}^* = K_{0{\cdot}03} = 1{\cdot}882$ and

$$N' = \frac{K_o^2+2}{2}\cdot\frac{K^2_{\frac{1-\gamma}{2}}}{(K\overset{\vee}{p}^*-K_o)^2}=583$$

Now $(N'-N)=(583-100)=483$ more leather pieces are drawn from the lot at random, and the bursting strengths determined in respect of each of them. Let the mean and standard deviation be determined on the basis of the entire 583 values, and suppose it is found that the revised mean and standard deviations are

$$\overline{X}' = 3{\cdot}95$$
$$S' = 0{\cdot}51$$

Then the revised value of K_o is

$$K_o'=\frac{3{\cdot}95-3{\cdot}00}{0{\cdot}51}=1{\cdot}863$$

$$\therefore K\overset{\vee}{p}^{**}=1{\cdot}863\pm1{\cdot}645\sqrt{\frac{1}{583}+\frac{3{\cdot}470}{2\times582}}=1{\cdot}863\pm0{\cdot}112$$

$$\therefore \quad K\overset{\vee}{p}^{**} = 1{\cdot}751 \text{ and } K\hat{p}^{**} = 1{\cdot}975$$

$$\therefore \quad \overset{\vee}{p}^{**} = 0{\cdot}040 \text{ and } \hat{p}^{**} = 0{\cdot}024$$

Thus the revised upper limit of unsatisfactory material in the lot is 4 per cent, determined with a confidence coefficient of 90 per cent.

If instead of L, an upper limit U of acceptable value of the characteristic is specified in Approach (i), the lot is acceptable if

$$\overline{X} + KS < U$$

and rejectable if

$$X + KS \geqslant U$$

In approach (ii), K_o is defined as

$$K_o = \frac{U-\overline{X}}{S}$$

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Vertical Ionospheric Soundings at Ahmedabad during the Partial Solar Eclipse of 19 April 1958

R. G. RASTOGI*
Physical Research Laboratory, Ahmedabad

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The changes in the ionospheric layers due to a partial solar eclipse which occurred in the early morning hours at Ahmedabad (23°N, 72·6°E) on 19 April 1958 are described. The critical frequencies of the F_2 layer show a large depression during the eclipse compared to control days. The E and E_2 layers show similar, but much feebler, effects than the F_2 layer. The changes in F_2 layer have been found to be mainly due to the lowering of the layer peak. The changes in the F_2 layer during this eclipse are compared with those of other solar eclipses which occurred in the forenoon hours.

THE results of ionospheric soundings during the solar eclipses of 30 June 1954 and 14 December 1955 have been described by Rastogi[1,2]. The present paper describes the results of ionospheric soundings during the annular solar eclipse on 19 April 1958.

The eclipse at Ahmedabad (23°N, 72·6°E) was partial (magnitude, 0·52) and of about two hours' duration. The eclipse started at 0604 hrs 75° E.M.T., about quarter of an hour after the ground sunrise and at a period when the ionization of each of the layers was increasing very rapidly. It ended at 0812 hrs.

Rastogi[3] has shown that the E_2 layer at Ahmedabad develops in the morning hours due to photo-ionization by solar radiation in the same way as the normal E layer, whereas in the afternoon hours, it is often formed out of the ledge in F_1 layer by a descent of the layer. Most of the properties of the E_2 layer have been shown to be similar to those of the normal E layer[4,5]. The time of the present eclipse was well suited for the study of response of the E_2 and F_2 layers during an eclipse. In the morning, the behaviour of F_2 is more regular than in the evening hours.

The values of geomagnetic K indices were high on the days around the eclipse day, but there were no magnetic disturbances on these days. The changes in the ionospheric characteristics on 19 April 1958 can, therefore, be attributed solely to the eclipse.

Experimental procedure

The British National Physical Laboratory type automatic ionospheric height recorder Mk II No. 14 installed in the laboratory was used for all the measurements. On the control days p'-f records were taken every 7·5 min. from 0400 to 0900 hrs. On the eclipse day more frequent observations at intervals of 5 min. were taken between 0500 and 0900 hrs.

Results and discussion

In Fig. 1 are shown the variations of the ordinary wave critical frequencies of E, E_2 and F_2 layers (f_oE, f_oE_2 and f_oF_2 respectively), the minimum virtual height of the F_2 layer ($h'F_2$) and the virtual height of the F_2 layer at $0{\cdot}83 \times f_oF_2$ (h_pF_2) on the eclipse and on the control days. The cosine of solar zenith angle (cos χ) as well as the product (p. cos χ) of the unobscured portion (p) of the solar disc and cos χ are also shown in Fig. 1 for comparison. It is seen that the eclipse occurred when the altitude of the sun was increasing rapidly and so there was no pronounced dip in the value of (p. cos χ) during the eclipse.

Lower layers — The F_1 layer was not observed up to 0900 hrs either on the control days or on the eclipse day.

E and E_2 layer reflections were well recorded up to 0830 hrs, after which, due to excessive absorption, these sometimes became too faint to be recorded.

*Present address: Post-doctorate Fellow, Radio and Electrical Engineering Division, National Research Council, Ottawa.

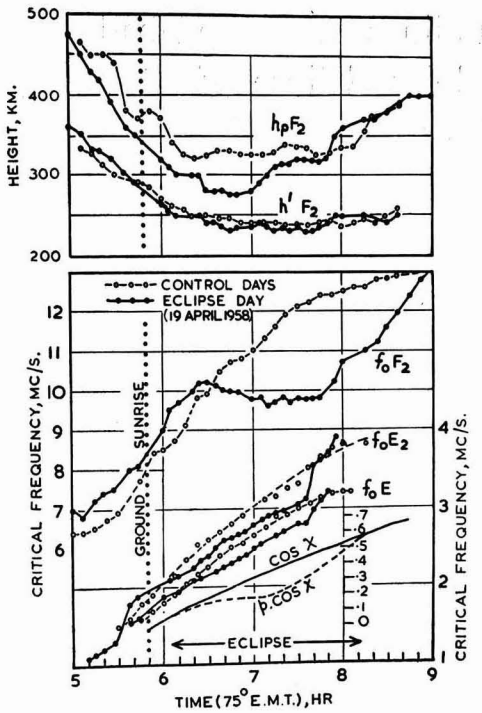

FIG. 1 — VARIATION OF COS χ, P COS χ, CRITICAL FREQUENCIES OF E, E_2 AND F_2 LAYERS AND VIRTUAL AND PEAK HEIGHTS OF F_2 LAYER WITH THE TIME OF THE DAY ON CONTROL DAYS AND ECLIPSE DAY

The critical frequencies of E and E_2 layers varied according to the law

$$f_o(E \text{ or } E_2) = k \cos^n \chi$$

where k and n are constants. The plots of control day values of f_oE and f_oE_2 against cos χ are shown in Fig. 2. Except for the first few points corresponding to very low altitudes of the sun, the rest of the points fitted well on straight lines. The subsolar critical frequencies (k) for the E and E_2 layers were 4·10 and 4·75 Mc/s. respectively. The sensitivity (n) of the E and E_2 layers were 0·36 and 0·38 respectively. Almost the same values of the sensitivities of E and E_2 layers suggest similar nature of the two layers.

During the eclipse period, f_oE and f_oE_2 were significantly lower than the corresponding control day values. There was no minimum in f_oE or f_oE_2; these increased steadily though maintaining subnormal values, being about 8 per cent lower than the control day values. The critical frequencies attained normal day values before the end of the eclipse. Such irregular behaviour might be caused by a pronounced non-uniform distribution of the sources of ionizing radiation on the solar disc. However, the *similarities* of the variations in f_oE and f_oE_2 suggest that both the layers were formed by wave radiations from the sun. A distinct decrease in f_oE_2 during an eclipse had been observed at Ahmedabad[2] during the eclipse of 20 June 1955.

F_2 layer — It may be noted from Fig. 1 that the F_2 layer is markedly affected by the eclipse. The sunrise effect in f_oF_2, i.e. the time of initial rise in f_oF_2 after the *layer sunrise*, was at about 0510 hrs on those days. So the eclipse started after the sunrise effect. The f_oF_2 value on the eclipse day was slightly higher than on the control days till about 0630 hrs after which it started decreasing and remained more or less at 9·7 Mc/s. till 0940 hrs; it again started increasing and attained the normal day value at about 0900 hrs. The eclipse effects were thus delayed by about half an hour in the F_2 region. The eclipse day values of f_oF_2 were about 20 per cent lower than the control day values, and so were larger than the decrease in f_oE or f_oE_2. Further, it can be noted that while h'F_2 on the eclipse day was not significantly different from the control day values, h_pF_2 was definitely lower during the eclipse.

To get a better understanding of the F_2 layer changes during the eclipse, the height of base (h_oF_2), the height of peak (h_mF_2) and the semi-thickness ($y_mF_2 = h_mF_2 - h_oF_2$) were calculated by Appleton and Beynon's method[6] using Booker and Seaton's function[7] for the eclipse day and for the days preceding and following it. The variations of h_oF_2, h_mF_2 and y_mF_2 on 18, 19 and 20 April 1958 are shown in Fig. 3. The semi-thickness of F_2 layer was smaller during the eclipse period on 19 April as compared to the corresponding periods on 18 or 20 April 1958.

The values of maximum electron density (N_mF_2) = $1{\cdot}24 \times 10^{-8}\ f_oF_2^2$ and of the total electron content in the F_2 region up to h_mF_2 ($nF_2 = 2/3\ y_mN_m$) were calculated for the eclipse day and two neighbouring days. Fig. 4 shows the variations of N_mF_2 and nF_2 on 18, 19 and 20 April 1958.

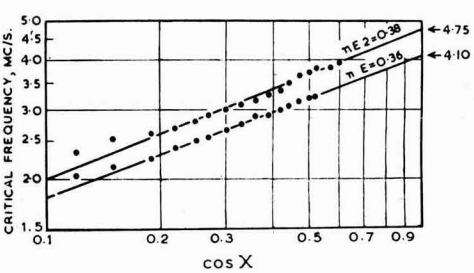

FIG. 2 — Log cos χ VS log f_oE AND log f_oE_2 FOR CONTROL DAYS

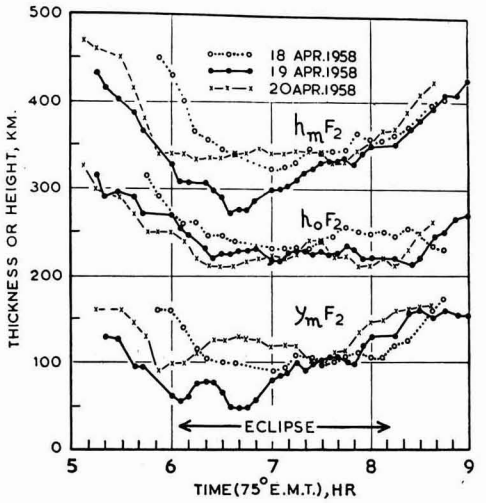

FIG. 3—VARIATION OF $h_o F_2$, $h_m F_2$ AND $y_m F_2$ ON THE ECLIPSE DAY AND THE NEIGHBOURING DAYS

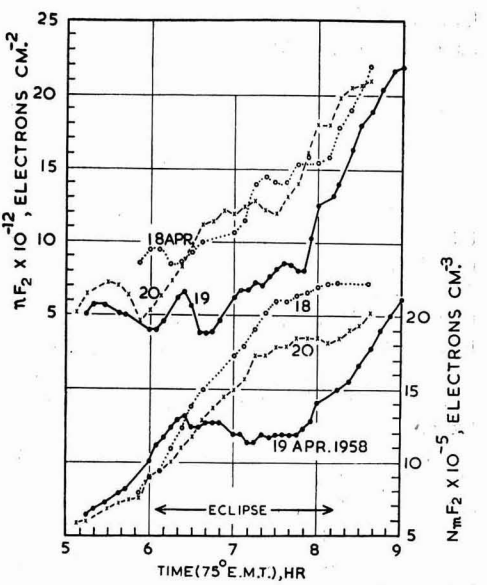

FIG. 4 — VARIATION OF $N_m F_2$ AND nF_2 ON THE ECLIPSE DAY AND NEIGHBOURING DAYS

It is again seen that N_mF_2 was significantly lower on the 19 than on the 18 or 20 April 1958 during the period 0630-0900 hrs. The total electron content too was lower throughout the eclipse period than on the 18 and 20 April. These observations indicate that F_2 layer ionizations were affected by radiations from the sun.

In general, the F_2 layer in high latitude stations is considerably affected by the solar eclipse. A survey of the results of the past eclipses shows that the F_2 layer in low latitude stations also is affected by the eclipse, if it occurs in the morning or forenoon hours. In Table 1 are given the results of the forenoon eclipses on the F_2 layer at low latitudes. At most of the stations the ionization in F_2 layer was

TABLE 1 — DATA ON THE RESPONSE OF F_2 LAYER TO SOLAR ECLIPSES OCCURRING IN FORENOON HOURS

DATE OF ECLIPSE	PLACE	GEOGRAPHIC LATITUDE	TIME OF MAX. PHASE *LMT*	MAGNITUDE OF ECLIPSE	N_mF_2 eclipse day / N_mF_2 control days	REFERENCE
25 January 1944	Huancayo	12°S	0917	0·88	0·69	Ledig *et al.*[8]
14 January 1945	Grahamstown	33°S	0515	0·88	0·53	Gledhill and Szendrei[9]
20 May 1947	Bebedouro	21°S	0930	1·00	0·70	Bosson *et al.*[10]
1 September 1951	Chincoteague	37°N	0545	0·95	0·46	Wells[11]
	Charlotteville	38°N	0600	0·94	0·41	
	Derwood	39°N	0550	0·92	0·53	
25 February 1952	Ibadan	7°N	1005	0·75	0·72	Piggott[12]
	Bangui	4°N	0835	1·00	0·79	Estrabaud[13]
	Leopoldville	4°S	0710	0·75	0·77	Lejay and Durand[14]
	Djibouti	12°N	1215	0·65	No effect	Meriau and Rawer[15]
	Khartoum	16°N	1123	0·97	0·80	Minnis[16]
	Gao	16°N	0810	0·50	0·85	Delobeau[17]
	Casablanca	34°N	0901	—	No effect	Haubert[18]
	Camaldoli	41°N	1020	0·30	0·92	Svensson *et al.*[19]
14 February 1953	Kokubunji	36°N	1005	0·53	0·67	Ionospheric Research Committee (Japan)[20]
25 December 1954	Grahamstown	33°S	0745	0·90	0·68	Szendrei and McElhinny[21]
20 January 1955	Singapore	1°N	1030	0·53	No effect	Minnis[22]
	Kodaikanal	11°N	0648	0·90	0·71	India Meteorological Department[23]
	Haringhata	23°N	0858	0·67	0·70	Saha *et al.*[24]
19 April 1958	Ahmedabad	23°N	0716	0·52	0·70	Rastogi (present paper)

lower during the eclipse period compared to that on control days. At Khartoum, f_oF_2 during the eclipse was lower than on the control day but remained almost constant for about 2 hr during the eclipse period. During the eclipse there were marked depressions in the electron density curves for fixed heights[25]. At Casablanca[18] there was no marked effect of the eclipse on f_oF_2 but the total electron content showed a bay due to the reduction of the semi-thickness of the layer. At Djibouti, where the eclipse maximum occurred later at 1215 LMT, there was no effect on the F_2 layer[15]. Thus even in cases where f_oF_2 did not show any change, there were changes in the shape of the layer which was definitely an effect due to the eclipse.

A study of the variation of the electron density at fixed heights during the eclipse has been carried out by Savitt[26] for the eclipse of 20 May 1947 at Bocayuva, by Szendrei and McElhinny[21] for the eclipse of 25 December 1954 at Grahamstown and by Minnis[16] for the eclipse of 25 February 1952 at Khartoum. These analyses show beyond doubt that the F_2 layer is affected by the ultraviolet radiations from the sun.

It is, therefore, concluded that both the E_2 and F_2 layers are photo-sensitive just as the E and F_1 layers. The eclipse effects are ambiguous when the eclipse occurs during the afternoon, because at those times, the F_2 layer is affected by other causes also, such as vertical movement of the layer or the horizontal transport of the ionized medium from neighbouring regions.

Conclusion

The E_2 layer is definitely a photo-ionized layer just as the normal E layer and is largely controlled by ultraviolet radiations from the sun. The F_2 layer is also found to be always affected by solar eclipses when they occur in the forenoon hours.

Acknowledgement

The work described forms part of the studies of the ionosphere during solar eclipses undertaken at the laboratory. The author wishes to express his thanks to Professor K. R. Ramanathan for his valuable guidance and to the Council of Scientific & Industrial Research, New Delhi, for financial support to the ionospheric station.

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Atmospheric Corrosion of Metals: Part II — Corrosion of Metals in Bombay

B. SANYAL, A. N. NANDI, A. NATARAJAN & D. BHADWAR

Defence Research Laboratories (Stores), Kanpur

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The rates of corrosion of mild steel and zinc have been determined under outdoor and indoor conditions of exposure at Bombay, representing an industrial-cum-marine atmosphere; some non-ferrous metals, other than zinc, such as copper and lead, have been investigated under outdoor conditions only. Correlation has been observed mainly between the rate of corrosion and the humidity of the atmosphere; the rate of corrosion increases with increase in humidity and is higher during the rainy season. The corrosion of mild steel under indoor conditions is about one-third of that suffered by it under outdoor conditions. Under outdoor conditions the corrosion of mild steel is 12 times that of zinc and galvanized iron, 44 times that of copper and brass, and 110 times that of lead.

IN Part I of this series, data on the rates of corrosion of mild steel and zinc at Kanpur under semi-industrial conditions were reported[1]. The results of investigations carried out at Bombay, representing industrial-cum-marine conditions, are reported in this paper.

Exposure site — Fig. 1 shows the location of the site where the tests were carried out and its proximity to industrial and marine sources of pollution. The site is surrounded on three sides by sea and is subjected to considerable pollution from sea-going vessels. In addition, smoke and other matter emitted from industrial chimneys situated north of the site are carried to the site when winds are blowing in that direction.

Experimental procedure

The procedures followed in the preparation of the metal panels and other experimental details were the same as those described in the earlier paper[1]. Atmospheric impurities were determined at ground level except where otherwise stated. Metal panels (6 × 4 in.) were exposed 3 ft above the ground level at an angle of 45° facing south, except those exposed during the period November 1954 to April 1955, which were hung vertically.

Salinity — The ' wet candle ' method employed by Ambler[2] was followed for the determination of the amount of atmospheric salt content. The candle consists of a piece of surgical bandage cloth, wrapped round a glass cylinder, maintained wet by dipping its two ends into a vessel containing distilled water. The candles were exposed on the roof of a high building at the exposure site and shielded from sun and rain by means of an overhead cover which allowed free passage of air.

Sulphur dioxide — The amounts of sulphur dioxide present in the atmosphere for different months during the period January 1955 to November 1956 were recorded (Fig. 2); the values were high during the winter months and particularly low during the rainy season.

Insoluble atmospheric impurities — A deposit gauge of standard dimensions as specified in the *British Standard Specification No.* 1747 (1951) was used for the collection and measurement of atmospheric insoluble impurities. The amounts and the nature of insoluble impurities present in the atmosphere are recorded in Table 1.

Meteorological data — The temperature data recorded during the period November 1954 to October 1956 showed that the average monthly temperature was maximum (*c.* 95°F.) during May and minimum (*c.* 68°F.) during January.

Wind velocity (Fig. 2) was maximum during July (10 and 16 miles/hr respectively in July 1953 and 1956) and minimum (6 miles/hr) during October.

The percentage relative humidity of the atmosphere recorded during the period showed that the average monthly maximum humidity was highest (95 per cent) during the period July to September each year and minimum (40 per cent) during November.

Results

Corrosion of mild steel under outdoor exposure condition — The rates of corrosion of mild steel under outdoor exposure condition during different months of the year are shown in Fig. 3. The results cover a period of two years (November 1954 to October 1956) and show the seasonal and yearly variations. Corrosion was very high during the rainy season (June-September).

Effect of initial exposure conditions on rate of corrosion — Fresh sets of mild steel panels were exposed in each successive month for a period of one year in order to ascertain if the total corrosion undergone by the panels is influenced by seasonal conditions at the time of initial exposure. The progressive weight increments and the total corrosion of the panels given in Table 2 indicate that the product of corrosion was removed from the metal surface during exposure in all cases (indicated by the negative values for weight increment figures) and that corrosion in one year varied from 2018 to 4385 mg./sq. dm.

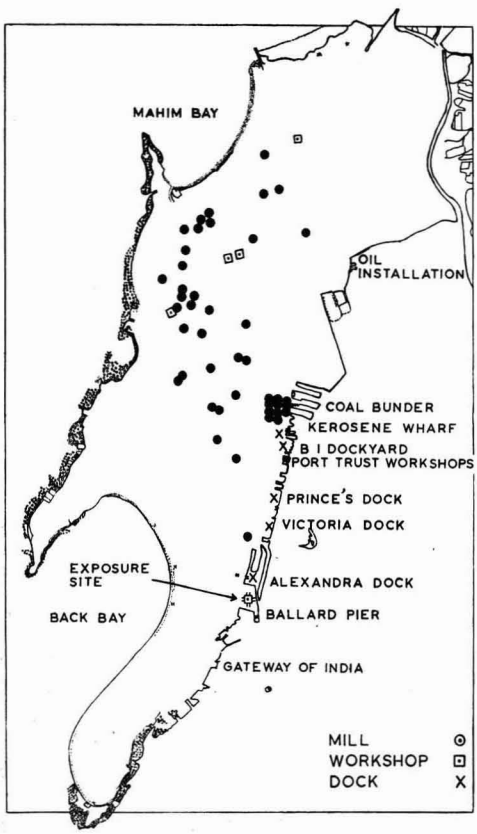

FIG. 1 — LOCATION OF EXPOSURE SITE AT BOMBAY

Non-ferrous metals — Bimonthly exposures of zinc panels were made to collect data on average monthly corrosion rates. In addition, separate sets of panels exposed bimonthly were continued to be exposed for a total period of one year to determine the yearly corrosion rates of panels started at different times of the year. The results obtained are recorded in Table 3.

A limited number of non-ferrous metals other than zinc and coatings of non-ferrous metals on steel were

TABLE 1 — INSOLUBLE ATMOSPHERIC IMPURITIES

Sl No.	Impurity	Month (1956)		
		February	March	April
1	Total undissolved matter, g./sq. m.	602·00	1085·00	897·00
2*	Undissolved matter soluble in CS_2 (tarry matter), %	0·20	0·20	0·90
3*	Other undissolved combustible matter, %	59·20	55·40	71·90
4*	Undissolved matter after ignition (ash), %	40·60	44·40	27·20

*These values are expressed as percentage of total undissolved matter.

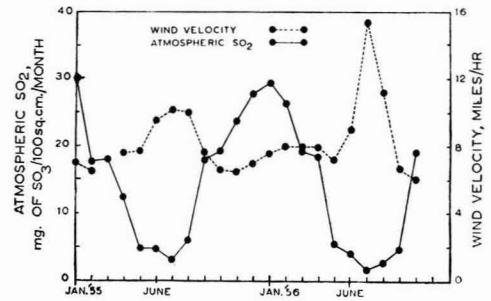

FIG. 2 — SULPHUR DIOXIDE CONTENT OF BOMBAY ATMOSPHERE AND WIND VELOCITY

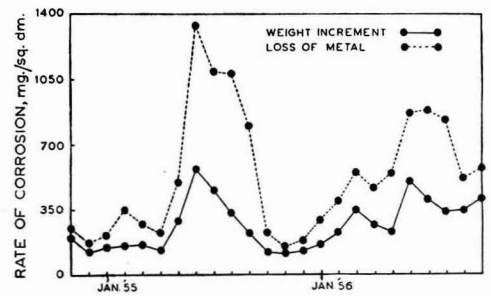

FIG. 3 — CORROSION OF MILD STEEL EXPOSED OUTDOORS DURING DIFFERENT MONTHS

TABLE 2 — CORROSION OF MILD STEEL UNDER OUTDOOR EXPOSURE CONDITIONS

Month in which exposure was started	Progressive wt increment in subsequent months* *mg./sq. dm.*												Loss of metal in 1 year's exposure *mg./sq. dm.*	Loss of metal in the first month of exposure *mg./sq. dm.*
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
1954														
November	190	219	107	33	−1·2	−8·9	126	518	866	834	483	334	3902	251
December	142	182	348	3	−11·4	124	479	496	1098	583	−1303	−1367	3981	169
1955														
January	147	62	26	30	156	507	851	752	446	−1084	−1108	−1108	3604	207
February	152	126	418	236	481	811	728	292	−580	−606	−616	−629	3124	345
March	168	144	343	668	1080	1250	960	−785	−1643	−1773	−1801	−1868	3824	273
April	136	330	649	701	474	−269	−450	−121	−829	−846	−1174	−1253	3235	222
May	261	579	657	530	−46	−367	−1199	−1229	−1280	−1289	—	−1494	3171	494
June	514	720	630	−1047	−2473	−2664	−2743	−2769	−2804	—	−3046	−3060	4385	1338
July	426	742	430	−606	−1541	−1837	−1892	−2081	—	−2427	−2386	−2078	3253	1096
August	301	148	106	58	30	21	15·5	—	−59	−30	56	85	2978	1076
September	96	112	37	9	11	−0·2	—	−60	72	269	505	61	2310	798
October	120	139	132	113	142	—	93	318	465	385	184	140	2108	219

*Calculated from the initial wt of panels.

TABLE 3 — CORROSION OF ZINC UNDER OUTDOOR EXPOSURE

Month in which exposure was started	Corrosion (loss of metal) *mg./sq. dm.*	
	Average monthly corrosion based on bimonthly exposure	Corrosion in 1 year
1956		
January	12	260
March	29	204
May	34	545
July	59	203
September	54	127
November	40	111

TABLE 4 — CORROSION OF NON-FERROUS METALS UNDER OUTDOOR EXPOSURE CONDITIONS

Metal	Wt. increment (*mg./sq. dm.*)		Loss of metal* in 1 year *mg./sq. dm.*
	After 6 months	After 1 year	
Copper	25	72	87(a)
Brass	11	78	69(a)
Lead	−17	24	30(b)
Galvanized iron (zinc coating 0·0014 in.)	36	85	293(c)

*Corrosion product removed by treatment with (a) 5 per cent H_2SO_4, (b) 1 per cent acetic acid, and (c) 10 per cent chromic acid.

included in tests under outdoor exposure conditions. The corrosion values obtained after one year's exposure are given in Table 4.

Corrosion of mild steel under indoor exposure condition — Mild steel panels were exposed in vertical positions inside a Stevenson's screen normally used in observatories. The screen was kept outside and prevented direct wetting of metal specimens by rain and dew but allowed free access of air through the louvers.

The rates of corrosion of mild steel in different months are recorded in Table 5. For comparison, the corrosion rates under outdoor conditions, calculated from Fig. 3, are also included.

The rates of corrosion of mild steel inside Stevenson's screen are consistently lower than those under outdoor conditions (Table 5), the difference being high during the rainy reason (June-September).

The yearly corrosion rates of mild steel and zinc panels started in January 1956 inside the Stevenson's screen were found to be 700 and 150 mg./sq. dm. respectively.

TABLE 5 — CORROSION OF MILD STEEL INSIDE A STEVENSON'S SCREEN

Month of exposure (1956)	Corrosion inside Stevenson's screen		Outdoor exposure* (loss of metal)
	Wt increment *mg./sq. dm.*	Loss of metal *mg./sq. dm.*	*mg./sq. dm.*
January	16	133	293
February	69	197	391
March	106	185	550
April	57	202	463
May	58	230	540
June	94	287	866
July	75	197	883
August	85	264	833
September	54	73	510
October	306	242	569
November	223	219	569
December	14	62	230

*Values calculated from data in Fig. 3.

Discussion

The maximum, mean and minimum humidities at Bombay are higher than the critical humidity value (*c.* 70 per cent) for corrosion of iron[3,4] for 12 months, 5 months and 4 months respectively in the year (Fig. 4). In addition, there is heavy rainfall (*c.* 80 in. per year) distributed over 5 months and the total number of rainy days is about 116. The concentration of sulphur dioxide in the atmosphere is also fairly high. Strong wind removes gaseous and suspended impurities in the atmosphere from their sources accounting for the lower values in some months. In winter months fog and condensation prevent the dispersal of atmospheric pollution. Lower values obtained in rainy season are attributed to the cleansing action of rain. The proximity of sea accounts for the salinity in the atmosphere (Fig. 4). Average temperature is high but the diurnal fluctuations are not big enough to induce condensation as was indicated by the absence of any measurable amount of dew in outside exposure tests. The site is thus characterized by heavy rainfall, high humidity, fairly high temperature and industrial and marine pollution. All these conditions favour corrosion and are responsible for the high incidence of corrosion of mild steel observed in this site under outdoor conditions.

Corrosion of mild steel under indoor conditions (inside Stevenson's screen) is lower (av. 191 mg./sq. dm./month) than under outdoor exposure conditions (av. 558 mg./sq. dm./month) (Table 5), because in the former case specimens are protected against rain.

The dependence of corrosion rate of mild steel on the time of initial exposure has been reported[1,5]. The yearly corrosion rate varies between 2000 and 4000 mg./sq. dm. but is not related to the initial rate of corrosion during the months in which exposure was started (Table 2).

In Fig. 4 are plotted the corrosion rates (loss of metal) during different months along with various factors which influence corrosion, viz. humidity, sulphur dioxide, salinity and rainfall. It would be

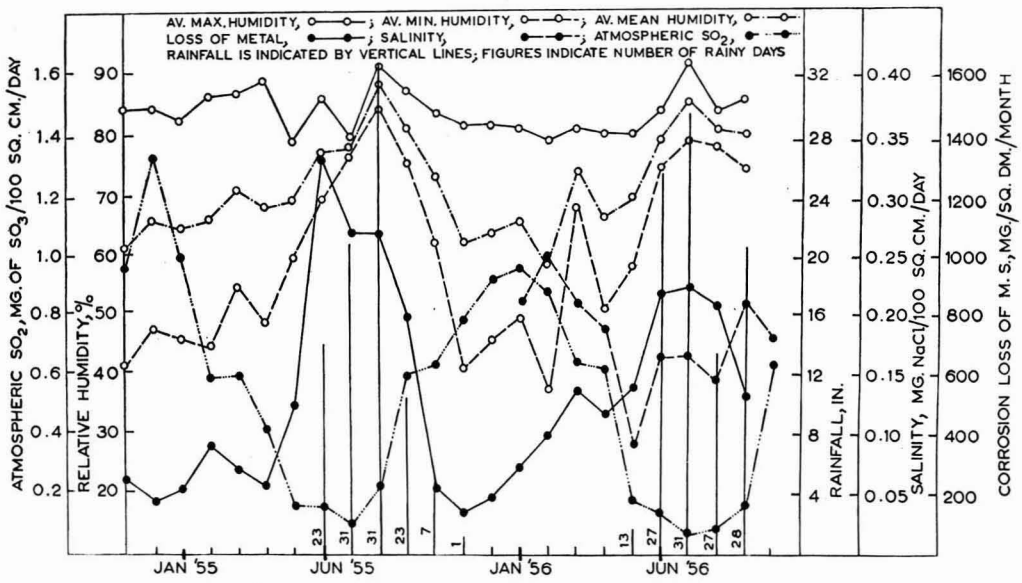

FIG. 4 — RELATION BETWEEN THE RATE OF CORROSION OF MILD STEEL AND FACTORS INFLUENCING CORROSION

seen that there is a marked similarity between the corrosion and the different relative humidity curves, particularly the minimum and mean humidity curves. During the rainy season the amount of corrosion is related to the quantity of rainfall. Sulphur dioxide does not appear to have any influence on corrosion. Hudson[6] established a correlation between the corrosion rates of mild steel and zinc and the amount of sulphur dioxide in air under industrial and highly humid conditions in U.K. The lack of such a correlation in the present investigation, in spite of the high humidity, at Bombay is attributed to the relatively lower amounts of sulphur dioxide (sulphur dioxide content of air at Bombay and Sheffield are 0·47 and 3·6 mg. SO_3/100 sq. cm./day respectively). Ambler[2] has found that in marine sites salinity of the atmosphere determines corrosion rates. Although the salinity at Bombay is much lower than that at the sites investigated by Ambler, some correlation between the salinity and the rate of corrosion of mild steel is evident (Fig. 4).

Among non-ferrous metals examined, the corrosion of zinc and galvanized steel is appreciable but much less severe than that of mild steel; the rate of corrosion of mild steel during one year is about 12 times greater than that of zinc. The rates of corrosion of copper and brass are low (about one-forty-fourth of mild steel), which is due to the formation of protective film of the corrosion product on the metals. The protective nature of the green 'patina' (basic copper sulphate) formed on copper has been examined by Vernon[7]. The corrosion of lead is negligible.

Summary

The rates of corrosion of mild steel exposed outdoors at Bombay are very high during the rainy season (*c.* 925 mg./sq. dm./month), and is lower, and nearly of the same order, during the other months (about 332 mg./sq. dm./month). The rate of corrosion during a year varies from 2108 mg./sq. dm. (1·01 mils per face) to 4385 mg./sq. dm. (2·11 mils per face) depending on the season of the year during which exposure was started.

The extent of atmospheric pollution in Bombay due to sulphur dioxide is appreciable (average value = 0·47 mg. of SO_3/100 sq. cm./day). Pollution is considerably reduced by rain and high wind velocity.

There is appreciable salinity also (av. = 5·4 mg. NaCl/100 sq. cm./month) in the atmosphere. There is a good correlation between the rate of corrosion of mild steel and humidity. The maximum humidity remains above the critical humidity value for the corrosion of steel (70 per cent) throughout the year and the mean and minimum humidities for about 4-5 months. Rain and salinity also influence corrosion rates.

Corrosion of mild steel under indoor conditions is about one-third of that suffered by it under outdoor conditions. Also, under outdoor conditions mild steel corrodes 12 times more than zinc and galvanized iron, 44 times more than copper and brass, and 110 times more than lead.

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Exploitation of Sambhar Lake Bitterns

K. SESHADRI & (Late) S. D. BUCH
Central Salt Research Institute, Bhavnagar

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A process for recovering sodium sulphate, sodium chloride and sodium carbonate from liquid and solid bitterns and sub-standard salt, worked out on the basis of phase rule studies, is described. It consists of the following steps: (1) elimination of algae from the liquid bittern or aqueous extracts of solid bitterns by chlorine treatment; (2) adjustment of the composition of the solution and chilling it to 0°C.; (3) separation of $Na_2SO_4.10H_2O$ by centrifuging; (4) dehydration and purification of sodium sulphate by solar heat; (5) recovery of sodium chloride by solar evaporation of desulphated liquor until the liquid reaches 10 per cent sodium carbonate strength; and (6) carbonation of the desalted liquor for the recovery of sodium carbonate as bicarbonate.

Improvements in recoveries are effected by simple recycling of the residual liquors. The overall recoveries are: sodium sulphate 90 per cent (technical grades of I.S.S.); sodium chloride (99 per cent purity), 55 per cent; and sodium carbonate (98 per cent purity), 73 per cent.

THE chief constituents of Sambhar Lake bittern are sodium chloride, sodium sulphate and sodium carbonate. It is estimated that it is possible to recover annually about 15,000 tons of sodium sulphate, 8000 tons of sodium carbonate and 40,000 tons of edible salt from the estimated 250,000 tons of liquid bittern[1] rejected annually at the Sambhar Lake.

The liquid bittern is discharged into a region of the lake called East Lake. The first fraction of solids separating from this liquid during solar evaporation is mostly sodium chloride but containing more impurities than tolerable for human consumption and is known as sub-standard salt. The solids resulting from complete drying up of the liquid bittern are known as solid bittern. The solids which have accumulated over some years in the East Lake and the liquid bitterns form a rich source of the products mentioned above. The composition of solid and liquid bitterns and of the sub-standard salt is given in Table 1. The solubility relationships of these salts have been studied[2] with the object of determining the conditions for separating the constituents from the liquid bittern.

Application of solubility data for the recovery of the constituents

The quaternary invariant compositions at lower temperatures given in Table 2 enable one to lay down the conditions for the separation of the constituents. The data show that the solubility of sodium sulphate in a solution saturated with sodium chloride and sodium carbonate diminishes with lowering of temperature. Therefore, if liquid bittern of 29°Bé at room temperature is cooled to 10°, 5° and 0°C., the amount of sodium sulphate separating out as decahydrate from the liquid at these different temperatures will be 36, 66 and 88 per cent respectively of the total sulphate content of the bittern. The desirable temperature to which cooling should be effected is 0°C. Chilling further to —5°C. will improve the yield to 90 per cent but the slight improvement will not be commensurate with the cost of cooling involved. For the maximum yield, it is desirable to have initially high concentration of sodium sulphate in the bittern (sample No. 2, Table 1) as the sodium sulphate left out at 0°C. is constant.

The purity of the sodium sulphate can likewise be predicted from the equilibrium concentrations. The volume diminution taking place on chilling the bittern to a lower temperature is due to two causes: (1) the removal of water as decahydrate with sodium sulphate; and (2) the removal of appreciable quantities of dissolved sodium sulphate as solid from the bittern. These two causes account, as determined by experiment, for a diminution of approximately 10-12 per cent in the volume of the solution thus raising the concentrations of sodium chloride and sodium carbonate in the chilled mother liquor. If the concentrations of sodium chloride and sodium car-

TABLE 1 — COMPOSITION OF LIQUID AND SOLID BITTERNS AND SUB-STANDARD SALT

PARTICULARS	SAMPLE No. 1	SAMPLE No. 2	SAMPLE No. 3	SAMPLE No. 4
Density, °Bé	29·2	30·7	—	—
NaCl, %	21·1	19·5	66·1	91·5
Na_2SO_4, %	6·3	7·5	30·1	7·5
Na_2CO_3, %	2·8	3·2	2·0	0·6
$NaHCO_3$, %	0·8	0·9	—	—
Insolubles, %	—	—	1·2	0·4

Sample No. 1, liquid bittern discharged from kyar; sample No. 2, liquid bittern from East Lake reservoir; sample No. 3, solid bittern; and sample No. 4, sub-standard salt.

TABLE 2 — QUATERNARY INVARIANT COMPOSITIONS

CONSTITUENT	COMPOSITION OF SATURATED SOLUTION AT			COMPOSITION OF SAMBHAR BITTERN AT
	0°C.	5°C.	10°C.	35°C.
NaCl, g./100 ml.	28·70	26·26	23·64	26·66
Na_2SO_4, g./100 ml.	0·94	2·64	4·99	7·80
Na_2CO_3, g./100 ml.	3·02	5·84	8·58	3·50

bonate in the mother liquor go above the invariant composition (287 g. of sodium chloride and 30·8 g. sodium carbonate per litre), sodium chloride and sodium carbonate also crystallize out along with sodium sulphate and contaminates it. For example, if one litre of 29°Bé bittern is chilled, 87 g. of water is removed as water of hydration raising the concentration of sodium chloride in the mother liquor from 266 to 292 g. sodium chloride per litre. Thus nearly 5 g. of sodium chloride separate out along with 69 g. of sodium sulphate on the first account and 8·5 g. of sodium chloride separate out because of the total diminution of 10-12 per cent of volume. The purity cannot, therefore, be higher than 89 per cent. Likewise, sodium carbonate contamination can also be predicted.

It is clear that straight chilling the liquid bittern of 29°Bé will yield impure sodium sulphate. In order to control the purity of sodium sulphate, the composition of the bittern should be adjusted by adding a calculated quantity of water to prevent the crystallization of sodium chloride, without appreciably affecting the yield of sodium sulphate. Such dilution which will be in the neighbourhood of about 10 per cent of the total volume will also obviate contamination with carbonate. The criterion is that the bittern when chilled for the precipitation of Glauber's salt must not leave a mother liquor having more than 285 g. sodium chloride per litre at 0°C.

The above argument is for treating the bittern for the recovery of sodium sulphate by chilling as the first step in the separation of its constituents. An examination of equilibrium concentration of sodium bicarbonate in a solution saturated with sodium sulphate and sodium chloride[3] is sufficient to convince that it will not be economical to carbonate large volumes of 3-4 per cent sodium carbonate solution to recover the carbonate as bicarbonate. Removal of sodium sulphate first by chilling and solar evaporation of desulphated liquor till it reaches about 10 per cent sodium carbonate (w/v) will yield pure sodium chloride. This mother liquor will be more suitable for the economical recovery of sodium carbonate by carbonation.

These deductions have been applied in working out the process described in this paper for the separation of the constituents.

Experimental procedure

Liquid bittern of Sambhar Lake was used as such for chilling. Suitable solutions were prepared from solid bittern and sub-standard salt by dissolving (a) one part of solid bittern in two parts of water and (b) one part of sub-standard salt with one part of water. In the case of solid bittern assaying 30 per cent and more of sodium sulphate, a small amount of sodium sulphate remains undissolved and this can be utilized in later batches. In the case of sub-standard salt, the proportion of solid/water was fixed from phase rule data, to secure a saturated solution, as nearly as possible, of invariant composition containing 75-80 g. of sodium sulphate per litre of solution on the one hand and to get on the other hand a solid residue, rich in sodium chloride and as free from sulphate and carbonate as possible. The residue thus obtained analysed: NaCl, 98; Na_2SO_4, 0·9; Na_2CO_3, 0·4 and insolubles, 0·6 per cent; this product is of the edible standard.

The natural liquid bittern or solution prepared from solid bittern or from sub-standard salt was next treated with sodium hypochlorite (or chlorine gas), the dosage being equivalent to 0·5 to 1·0 g. of available chlorine per litre, to eliminate algae[4], decolourize and deodorize the solution. This liquid was then allowed to stand for about 24 hr, and clear solution siphoned out and diluted with approximately 10-12 per cent of its volume of water and transferred to a cylindrical S.S. vessel fitted with a S.S. tube coil through which cooling brine at −5°C. was circulated. The bittern was kept vigorously stirred and temperature allowed to fall to 0°C. A small quantity of Glauber's salt was added for seeding and the temperature maintained at 0°C. for about half an hour during which the crystallization of decahydrate was practically complete. The slurry was pumped into a basket centrifuge for the separation of the solid. The solid obtained from the centrifuge was sodium sulphate in the form of decahydrate

TABLE 3 — RECOVERY OF SODIUM SULPHATE BY CHILLING

Particulars	Bittern sample			
	No. 1	No. 2	No. 3	No. 4
Vol. of bittern, litre	5·0	5·0	5·0	5·0
Density of bittern, °Bé	26·5	28·5	28·5	30·0
Composition of bittern (g./100 ml.)				
NaCl	25·8	26·6	26·6	25·6
Na_2SO_4	7·0	10·8	10·8	8·9
Na_2CO_3	0·7	0·9	0·9	4·6
Water added to bittern, litre	nil	nil	0·5	0·6
Chilling temp., °C.	5	0	0	0
Vol. of filtrate after chilling, litre	4·8	4·4	4·8	4·9
Density of filtrate, °Bé	24·5	24·5	24·6	25·6
Composition of filtrate (g./100 ml.)				
NaCl	26·6	28·7	26·8	26·2
Na_2SO_4	2·8	1·3	1·4	1·9
Na_2CO_3	0·6	1·0	0·9	4·4
Yield of Na_2SO_4 (dried at 110°C.), g.	225	510	480	370
Composition of solid product (%)				
Na_2SO_4	97·5	94·2	98·0	92·6
NaCl	1·7	5·2	1·2	3·4
Na_2CO_3	0·8	0·6	0·8	3·4
Recovery, %	62·4	89·0	87·5	81·2

Sample No. 1, bittern from sub-standard salt; sample Nos. 2 and 3, obtained from solid bittern; and sample No. 4, natural liquid bittern.

TABLE 4 — EVAPORATION DATA FOR DESULPHATED LIQUID BITTERN

[*Volume of bittern used*, 17 *litres*; *density*, 25·8°*Bé*; *composition of bittern*: *NaCl*, 23·4%; Na_2SO_4, 1·9%; Na_2CO_3, 4·2% (*w/v*); *evaporation was carried out during October*]

Particulars	Crops collected between		Liquor at 32°Bé
	25·8° and 30°Bé	30° and 32°Bé	
Purity of NaCl			
NaCl, %	99·3	97·1	22·3
Na_2SO_4, %	0·1	0·4	5·5
Na_2CO_3, %	0·6	2·9	10·1
Yield of NaCl, kg./litre	2·2	0·5	6·0
Recovery of NaCl, %	55·0	12·0	33·0

The analytical figures are for samples dried at 110°C.

$Na_2SO_4.10H_2O$). Typical data obtained with 5-litre batches are recorded in Table 3.

The effluent from the centrifuge had a density of about 25°Bé and contained 260-275 g./litre of sodium chloride. This liquid was transferred to enamelled trays for solar evaporation and concentrated until the density rose to 29°-30°Bé. Yields and purities of sodium chloride are given in Table 4.

The liquor from the previous stage, after the separation of sodium chloride, contained 80-100 g./litre of sodium carbonate. This was subjected to the action of carbon dioxide in a glass carbonating tower, which was maintained at 20°-22°C. by circulating cold water through a coil. The bicarbonate precipitated was next centrifuged out and washed with a small quantity of cold water. The filtrate was transferred to the chilling tank for the recovery of residual sodium sulphate. The centrifuged solid was calcined at 180° to obtain sodium carbonate. The recovery of technical grade sodium carbonate (Na_2O, 57-58 per cent) on the basis of the original carbonate content of bittern was 73 per cent.

Dehydration and purification of sodium sulphate decahydrate — A number of technical and mechanized methods have been worked out for the dehydration of Glauber's salt. A method worked out in this Institute makes use of solar energy for dehydrating and purifying the sulphate.

Sodium sulphate decahydrate (56 per cent water and 44 per cent Na_2SO_4) melts at 32·5°C. leaving 63·6 per cent of the original sodium sulphate in solid anhydrous form and a saturated solution of the remainder of the sodium sulphate. When the decahydrate is spread in a layer of 3 in. thickness on an inclined platform in the open sun, the hydrate melts out in 3-4 hr. Anhydrous sodium sulphate is left behind on the platform while the saturated solution runs down the platform. The latter is allowed to collect in a shallow tank at the bottom of the platform and evaporated by solar heat. The density of saturated solution of pure sodium sulphate is 36°Bé at 32°C., but the density of the solution obtained from the cake in this process is lower, on account of the presence of sodium chloride, and varies between 33° and 34°Bé. As solar evaporation progresses, anhydrous sodium sulphate separates out. This is ladled out when sufficient quantities separate out. The evaporation is allowed to continue until the density of the liquid reaches 29°Bé when the composition corresponds to that of quaternary invariant point. Evaporation beyond this density contaminates the sodium sulphate with more than the desired

TABLE 5 — YIELD AND PURITY OF SODIUM SULPHATE OBTAINED BY SOLAR EVAPORATION

$Na_2SO_4.10H_2O$ present in original product %	Crop yield between		Total recovery: Technical Grade (A+B) %
	33° and 31°Bé Grade A %	31° and 29°Bé Grade B %	
96	76	14	90
90	77	11	88
85	—	75	75

I.S.S. Technical Grade A: Na_2SO_4, 99·2%; NaCl, 0·5%.
I.S.S. Technical Grade B: Na_2SO_4, 96%, NaCl, 1·5%.

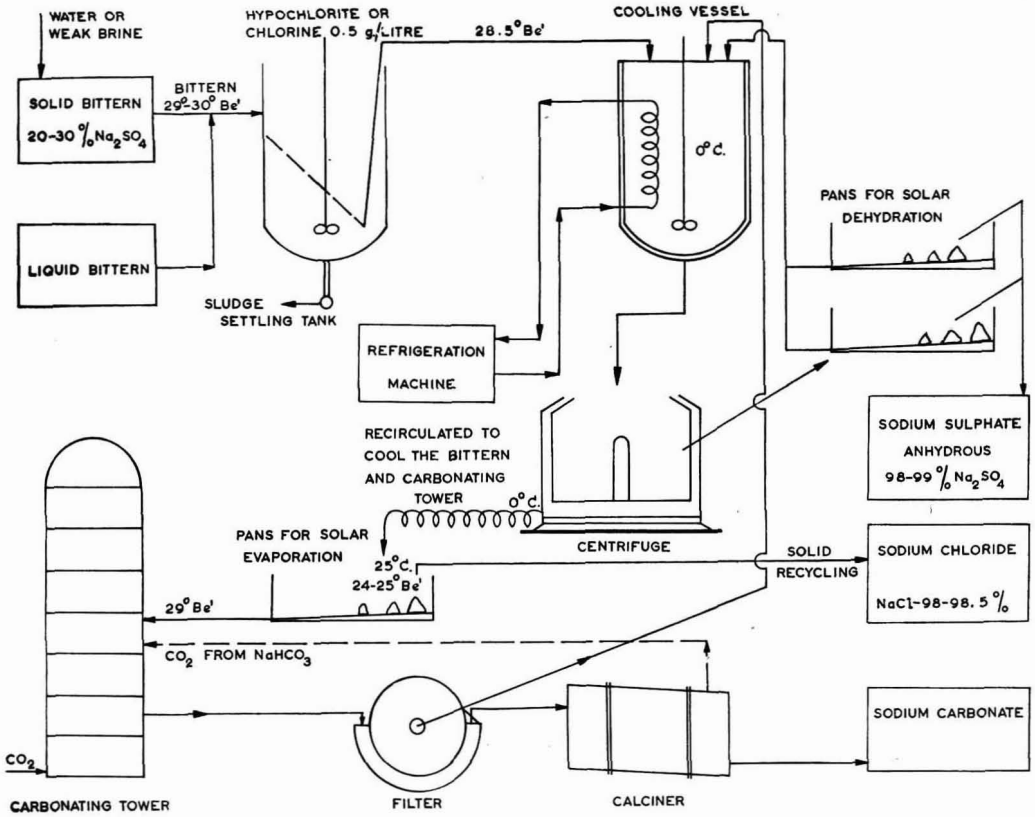

FIG. 1 — FLOWSHEET: PROCESS FOR THE RECOVERY OF SODIUM SULPHATE, SODIUM CHLORIDE AND SODIUM CARBONATE FROM SAMBHAR LAKE BITTERN

quantity of sodium chloride. The liquid, therefore, is now transferred to the chilling tank. The anhydrous sodium sulphate left on the platform in the first instance and fractions collected from the evaporating liquid between 33° and 31°Bé analyse to 99·7 per cent purity (I.S.S. Technical Grade A[5], Na_2SO_4, 99·2 and NaCl, 0·5 per cent) while the fraction separating out between 31° and 29°Bé analyses to more than 98·5 per cent sodium sulphate (I.S.S. Technical Grade B[5], Na_2SO_4, 96·0 and NaCl, 1·5 per cent). The total recovery of Grade A and Grade B sodium sulphate from the cake is 90 per cent (Table 5).

It should be mentioned that the decahydrate also separates from the saturated solution mentioned above during cool nights but the decahydrate could once again be spread on the inclined platform during sunshine to get anhydrous salt. This process has been tried out on a larger scale with batches of 3-4 cwt. and the results are reproducible and satisfactory.

The entire process (Fig. 1) has been worked out on a bench pilot plant scale, dealing with 100 gallons of bittern per batch and effecting economies (1) in refrigeration by precooling the liquor to be chilled with the cold desulphated liquor emerging from the centrifuge in the previous operation and (2) in water consumption by using desulphated liquor to leach sulphate and carbonate from solid bittern, which incidentally leaves as solid residue upgraded sodium chloride. The process has been worked continuously on this scale with satisfactory results.

Acknowledgement

We wish to express our thanks to Dr A. N. Kappanna for his keen interest and valuable suggestions during this investigation.

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REVIEWS

PERKIN CENTENARY, LONDON — 100 YEARS OF SYNTHETIC DYESTUFFS (Pergamon Press Ltd, London), 1958. Pp. xii + 136. Price 42*s*. net

A note on the Perkin Centenary and its importance appeared in this *Journal* [**15A** (1956), 211]. The present volume is a record of the celebrations which were held in London from 7 to 10 May 1956. In a brief foreword Sir Robert Robinson, Chairman of the Perkin Centenary Celebrations Committee, reminds us that Perkin "was inspired by a sense of mission due to his intimate personal conviction of the importance of the thing he had been entrusted with" and that "many of the circumstances connected with Perkin and his great achievement were dramatic and even romantic". The main contents of the volume are four lectures: (1) The life and work of Perkin by Prof. John Read, (2) The development of the dyestuffs industry by Mr Clifford Paine, Chairman of the I.C.I. Dyestuffs Division, (3) The tinctorial arts today by Dr J. G. Evans, Director, Calico Printers' Association, and (4) The development of organic chemistry since Perkin's discovery by Sir Alexander Todd. All the four lectures are worthy of the great occasion. As Prof. Read has stated, "scientists are apt to dwell upon the progress of science without paying proper tribute to the work and the personalities of those forbears to whom their own labours owe so much". The form which the tribute to Perkin has taken is particularly appropriate. Prof. Read has given us new and interesting glimpses into Perkin's domestic life. Mr Paine's account of a hundred years of the dyestuff industry is an absorbing story, but disappointingly short. Dr Evans writes with long and intimate knowledge of dyeing and printing. No one could present a clearer picture than Sir Alexander Todd of the highlights of organic chemistry in its progress during the last century. Apropos frequent and somewhat irritating discussions concerning our National Laboratories, one might quote from Todd: "In these days we hear a lot ot talk about fundamental research, applied research, pure research, academic research, and so on. I find it hard at times to understand exactly what people mean by these terms, and in organic chemistry they seem rather meaningless, save in so far as research in an academic laboratory is, or should be, pursued without a purely economic objective, whereas industrial research must necessarily, at shorter or longer range, have an economic objective." And again from him: "Our science has its surprises and its rewards in store for the Perkins of 1956, just as it had in 1856".

The speeches made by the Marques of Salisbury and others at the celebration banquet are also reported.

K.V.

SUGAR FROM SCARCITY TO SURPLUS by Hubert Edson (Chemical Publishing Co. Inc., New York), 1958. Pp. 217. Price $ 5.00

History is read in the lives of outstanding personalities. This book, a narrative of the life of a sugar technologist, Hubert Edson, depicts the history of the development of the sugarcane industry in the western hemisphere. The story relates to a period of sixty-two years, from 1888 to 1950, during which Edson served the sugar industry, as a chemist, as a builder of factories and finally as an engineering consultant. During these six decades or so the world sugar industry developed from scarcity to surplus, from a world production of about 5 million tons of sugar in 1888 to about 50 million tons in 1950. At the turn of the century men were looking for new crops and new processing techniques to satisfy the growing demand. Now the problem is what to do with surplus sugar. Sugar is now being utilized in the manufacture of cosmetics, plastics and detergents. The book is in fact a dual story: a description of important men and their projects, and a recount of difficulties and technological triumphs.

India is somewhat in a similar phase of development. Much that is said in the book can be usefully adopted in India.

Efficiency of production was so low in the closing years of the last century and the people had almost lost faith in the suitability of sugarcane as the raw material for sugar production. Extensive experiments were made to develop Sorghum as an alternative crop. The diffusion process of sugar extraction, practised in Europe for beet sugar manufacture, appeared to be more attractive than the milling process. But systematic chemical control introduced for the first time by Edson and subsequent improvements in mill design, from small tandems of low grinding rates of about 300 tons per day to large heavily powered tandems of 5000 tons per day comprising a larger number of mills and preparatory devices, rehabilitated confidence in sugarcane and the milling process. These developments made all the difference between success and failure. Edson's

pioneering work as a chemist established the fact that the chemist was the logical man to direct processing operations since from him came the information necessary to efficient processing. This fact is still to be fully realized in India. The salvation of the Indian sugar industry also appears to lie in changing over to large milling tandems.

Edson's experiences given in the book bring out clearly some notable conclusions: apathy and conservatism of operatives towards the introduction of new ideas often affect the success of a new project and the executives should bear them out patiently if success is to be achieved; inefficiency of labour, whether resulting from undernourishment or ignorance, is one of the usual drawbacks and hinders progress but such situations have to be handled with sympathy; good plants and projects can end in failure due to bad management; no new experiments should be made in a new enterprise; and patience and perseverance are most essential during difficult situations.

Finally to the question '*what is the most important factor in producing sugar yields at low cost?*', Edson's answer is '*cleanliness and common sense*'. Besides avoiding trouble and repairs, cleanliness is a great moral builder for employees. Without order and cleanliness the finest plant can end up as a financial burden. By 'common sense' Edson means the ability to do the right thing at the right time.

After reading the book one cannot help wishing that Edson would give to the sugar world yet another book containing a more detailed account of his technological pursuits, his tips on how to design, operate and manage a sugar factory.

S. N. GUNDU RAO

AN INTRODUCTION TO STATISTICAL MECHANICS — International Series of Monographs on Physics, Vol. 2, by J. S. R. Chisholm & A. H. de Borde (Pergamon Press Ltd, London), 1958. Pp. ix + 160. Price 35*s*. net

The book is intended for students pursuing an Honours course in physics or mathematics, as the authors state in the preface. The method of treatment is the ensemble method introduced by a modification of the Darwin-Fowler method. This is a welcome feature as also the avoidance of the theory of complex integration. The treatment given is that of equilibrium statistical mechanics which has been done in a concise and yet clear manner. 'Fluctuations' has been considered as also the Nernst Heat Theorem and Absolute Entropy. The Law of Mass Action, Equilibrium of Hydrogen Isotopes, Specific Heats, Electronic Specific Heat, Debye Theory of Crystals, Equilibrium of the Crystal and Its Vapour, Thermionic Emission, Metallic Conduction, Weiss Theory of Ferromagnetism, Hysterisis and Domain Theory, Oscillator and Field of Radiation, are the topics treated. The book contains little original material as the authors say but the attempt at an elementary exposition is, however, to be appreciated. It may very well serve as an introduction to advanced texts in the field, and may be recommended for the postgraduate students of Indian universities.

D. S. SUBBARAMAIYA

PROCEDURE FOR OBTAINING TRANSIENT RESPONSE FROM FREQUENCY RESPONSE by V. V. Solodovnikov, Yu. I. Topchev & G. V. Krutikova. Translated from the Russian and edited by A. Gelbtuch (Infosearch Ltd, London; *Distributors*: Cleaver-Hume Press Ltd, London), 1958. Pp. 193 + 13 nomographs. Price 42*s*.

In the analysis of automatic control problems, the transient response method was originally employed, but the difficulty encountered in applying it to cases involving higher order differential equations made workers turn to the frequency response method which had been highly developed with the aid of many skilled techniques. In the last few years, however, there has been a noticeable increase in the interest of designers of feedback systems for calculating the transients resulting from step changes in the input. In the classical method of calculating the transient response of a control loop, the essential difficulty has been the determination of the roots of the characteristic equation, and special devices, like the root-locus method, the algebraic method of synthetic division, the method of conformal mapping, and other graphical methods have recently been employed. Since the method of computing transient response from frequency response is nothing but the finding of an inverse Laplace transform, this difficulty can be ascribed to the fact that the exact determination of such inverses becomes extremely complicated in almost all the cases that are of interest in engineering practice.

It, therefore, becomes essential to devise suitable approximate methods in dealing with transients. Notable work has already been done to enhance the utility of this method by suitable systematization, and by preparing nomographic charts using graphs. One such method which materially reduces the labour of computing transient response from frequency response is that originally due to Floyd [see *Principles of Servomechanisms* by G. S. Brown and D. P. Campbell (Wiley & Sons, New York), 1948, Chap. XI, p. 338], which approximates to the shape of the frequency response curve by a series of straight line segments, and finding the time response function $h(t)$

depending on the driving function (not on the initial conditions), corresponding to this approximation. The straight line approximation is written as a sum of trapezoidal functions, the inverse Laplace transform is applied to each of these trapezoids, and the resulting time functions are added to obtain the approximate $h(t)$.

The authors of the book under review fully exploit this method of trapezoidal frequency responses for the derivation of transient responses, as it can be applied even when the starting data consist of frequency responses only. Auxiliary graphs and nomograms, facilitating plotting of frequency responses used for derivation of transient responses, are given in an insert at the end of the book, and extensive tables covering nearly a hundred pages of the h_k-functions are also given to satisfy numerous requests from workers in the field.

Before setting up these graphs, nomograms and tables, an introductory chapter is devoted to the explanation of the principles, and the essence of the method of trapezoidal responses. Analysis of transient responses with the aid of the Laplace transform in the general case, thereby bringing out the relation between the frequency response and the impulse t-function, the consideration of special cases, in particular the trapezoidal frequency method indicating the conditions for its applicability, and the assessment of accuracy in using it form the major part of this chapter. The other deals with special features of application of the trapezoidal frequency method, an elegant derivation of the frequency response functions using the real circle diagram, and an explanation of the graphical method for determining these functions.

The second chapter, which is perhaps the most interesting part of the book, gives examples of plotting transient responses for seven specific automation problems, indicating also how the trapezoidal frequency response method can be applied to these cases. The seventh problem dealing with an automatic control system of the speed of a hydraulic turbine contains some novel features.

The third chapter is a preliminary to the explanation of the tables and nomographs that follow. Tables and nomographs for the construction of real and imaginary circle diagrams, and special cases of the same, in particular the case relating to the determination of the closed-loop magnitude and frequency characteristics from the open-loop magnitude-phase characteristic, are dealt with extensively. These are followed by tables of the h_k-functions and the insert nomographs.

The book is bound to be of great value to workers in the field and is also a clear indication of the advanced state of the science of automation in the U.S.S.R.

B. S. MADHAVA RAO

SOURCEBOOK ON ATOMIC ENERGY by Samuel Glasstone (D. Van Nostrand Co. Inc., Toronto, New York, London), Second Edition, 1958. Pp. 641. Price $ 4.40

The rapid advances that have taken place in the field of atomic energy since the first edition of this book was published in 1950 have made the publication of a revised edition desirable. Dr Samuel Glasstone, who is an eminent author and scientist of repute, is now consultant to the U.S. Atomic Energy Commission. In writing this book the author has provided a source of basic atomic energy information to people with different interests.

The earlier chapters give an introduction to the field of nuclear science. The foundations of the atomic theory and the different types of existing fundamental particles and their properties are clearly explained. Later, the developments in our ideas of atomic structure are described and a wave-mechanical treatment of this subject has been introduced. A chapter on natural radioactivity gives an historical development of the field, defines basic terms like decay constant and half-life, and describes the different radioactive series occurring in nature. Two chapters deal with nuclear radiations, their origin and interaction with matter, and the methods utilized for measuring them. The various instruments used for this purpose like ionization chambers, proportional, Geiger-Müller, scintillation and Cerenkov counters have all been described.

There is a useful chapter on isotopes, in which the discovery of the phenomenon of isotopy by Soddy and its relation to nuclear structure is given along with an account of the different methods used to separate stable isotopes. These include the gaseous and thermal diffusion methods, distillation methods, electrolytic separation, and chemical exchange methods.

Various particle accelerators developed in recent years to obtain charged particles of very high energy include the synchrocyclotron, the betatron and the electron and proton synchrotrons; of the last kind several recent machines have reached the billion electron volt mark and a brief description of these is included in the chapter on the acceleration of charged particles.

Three chapters deal with nuclear fission, the utilization of atomic energy and nuclear reactors respectively. They give an excellent account of the developments in this field since the fission of the nucleus was first established about twenty years

back. The first two of these chapters have been brought up to date and a brief account of the work on fusion reactions is also given. A completely new chapter on nuclear reactors has been included in this edition. General aspects of reactor design have been discussed and typical power reactors are described.

Radio-isotopes have found wide application in recent years in the fields of research, industry and medicine, and a complete chapter has been devoted to this aspect of the benefits of atomic energy. One is impressed with the versatile nature of the isotopic tool from the examples of applications given which extend over widely different fields, from the study of photosynthesis to the treatment of *Polycythemia versa*, from the determination of the uptake of phosphorus by plants to the measurement of the age of Egyptian tombs.

In a final chapter on radiation protection and health physics, the author defines the various radiation units employed and describes the possible radiation hazards and the area and personnel monitors used for protection. A brief mention is also made of the genetic effects of radiation.

The clear and highly readable style, as well as the comprehensive and up-to-date nature of this book, should make it worthy of possession by all scientific institutions and university libraries in the country.

V. K. IYA

CONSTITUTION OF BINARY ALLOYS — Metallurgy and Metallurgical Series — by Max Hansen in co-operation with Kurt Anderko (McGraw-Hill Book Co. Inc., New York), Second Edition, 1958. Pp. xix + 1305. Price $ 32.50

This book is the long-awaited, completely revised edition of Max Hansen's classic German work, *Der Aufbau der Zwistofflegierungen* (The Constitution of Binary Alloys), published by Julius Springer, Berlin, in 1936. The enormous amount of information made available in this field by metallurgists, crystallographers, physicists and chemists in the last two decades has been carefully analysed, critically evaluated and judiciously incorporated in the present work. Whereas the first German edition covered 828 binary alloy systems and contained 456 equilibrium diagrams, this English edition includes 1334 systems and 717 diagrams. The number of references has gone up from 5500 to 9800 and covers all publications up to the end of 1957.

The compositions of the alloys are given in all diagrams in atomic per cent. The weight percentages are just indicated along the other composition axis. An easy guide to the interconversion of atomic and weight percentages is given with the necessary logarithmic tables. Crystallographic data have been presented systematically and much valuable information on phase transformations in the solid state has also been included. The Appendix contains tables for the interconversion of temperatures in the Centigrade and Fahrenheit systems, the structural data of elements and crystal structure types. The book is neatly printed and attractively got up.

One cannot overstress the usefulness of this monumental work to teachers and investigators in the metallurgical and crystallographic fields. Although rather expensive, it ought to find a place in the libraries of all institutions devoted to teaching, research and development work in metallurgy. The authors deserve all praise for a magnificent achievement.

The usefulness of the work may be enhanced in the next edition by the inclusion of available information on phase transformations in pure metals. As far as the diagrams are concerned, the temperatures may perhaps also be indicated in the Fahrenheit system along the second temperature axis just as weight percentages have been marked along the second composition axis in the present edition.

T. R. ANANTHARAMAN

MECHANICS APPLIED TO ENGINEERING by G. H. Ryder (Cleaver-Hume Press Ltd, London), 1958. Pp. viii + 244. Price 21*s*. net

This book is a good contribution to the junior undergraduate texts on the important subject of Engineering Mechanics. The book offers a balanced presentation of the basic principles and the engineering applications of Statics and Dynamics. The first half of the book contains a fairly comprehensive discussion of Statics with chapters on concurrent, parallel and coplanar forces, friction, hanging cables and chains, and forces in three dimensions. Plane problems are considered extensively by both analytical and graphical means. The second half of the book, dealing with Dynamics, begins with chapters on straight line and plane motion of a particle. This is followed by an extensive treatment of work and energy, including a brief discussion on the principle of virtual work. The subsequent chapters deal with linear momentum and impulse, angular momentum, combined linear and angular motion, oscillations and motion in space.

The book includes a number of examples drawn from several fields of engineering and are illustrated with clear diagrams. The author has presented the material in a well written and a compact form. The reviewer, however, feels that, at places, brevity has been carried a little too far, particularly from the point of freshmen for whom the work is

intended. Thus in the case of three-dimensional force systems, the entire principles of equilibrium for concurrent and non-concurrent forces, concept of moments, along with illustrative examples, etc., have been compressed in about six pages of the text.

B. R. SINGH

FUNDAMENTALS OF HIGH POLYMERS — A Basic Orientation Text by O. A. Battista (Reinhold Publishing Corp., New York), 1958. Pp. 140. Price $ 5.50

This slender volume of 133 pages has been " written with the hope that it may serve as an introductory text-book for courses on high polymers at the undergraduate level " and to " serve as a handy reference for chemists, engineers, physicists and biologists engaged in academic research or industrial high polymer technology ".

It is evidently impossible to attain the prescribed goal within the compass of a few bulky monographs and understandably the present book falls far short of its professed goal. This volume is very similar to the ' rapid reading ' or ' made easy ' series with which Indian students are familiar. It touches upon almost all commercially important high polymers and their fundamental and technical aspects in a nutshell or ' headline ' manner. In doing so, however, many interesting facts and ideas have been collected often in a journalistic way; to mention a few: " In recent years hybrid corns have been developed in which the proportion of amylose has been increased to 70 to 80 per cent " (page 18); that the most notable use of methyl cellulose in pharmaceutical field is as appetite depresser, the product swelling in the stomach and giving one a ' full ' feeling even though it has no calorific value (page 27); the eating of wool by moth larvae " involves an initial breakdown of these cross-linkages by means of an alkaline fluid produced by the larvae, which makes the wool soluble for subsequent digestion " (page 31), etc.

The presentation, however, is highly unbalanced and scrappy. The author does not hesitate to treat readers whose knowledge of chemistry is of such level that the author has to inform them that " cellulose is made from water and carbon dioxide which contain three elements necessary for carbohydrate formation — carbon, oxygen and hydrogen " (page 14), to the intricacies of the integral and differential molecular weight distribution, the significance of X-ray diffraction diagrams, transitional geometry of high polymers, lateral order differential distribution curves, modulus of elasticity (without any definition or explanation), " electrons do possess an axial symmetry ", etc. The reviewer wonders what type of reader would derive any benefit from this sort of book with such unbalanced presentation and ' miniature dose ' but often fairly accurate information. The above defects definitely make the book unsuitable as a text-book or even as a ' popular science ' book, but may serve as rapid reading material for chemists of other disciplines. Figs. 2 and 3 contain some serious printing mistakes.

SANTI R. PALIT

COMPLEXOMETRIC TITRATIONS by G. Schwarzenbach. Translated by H. Irving (Methuen & Co. Ltd, London & Interscience Publishers Inc., New York), 1957. Pp. 132. Price 21*s*.

The present book is a translation of the original monograph in German entitled *Die Komplexometrische Titration*, first published in 1955. Since the subject of complexometry — a term now firmly established in scientific usage — has been developed a little over ten years only, this monograph, coming as it does from the pen of the person responsible for the development of this branch of analytical chemistry, is remarkable in many ways. It is particularly to be commended for the directness of approach, a clear exposition of the principles involved and indication of the many gaps that remain to be filled. The very opening paragraph of the book on page 1, "*A reaction can only serve as a basis of titration procedures, if the following conditions are satisfied*: (i) *The reaction must be a fast one*; (ii) *it must proceed stoichiometrically*; *and* (iii) *the change in free energy must be sufficiently large*", is a complete and unambiguous forestatement of what follows regarding the remarkable properties and applications of complexones.

The book is divided into seven main chapters: (1) Polyamines and complexones, (2) Basic theory of complexometric titrations, (3) Indicators used in complexometry, (4) Titration of mixtures, (5) Solutions used in complexometric titrations, (6) Details of procedures, and (7) Concluding remarks. At the end, there is a list of references roughly covering the period ending August 1956.

The book has not only succeeded in presenting a very clear exposition of the subject, but has further whetted the appetite in giving a pointer to the direction in which rich rewards await any one caring to delve in, e.g. (i) complexometric (direct) methods are lacking for the alkali metals, (ii) there is a very definite shortage of metal indicators, and (iii) there are many yet unexplored possibilities for masking agents of novel type, etc. Prof. Irving is to be particularly congratulated for bringing Prof. Schwarzenbach's monograph within the reach of English-knowing workers in this fast developing field of analytical chemistry.

M. R. VERMA

POLAR ATMOSPHERE SYMPOSIUM: PART I—METEOROLOGY SECTION, AGARDograph No. 29: Part I. Editor: R. C. Sutcliffe (Pergamon Press Ltd, London & New York), 1958. Pp. xii + 341. Price 70s.

An exploratory symposium on the pressing problems of the Polar Atmosphere was held at Oslo during 2-8 July 1956, under the auspices of the Advisory Group for Aeronautical Research and Development of the North Atlantic Treaty Organization. It is a matter of tribute to Dr L. Harang, the distinguished Norwegian geophysicist, who suggested the theme of the symposium and to outstanding Norwegian contribution to polar studies that the symposium on the 'Polar Atmosphere' was held in the Norwegian capital. The publication under review is a collection of papers presented and discussed at the symposium. There are 23 papers arranged into four sections with valuable combined discussions on the papers in each section, besides the Opening Address by the Director of the AGARD, and a thought-provoking introductory speech by the late Prof. Harald Sverdrup, who was the Chairman of the Executive Committee of the symposium. The first impact of this report is to show how much intensive observational and theoretical work has been carried out in recent years on Polar Meteorology and of course also to draw attention to the vast fields for work that are yet to be attacked.

Section I of the report contains four papers relating to Polar Climatology. One of the papers in this section deals with the climatic changes in the Norwegian arctic region in recent times. It is reported that there was a rapid rise in the temperature, particularly, winter temperature, during the years 1917 to 1922. After the year 1922, the temperature continued to rise but much more slowly till the World War II after which the temperature has been a little lower indicating that the period of rise has most probably terminated. This being a controversial topic, considerable discussions took place which seem to indicate that the general rise of winter temperatures in the arctic regions can be linked with certain changes in the general circulation patterns of the atmosphere. The question then naturally arises as to what is the cause of these variations. According to the author of the paper, " we cannot find the cause without taking into account the varying activity of the Sun ".

Section II contains five papers dealing with the general circulation over the polar regions. The connections of the flow patterns over the arctic regions have been related with those over other regions of the globe because of the important bearing which these relations have in the field of medium range weather forecasting.

Section III contains five papers related to Arctic Weather Analysis and Forecasting. One author, on the basis of his examinations, points out the limitations to the extension of the methods of frontal analysis of weather charts, at one time the most powerful and the only method of analysis in the hands of synoptic meteorologists, to the polar regions.

Section IV is the largest and contains nine papers. One paper deals with correlation between the ozone content at Tromso and various meteorological elements. Other papers deal with topics such as 'Problems of Recording Meteorological Observations', 'Sea Ice Conditions and Their Forecasting' and 'Problems Associated with Visibility'.

The investigations connected with the thermal behaviour of the atmosphere are perhaps the most significant in a symposium on Polar Meteorology. More so, because only in this region conditions similar to those familiar to physicist in his laboratory are experienced and we have conditions of totally absent or continually present insolation. The three papers in this section on topics closely associated with radiation, inversion and allied phenomena should, therefore, receive special mention.

In the words of the late Prof. Sverdrup, the symposium (hence this collection of papers and discussions) will serve particularly two purposes: it will help to clarify a number of problems of the polar regions and in the second place it will stress the importance of developments in the polar regions to the solution of problems in the middle latitudes. It is likely that the tropical regions are also to be effected by the developments in the polar regions via the middle latitudes. Therefore, tropical meteorologists cannot afford to remain ignorant of the scientific advances made in the study of the polar regions. The volume under review would serve a useful purpose in this direction. It is hoped that knowledge on polar meteorology (both arctic as well as antarctic) is bound to increase considerably when the information collected during the IGY is analysed and assimilated and the results made available in volumes such as the present one.

P. R. PISHAROTY
U. K. BOSE

THE EXPLORATION OF SPACE BY RADIO by R. Hanbury Brown & A. C. B. Lovell (Chapman & Hall Ltd, London; *Distributors in India*: Asia Publishing House, Bombay), 1957. Pp. xii + 207 + 132 figures. Price 35s.

It was in December 1931, as the authors point out, that Jansky made the surprising discovery that radio waves were reaching the earth from some source in

space. But for the next ten years, the study of these waves was not pursued vigorously until Reber's pioneering work between the years 1940 and 1944, and it can be said that observational radio-astronomy came into its own only after the improvements in high-frequency techniques that accompanied the development of radar in the war years. The thirteen years or so, since the end of the war, have seen startlingly new and useful radio techniques for the observation of both extra-terrestrial matter and the terrestrial atmosphere, and it is indicative of the times that a book dealing with such investigations should be entitled as this one is. During these years of active growth, there have only been two books in English on radio-astronomy — and it must be remembered that the major contributions to this field have been made by the English-speaking nations, only the Dutch being associated with the British, Austrians and Americans in the early stages. One of the present authors, Prof. Lovell, published in 1952, in association with Dr Clegg, a small and popular account entitled *Radio Astronomy* and in 1954, Pawsey and Bracewell published their definitive book. The book under review, which is a successor to the earlier book by Lovell and Clegg, is to be welcomed as another contribution to the literature on this subject.

Dr Lovell is the Director of the Jodrell Bank Experimental Station of the University of Manchester and is largely responsible for the erection of the world's largest steerable radio telescope, the 250-foot paraboloid which has been in the public eye recently for the observation of the moon probe. He has been continually in charge of the research work in radio astronomy at Manchester since the war and is known for his contributions to Meteor Astronomy in particular. Dr Hanbury Brown is well known as an outstanding electronics man and has also achieved distinction in astronomical research in recent years. In association with Twiss, he developed the new method of the post-detector correlation interferometer which has found application both in radio and optical astronomy as a method of measuring the size of and distribution in sources. He has prepared a radio survey of the galactic radio emission.

While Pawsey and Bracewell's book remains the pre-eminent treatise on radio astronomy, this book is a useful introduction for those who are new to the field and will help to provide active workers with a perspective of the subject. It contains chapters on techniques of radio astronomy, the continuum radio emission, some properties of radio waves, the moon, the earth satellite and planets, a review of astronomy, radar study of meteors, hydrogen line radiation, scintillation of radio stars, radio emission and reflection from aurorae and contains a chapter on the impressive 250-foot radio telescope along with ten excellent photographs showing details of the telescope.

It is very difficult indeed to write as cogently as the authors have done on all these subjects in the short space at their disposal. They have succeeded in including a certain amount of new information like the explanation of the origin of the isotropic component of galactic radiation and of the emission from the Crab nebula as being due to a synchrotron mechanism as proposed by Shklovsky. However, quite a few advances since 1954 remain unreported in this book. There is for instance only a very brief mention of spectroscopic observations of solar active regions which were pioneered by Dr Wilde in the last four years. It is also unfortunate that the authors failed to provide a bibliography as it would have been most useful to those who wish to pursue their knowledge of the subject further. As is to be expected, the chapter on Meteors is of a very high standard and contains a succinct account of techniques and results.

The printing is specially good and the reviewer could note only two errors — one due to the authors and the other to printer's devil. The fringes in Fig. 33(a) on page 48 should be vertical and not slanting. The reference on page 195 is to Fig. 124 and not to Fig. 114.

It is an attractive and readable book and is to be recommended to all libraries and newcomers to the subject. It is hoped that the authors will follow this book with one covering in greater detail the techniques of observation which their wide experimental knowledge makes them especially qualified to write.

T. KRISHNAN

UPLIFT IN GRAVITY DAMS — CALCULATION METHODS, EXPERIMENTS AND DESIGN THEORIES by Serge Leliavsky (Constable & Co. Ltd, London), 1958. Pp. vii + 267. Price 45s. net

This is perhaps the first book in English language entirely devoted to the subject 'Uplift in Gravity Dam' which is perhaps one of the most debated topics under dam engineering ever since this phenomenon was introduced into the calculation of stability of dams as early as 1895.

The book has been divided into four parts, viz. (i) Earlier theories; (ii) New theories; (iii) Experimental approach and relevant problems; and (iv) Structural methods of reducing uplift pressure and leakage in dams.

In Part I the author has dealt with the evolution of the theory of uplift phenomenon in gravity dams, describing the theory enunciated by Leickfeldt, Link and Levy. The factor of uplift to be used in

the design varied with different theories and was based on the conception of the existence or formation of cracks in the masonry. The author has illustrated the various theories by means of calculations of the relative quantities of the masonry per unit length of the dam, corresponding to various assumptions concerning the uplift forces.

The new theories, which emphasize the fact that the water filling through the pores of masonry and concrete will create uplift pressure, are dealt with in Part II. The percentage of pores in the masonry or concrete to be assumed has been stated as still lacking universal agreement and the question is still open to conjecture. The author has effectively dealt with two alternative approaches for visualizing and calculating the uplift. One is the ' inductive ' or volumetric method which is based on infinitesimal uplift forces calculated for the individual infinitely small element of volume and integrated over the entire volume of the block. The other approach is the ' deductive ' or ' peripheral ' method, which takes into consideration the resultant of all hydrostatic pressures acting on the water contents of the pores on the respective sections of the dam. Both methods are proved to give almost the same results. The author describes in detail the Fillunger's law and Terzaghi's solutions and significantly brings forth that the volumetric porosity should be used in the uplift formula and further substantiates this with a series of auxiliary tests. It is suggested that when the construction of a new dam is contemplated, the effective volumetric porosity should be determined experimentally before the profile is designed.

Part III deals with the testing methods and the equipment used in connection with the determination of effective porosity, buoyancy and ultimately the uplift factor, and their shortcomings. The areas of dam profiles corresponding to the various assumptions have been calculated and compared.

Interesting methods for reducing the uplift pressure and leakage in dams are discussed in the last part. Relative merits and demerits of each method have been assessed with the help of appropriate examples. A comparison of the effectiveness of the various types of screens has been given. The author arrives at the conclusion that with any type of screen, if properly designed, the uplift pressure on the dam can be relieved altogether, without introducing new stresses.

The discussion on the various theories of uplift in dams has been exhaustive and illuminating, and the author has pointed out that the uplift theory is scientific. Research workers in the field should be able to further this theory.

The author would have done well if he had added one more part dealing with the various uplift assumptions made for dams for the purpose of stability analysis, including the effect of drainage gallery, deep curtain grouting and tail water.

Y. K. MURTHY

GENERAL AND INORGANIC CHEMISTRY FOR UNIVERSITY STUDENTS by J. R. Partington (Macmillan & Co. Ltd, London), Third Edition, 1958. Pp. xxiii + 927. Price 60s.

Although the format of the first edition is followed in this edition, the author has, by the addition of a wealth of new material, brought up to date the book that has been indispensable to inorganic chemists since 1946. Thoroughly revised and enlarged, this new third edition surpasses even its classic predecessors in being refreshingly modern and supplies a well-rounded survey of the subject which may be easily followed by the graduate students. Unlike other text-books which deal with the subject matter in inorganic chemistry after a brief introduction to the periodic classification and atomic structure, the present volume has incorporated several topics in physical chemistry in the first ten chapters to acquaint the student with the fundamental concepts of general chemistry. Notable among these introductory chapters is the unusually well-integrated treatment of the solid state and the quantum theory of the atom. Then comes the logical and necessary sequence carrying the reader through the chemistry of elements based on the periodic system. This includes pertinent information about the rare elements and the new synthetic elements right up to nobelium. The principal additions in the chemistry of the common elements are in the section on hydrides and the thionic acids.

Written in a simple language, the book is a completely modern presentation of inorganic chemistry which will be welcomed by teachers, and as a text-book for graduate students this volume is in a class by itself. Copious literature references are included in the text and anyone seeking more specific detail will find this outstanding treatise a valuable source of ready reference. The book is written to make it readily adaptable for instructional use and should find place on the shelf of every inorganic chemist.

G. S. DESHMUKH

NOTES & NEWS

New supersonic phenomenon

STUDIES ON THE PROPAGATION OF stress waves in glass and plastics using polarized light, carried out at the Franklin Institute Laboratories for Research and Development, Philadelphia, U.S.A., have revealed evidence of a new supersonic phenomenon. In this investigation transparent samples (4×6 in. sheets of glass and plastics) were shock-loaded by exploding small amounts of lead azide with an electric bridge and the optical stress pattern employing a classical experimental arrangement using circularly polarized light has been photographed by means of a delayed flash of duration variable from 0 to 30 μsec. Both 'single' and 'meeting' shots (in which two explosive charges at the centres of the short ends of the sample were exploded in series) were tried.

Both 'single' and 'meeting' shots gave evidence of a new, theoretically unexpected wave component travelling about five times faster than the compressional velocity of sound. In 'meeting' shots when the delay was such that the compressional waves were propagated *c.* 1 in. into the sample, a sharp pattern of parallel lines was observed in the centre of the sample much in advance of the compressional wave. Similarly parallel line patterns were observed near the sides of the sample. Similar photographs made in colour showed that the blue interference patterns had a completely different colour from the reddish yellow colour of the explosion.

In the case of plastics like methyl methacrylate (Lucite) and CR39 resin, though less distinct, basically the same phenomenon as in glass has been observed.

The patterns depend on the thickness of the sample; they are sharper with thin plates; the spacing of the lines increases linearly with the thickness of the plate. The intensity of the newly found wave component was faint compared to that of the compressional wave; however, contrary to the latter which travels with the velocity of sound, the faster component seemed to manifest as standing waves. This was confirmed by photographing it with the help of a 2 sec. flash when it came out as a sharply defined trace while the compressional wave appeared blurred. Experiments using an electrical delay line between the parallel charges showed a shift of the meeting pattern equivalent to the speed of a compressional wave. The patterns are thus completely different from the regular ones obtained by the Huygens construction. All evidence obtained on these line patterns showed that they did not move at all.

The phenomenon could be caused by a very fast wave propagated on the surfaces of the sample, with the two compressional waves generated interfering to produce the pattern by exciting thickness vibrations of the plate.

Studies on the formation of cracks in glass indicated that the cracks progress with the velocity of the compressional wave, and even ahead of it, compared to the generally accepted value of the velocity of crack propagation of $\frac{1}{2}\sqrt{E/\rho}$. Also the cracks were irregular occurring at flaws in the sample, again departing from the usual radial cracks in impact loading. These observations confirm that the new phenomenon is not spurious but distinctly exists [*Nature, Lond.*, **182** (1958), 1011].

Molecular rotation and nuclear magnetic resonance

EXPERIMENTAL CONFIRMATION FOR theoretical interpretations of certain observations on the consequences of hindered molecular rotation on the nuclear magnetic resonance spectrum has been afforded by studies conducted at the Univeristy College of North Wales, Bangor, Caernarvonshire, England. In the case of dipolar-broadened spectra the discrepancy between the experimentally measured decrease and the theoretically expected invariance in the second moments has been sought to be satisfactorily explained by dividing the nuclear magnetic interaction into two parts — a steady mean interaction and a fluctuating part. According to this theoretical interpretation the steady mean interaction in a crystal in which hindered rotation occurs is less than that in the case of a crystal devoid of it and hence a narrower spectrum is obtained. The fluctuating part generates side spectra set at integral multiples of the frequency of molecular rotation; side bands are dispersed over a band of frequencies due to irregular molecular rotation; their intensity is too weak and hence could not be observed till these above experiments were devised to detect their presence.

Experimental detection of these side bands has been made possible by choosing a single crystal of sodium chloride within which there is no appreciable motion of the nuclei and rotating it at a speed of 50,000 r.p.m., about the [001] direction, in a 6000 gauss magnetic field normal to the axis of rotation. Under these circumstances the side spectra would be centred at well-defined frequencies and have sufficient intensity to be observed. The first order side spectra are clearly seen at the highest rotation rates and occur at a separation of $2\nu_r$ from the centre of the spectrum and the central portion is approximately halved in width in accordance with the predictions of the theory. There is good general agreement between the shape of the derivatives recorded and those calculated at all rates of rotation. The experimental mean second moment value with the magnetic field in the [001] plane closely agrees with the value theoretically calculated from Van Vleck's formula.

The experiment, besides providing evidence in a direct way that the relative rotation of nuclei in solids does cause a narrowing of the nuclear magnetic resonance spectrum, shows that for spectral narrowing the necessary rate of nuclear motion is of the order of the spectral width. (The r.m.s. line width 0·74 gauss is equivalent to 833 c/s.) [*Nature, Lond.*, **182** (1958), 1659].

Gyromagnetic ratio of proton

AS PART OF A GENERAL PROGRAMME undertaken by the U.S. National

Bureau to obtain more accurate values for important physical constants like the velocity of light (v), the acceleration due to gravity (g) and the various atomic constants, the gyromagnetic ratio of the proton, a measure of its interaction with magnetic fields, has been redetermined with significant increase in accuracy. The error in this determination is reduced by a factor of four to that involved in an earlier determination in 1949 using the nuclear magnetic resonance technique. This result provides a better standard for many of the fundamental physical constants like the electron charge to mass ratio (e/m), the magnetic moment of the proton, Planck's constant (h), etc., whose values depend on magnetic field measurements. The new value is especially useful in the design and development of scientific and industrial apparatus in which it is important to know accurately the spatial distribution of a magnetic field or to regulate closely, e.g. cyclotrons, mass spectrographs, beta ray spectrometers, servomechanisms, electromagnets, etc. The accuracy of the 1949 experiments was governed by the limitations in the measurement of the value of a strong magnetic field used, *c.* 5000 gauss, which was determined by finding the force exerted by the magnetic field on a wire carrying a known current. In the present method, using a simpler technique, the hydrogen protons in a water sample are caused to precess in a magnetic field, the value of which can be calculated to a very high precision. To avoid spurious effects due to interference from other magnetic fields, the measurements have been carried out at the Fredericksburg Magnetic Observatory of the U.S. Coast and Geodetic Survey, which is free from magnetic field disturbances, in a non-magnetic building, i.e. compensated for the effects of earth's magnetic field. The precession rate is obtained from the frequency of the voltage induced in a pick-up coil surrounding the sample measured against the standard frequency broadcasts by the Bureau's radio station. The gyromagnetic ratio is then obtained as the ratio of angular precession frequency to the field strength.

A value of $(2{\cdot}67513 \pm 0{\cdot}0002) \times 10^4$ radians/(sec. gauss), uncorrected for diamagnetism of the water sample, has been obtained for the gyromagnetic ratio in terms of the ampere as now recently determined by Driscoll and Cutkosky of the Bureau. The value obtained in the 1949 experiments was $(2{\cdot}67523 \pm 0{\cdot}00006) \times 10^4$ radians/(sec. gauss) [*Tech. News Bull., U.S. Bur. Stand.*, **42** (1958), 217].

Magnetic writing

THE FEASIBILITY OF 'MAGNETIC writing' using an electron beam, particularly suitable for electronic computers, has been reported. The method gives well-defined traces and could also be used to make magnetic 'halftone images'. The method is based on Curie point writing, in which the direction of magnetization in a pre-magnetized film is reversed by elevating the temperature. The magnetic film upon which information is to be stored is set up as an anode in a television tube-like device. A focussed electron beam heats (by the absorption of the energy of the beam) the film in those areas where electrons impinge. The heated areas become non-magnetic if the temperature rises above the Curie point.

Writing speeds of up to 30,000 binary digits and higher each second are possible. Magnetic halftone images are accomplished by controlling the size of the spots of reversed magnetization. The magnetic picture so obtained would be similar to the one obtained by conventional printing. The magnetically stored information can be retrieved by electronic read-out and also the traces can be erased magnetically [*Sci. Newslett., Wash.*, **74** (1958), 329].

Silicon solar cells

SILICON SOLAR CONVERTERS MANUfactured by the Semiconductor Division of Hoffman Electronics Corporation, Evanston, Illinois, U.S.A., convert sun's energy directly into electrical power. These are wafer-thin discs of extremely pure silicon fused with minute amounts of arsenic and boron which help create the electron groupings that provide positive and negative electrical fields. After etching and plating, each cell is tested and then joined in series, in various sizes and shapes to meet requirements of specific applications. Photons penetrate the silicon and cause the flow of electrons resulting in a voltage build-up within each cell. This converted energy is then conducted to an outlet from where it can be tapped. The maximum efficiency of conversion, at present, is 10 per cent. The cells have an estimated life of 10,000 years, do not deteriorate and are virtually unaffected by temperature and humidity variations. They can also convert incandescent light into electricity.

The first commercial solar cell panel, a 144-cell modular assembly made by Hoffman, is designed to supply electrical power in multiples of 5 W. These modular units of constant power are suitable for supplying low demands of power to remote areas without electrical power sources.

The most notable use of these cells has been in the U.S. Navy's Vanguard satellite to operate its transmitters and in the Aerobee High rocket as a 'sensor' to activate a motion picture camera to photograph earth from extremely high altitudes. Their ability to respond at a rate of 50,000 impulses/sec. makes them ideal for use in high speed air and ground computers. They can also be used as infrared sensors or flame detectors [*J. Franklin Inst.*, **266** (1958), 321].

New alloys by micrometeorite bombardment

ALLOYS AND COMPOUNDS OF INcompatible materials can now be produced as a result of a novel technique evolved at the Wright Air Development Centre, Dayton, Ohio. The method can also be adapted for producing 'perfect' vacuums. For example, aluminium which boils at 3740°F. cannot be combined as a liquid with iridium which does not melt until a temperature of 4450°F. is reached. In the new method, the impossibility of mixing the two metals in the molten state is avoided by pulverizing iridium to very fine particles, *c.*1 μ in diameter, and shooting them at extremely high speeds into the tiny crevices in the aluminium lattice structure. In this way an alloy that will have aluminium's desirable properties and a much

higher melting point is obtained; this alloy has the favourable requisites of an alloy for use in space craft.

The micrometeorite bombardment can also be used to produce long molecular chains of compounds composed of organic and non-organic substances which could not be previously produced by any method. Also 'perfect' vacuums, an essential preliminary requisite in many laboratory studies, can be created by blasting out the last traces of air with the high speed particles used in this method [*Sci. Newslett., Wash.*, **74** (1958), 66].

Radiation-resistant high temperature lubricants

A SERIES OF RADIATION-RESISTANT fluids, polyphenyl ethers, developed by the Monsanto Chemical Co. and the Shell Development Co., has been found useful as lubricants, reactor coolants or hydraulic fluids over a wide temperature range; this development is considered a major advance in lubrication technology. These lubricants remain liquid from 20° to 800°F. and retain lubrication properties throughout this range, and can also withstand exposure at higher temperatures for brief periods. They are 2-5 times more stable under nuclear radiation than the organic lubricants in use and do not undergo decomposition below 800°F. The fluids are effective under severe oxidizing conditions even at 500°F. High temperature coking tests up to 1000°F. have indicated very little coke formation [*J. Franklin Inst.*, **266** (1958), 323].

Dichromography

A NON-DESTRUCTIVE METHOD, based on the absorption measurements of monochromatic X-rays, has been developed for the quantitative analysis of certain elements inside a living person. The method will be of great importance in diagnostic and physiological studies for determining the function of vital organs, like liver, kidneys, or lungs. A single element can be quantitatively determined according to the Beer law by measuring the attenuation of one monochromatic X-ray beam. Similarly two elements can be analysed with two monochromatic beams, provided that the ratios of the mass absorption coefficients of the elements are sufficiently different at the two wavelengths.

The equipment comprises an X-ray tube for the production of monochromatic radiation through secondary emission, a system composed of two servo-controlled absorption wedges, a scintillator photomultiplier unit sensing the X-ray intensity, and an electronic feedback loop from the multiplier to the two servomotors. One wedge is composed of material equivalent to soft tissue (for example, water) and the other, of iodine. The two wedges are automatically kept in such a position that the intensities at the scintillator are constant. When the patient is interposed in the path of the beam, the two wedges are withdrawn a certain distance corresponding to the amount of soft tissue and iodine in the patient. Thus, the displacements of the two wedges are quantitative measures of the amounts of these substances. A scanning process is employed when producing images, showing the quantitative distribution.

At present the accuracy of the method is within $\pm 0{\cdot}2$ mg. of iodine/sq. cm. for static measurements and $\pm 0{\cdot}5$ mg./sq. cm. when scanning is employed at a rate of 0·5 cm./sec. and with a beam cross-section of 0·25 sq. cm. The accuracy is limited by statistical fluctuations of the number of quanta in the X-ray beam and by photomultiplier drift. The presence of fat in the tissues introduces a slight error [*Science*, **128** (1958), 1346].

Determination of O^{18}

A PROCEDURE HAS BEEN DEVELOPED for the estimation of O^{18} in inorganic phosphates in biological specimens. The method involves heating of potassium dihydrogen phosphate (KH_2PO_4) and mercuric cyanide [$Hg(CN)_2$] in a sealed tube for 1 hr at 250°C. Under these conditions the phosphate oxygens are converted to carbon dioxide without dilution. The carbon dioxide is collected and subsequently analysed in a mass spectrometer. The heating conditions do not have to be reproduced to any high degree of consistency. Over a temperature range of 230° to 300°C. a time range of 40 min. to 2 hr, identical O^{18} values are obtained. The O^{18} concentration of KH_2PO_4 over a range from 2 to 50 mg. of the salt could be determined with a deviation of $\pm 0{\cdot}5$ per cent [*Science*, **128** (1958), 1434].

Determination of liquid/solid content of fats

A NEW METHOD FOR DETERMINING the liquid/solid contents of fats, developed jointly by the Unilever Ltd and Physical Chemistry Laboratory, Oxford, makes use of low-resolution nuclear magnetic resonance spectroscopy. The method has several advantages over the dilatation method previously used: (i) fats or mixtures can be examined in the state in which they are received, i.e. without altering the structure by melting or crystallization; (ii) the results are independent of the particular composition of the fat, i.e. no prior knowledge of the glycerides present is required; and (iii) the results are independent of the polymorphic form of the solid present.

The working of the method is illustrated by the determination of the liquid content of simple mixtures containing known amounts of tristearin and triolein (tristearin does not form a solid solution in the triolein phase). A bridged-T nuclear magnetic resonance spectrometer was used. The magnetic field was modulated at a sinusoidal frequency of about 40 c/s. with a magnitude of about 30 milligauss, peak to peak. The line width was determined by the inhomogeneity of the magnetic field and was about 100 milligauss at half height. Under these conditions the derivative curve shows no signal due to the broad band of the solid, and a measure of the peak-to-peak height of the recorded derivative curve is a direct measure of the amount of liquid present. By comparing the peak height for any of the mixtures with that for 100 per cent liquid, the liquid content can be determined [*Nature, Lond.*, **183** (1959), 44].

Determination of lipid peroxides

AN IMPROVED AND ACCURATE IODOmetric method for the determination of lipid peroxides in fats and oils is reported. The improve-

ments in the procedure relate to (a) the adoption of a procedure allowing continuous deaeration to reduce the errors caused by induced oxidation and (b) the development of a microspectrophotometric method yielding accurate results at very low peroxide concentrations from 0·02 to 5 μmoles.

Deaeration is effected by bubbling nitrogen vigorously through the solution. Commercial oxygen-free nitrogen (99·9 per cent) is further purified by the removal of traces of oxygen by passing the gas through three Friendrich gas-washing bottles filled with a solution of sodium hydrosulphite (15 per cent), sodium hydroxide (10 per cent), and containing 0·2 per cent sodium anthraquinone sulphonate as indicator. The purified nitrogen is then passed through distilled water and finally through the solvent mixture (2 vol. of glacial acetic acid + 1 vol. of chloroform) to saturate the gas with solvent vapour.

The solvent mixture used in the micro-determination, is deaerated in bulk prior to use, since deaeration *in situ* is slower. The volume of solvent mixture used is 7·5 ml. and together with the sample and the potassium iodide the total volume should not exceed 10 ml. One additional tube containing the solvent plus potassium iodide is used as the blank in the spectrophotometer. During the deaeration, 0·5 ml. of a 50 per cent aqueous solution of potassium iodide is added. Gentle inversion of the tubes is advisable after the addition of potassium iodide in order to ensure complete mixing prior to their keeping in the dark for a period of approximately 1 hr.

The measurement of optical density is carried out in the region 370-500 mμ with the Unicam SP 600 spectrophotometer, the wavelength being varied according to concentration, thus permitting readings to be taken in the optimum range. The volume of liquid is then determined with an accuracy of ±0·05 ml. since it is otherwise difficult to ascertain evaporation losses during deaeration. The recording of the optical density allows calculation of the peroxide concentration by means of a calibration curve which can be based on either hydroperoxide or iodine.

Beer's law is obeyed up to a peroxide content of ~5 μmoles. Liberated iodine has been measured with an accuracy of ±5 per cent at a concentration of 10^{-5}M [*J. Sci. Fd Agric.*, **9** (1958), 782].

Determination of olefinic unsaturation

AN ANALYTICAL TECHNIQUE, WHICH makes use of ozone instead of bromine as an analytical tool, has been developed which measures unsaturation in mono- as well as poly-unsaturated compounds, i.e. whether the double bond is conjugated or not. The presence of tertiary hydrogens does not cause any wide variation in the results.

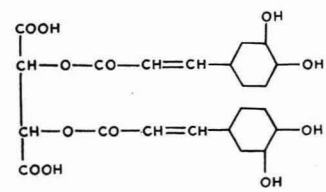
The new method uses available commercial apparatus — a gas liquid reactor and an ozone meter. In actual operation a weighed sample of olefin is cooled to −10°C. in a dry ice-alcohol bath. At this temperature a sharp end point of ozone absorption is obtained and also there is no further reaction between the products of ozonolysis and ozone. Ozone is then passed into the reaction vessel and the contents are stirred at about 1200-1500 r.p.m. At the end point, a sharp deflection of the meter's indicating needle shows the marked increase in unabsorbed ozone. The results are expressed as unsaturation equivalents — number of grammes of material containing one double bond instead of ozone number which has no chemical significance [*Chem. Engng News*, **36** (42) (1958), 41].

Haemoglobin synthesis

THE FIRST SUCCESSFUL DUPLICATION of haemoglobin (which consists of 16 different amino acids) of red blood cells under ' test tube ' conditions has been reported by workers at the City of Hope Medical Centre, Durate, California. The technique used enabled the protein to develop free from living cells. Microsomes from immature red blood cells of rabbits have been extracted and were tagged (with radioactive carbon) with an amino acid used by microsomes in their production of haemoglobin. Then the other 15 amino acids were added. Radioactive haemoglobin was isolated from the test tube mixture, which points to the conclusion that the microsomes used up the tagged amino acid to manufacture the newly made haemoglobin in a cell-free system. These findings make it possible to study the production of a given protein in a detailed manner which was not hitherto possible [*Sci. Newslett. Wash.*, **74** (1958), 327].

Chicoric acid

A NEW OPTICALLY ACTIVE CRYSTALline substance, chicoric acid, has been isolated from an aqueous decoction of chicory leaves (*Chicorium intybus*). From a study of its degradation products obtained by alkaline hydrolysis of chicoric acid in a hydrogen atmosphere, it was concluded that chicoric acid is composed of two molecules of caffeic acid and one of laevo tartaric acid and the structure (I) was proposed for chicoric acid. This structure is further confirmed by a synthesis of chicoric acid by condensation of two molecules of carbonyl-caffeic acid chloride with laevo tartaric acid. The synthesis is effected by heating an intimate mixture of carbonyl caffeic acid chloride (4·6 g.) and (+)—tartaric acid (1·72 g.) under pressure in a flask in a silicone bath. Reaction begins at 115° and the mixture fuses with evolution of hydrogen chloride. The temperature of the bath is raised to 135° and maintained at that level for 10 min. and then cooled. The white solid is heated with 80 per cent acetic acid (90 ml.) on a steam bath, then evaporated under reduced pressure at 40°. The residue, consisting of chicoric acid and unchanged caffeic and tartaric acids, is heated with water (25 ml.) at 50°. The filtrate is twice extracted with ether (40 ml.), which dissolves chicoric acid and any remaining caffeic acid, leaving tartaric acid in the aqueous layer. The ether layer is separated and evaporated, the residue is mixed with warm water (10 ml.) and the *p*H adjusted to 6 by addition of sodium hydrogen carbonate. Addition of saturated



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barium acetate solution precipitates the barium salt of chicoric acid, which is separated by centrifuging, acidified with 2*N* HCl (15 ml.) and twice extracted with ether (40 ml.). The residue (2·2·5 g.) obtained on removal of ether is decolourized with charcoal and crystallized from water in tuft-like needles (1·5-1·9 g.), m.p. 206° [*Tetrahedron*, **4** (1,2) (1958), 43].

Reserpine activity

RESEARCH WORKERS OF THE CIBA Pharmaceutical Products reported to the 134th National Meeting of the American Chemical Society their success in separating the dual properties of reserpine, viz. acting both as a tranquillizer and as a reducer of blood pressure. They prepared two separate derivatives each having an explicit and mutually exclusive property. The new hypotensive agent, methyl carbethoxy syringoyl reserpate, is as strong as reserpine in this respect but has only a twentieth of reserpine's potency as a tranquillizer. The other new drug, methyl 3-dimethyl aminobenzoyl reserpate, is about a fourth as effective a tranquillizer as reserpine, and has one-fortieth of its hypotensive activity [*Sci. Amer.*, **199** (1958), 56].

Mineralized biological specimens

A NEW METHOD FOR PREPARING mineralized biological specimens for their quantitative analyses with X-ray, interference microscopy and isotope techniques has been developed. The method is based on lapping technique and gives an ideal specimen as a thin, plane parallel tissue section with a known thickness within the region 10-100 μ. Mineralized tissues embedded in methyl methacrylate are sawn into sections 3-4 mm. thick. One side of the section is lapped against cast iron using very fine diamond abrasive, which gives the surface an extremely good quality with regard to both planarity and surface finish.

For the subsequent steps of the lapping procedure a small steel cylinder is used as a fixture for the specimen. A square-ruled area is etched on one of the plane surfaces of the cylinder, which are perpendicular to its axis. The etched lines are a few microns deep and have a width of about 50 μ. On top of the etched area the lapped surface of the specimen is attached with the aid of a glue which is easy to work out to a thin film less than 0·5 μ thick. When the glue is dry the specimen is cooled and ground by hand against an ordinary emery plate, down to about 1 mm. thickness.

The next step comprises grinding against a fine-grained diamond plate. The fixture is moved by hand in a V-shaped prism which is oriented perpendicularly to the rotating plane of the grinding plate. At this stage, a section of about 100 μ is obtained within a few minutes. The shape of the fixture allows continuous approximate measurements of the specimen with the aid of an ordinary micrometer.

In the last step the specimen is lapped against a cast-iron plate using fine-grained diamond abrasive, the fixture being oriented with its longitudinal axis perpendicular to the lapping plane. The sections are lapped by hand to the desired thickness, checked by repeated measurements. A coarse control of the thickness of about ±2 μ can be obtained with the aid of a good micrometer [*Nature, Lond.*, **182** (1958), 1225].

Preservation of whole blood

A MODIFIED TECHNIQUE FOR PRESERVING whole blood in the frozen state for transfusion and in which the survival of erythrocytes thus frozen is satisfactory after 6 months of storage at −93°C., has been developed. Haemolysis of erythrocytes is prevented by mixing equal parts of acid citrated blood with the sugar solution to obtain a 0·2M concentration of lactose, a 0·7M concentration of dextrose, or an additive molarity of 0·6M with both sugars. The duration of this modification process is not critical, and periods of 5-270 min. have given similar results.

Modified blood is frozen in flat containers made of thin aluminium or tin-plated copper by immersion in carbon dioxide-ethanol mixture at −60° to −78°C. Thawing is obtained by immersion in a water bath at 37°C. Optimally the time of cooling and freezing (from −3° to −40°C.) and the time of thawing must not exceed 10 sec.

When freezing is effected in the presence of sugars the average optimum recovery rate of erythrocytes is about 95 per cent. The 24-hr survival of erythrocytes in five transfusions of human whole blood, which has been frozen and thawed without storing it for an appreciable period, is only 2 per cent below the optimal value for fresh, autotransfused erythrocytes; the curve of disappearance of erythrocytes after the first 24 hr is similar to that of fresh cells [*Science*, **128** (1958), 1002].

A new anti-inflammatory drug

GLYCYRRHETINIC ACID, OR GLYCYRrhetic acid, a new anti-inflammatory drug which can be applied safely to the skin in dermatological conditions, has been announced jointly from the Leicester College of Technology, University of London, and Westminster Hospital, London. The drug, obtained from liquorice, has an extremely low toxicity and is non-irritant. It is claimed to have no adverse effects on the heart, circulation or respiration and shows no glucocorticoid-like activity (a serious disadvantage with corticosteroids). In large doses it produces water retention, slight sodium retention and an increased excretion of potassium in animals. These effects are, however, not seen when smaller doses are used in man [*J. Pharm., London*, **10** (1958), 687].

Food additives

THE SECOND REPORT OF THE Joint FAO/WHO Expert Committee on Food Additives (*Technical Report Series No.* 144, World Health Organization, Geneva, 1958) published recently contains many critical observations and a number of useful recommendations. The report is intended to provide guidance on procedures for the testing of international food additives with a view to establishing their safety in use.

Pointing out that "the toxic or other biological effects of the test material cannot be predicted solely from a consideration of its chemical and physical properties", the Committee has emphasized the need for long-term animal feeding experiments. The imperative necessity for such experiments will be

evident from the following considerations: (1) A deleterious effect might be due not to the additive directly but to its effect on some other substance in the food or to changes consequent upon cooking, long storage, etc.; (2) the same substance might exert a different effect when added to different foods or when fed to different age groups, or when used in diets of communities with different disease patterns; (3) hazard to the consumer results from the total number of additives in the diet; and (4) the resultant effect of interplay between different additives may vary with variations in the mixture of foods which constitute the basic diet. Hence up-to-date information on the diets used by different communities is necessary before resorting to legislation.

Provision of an efficient and effective test procedure on such additives is difficult in organization and training of personnel and prohibitive in cost; not every Government can afford it. Yet the use of such food additives without prior testing exposes the public to new risks of unknown magnitude and necessitates protective legislation. The difficulties can be minimized by reducing the number of additives now used. The Committee recommends that a new additive should be proposed only when clear evidence, that benefits to the consumer will follow, is available. The Committee is also emphatic that "no proved carcinogen should be considered suitable for use in any amount" [*Nature, Lond.*, **182** (1958), 850].

European sources of technical information

IN THE CONTEXT OF THE PRESENT rapid rate of scientific and technological advances in the different countries of the world, the need for quick exchange of information among the research workers and the technologists has become very acute in order to avoid duplication of research effort. Recognizing this, the European Productivity Agency, with the co-operation of the O.E.E.C. member countries, has brought out a valuable publication with the title *International Guide to European Sources of Technical Information* (publishers: The European Productivity Agency, 2 Rue Andre Pascal, Paris 16). The volume under review is the second reprint published in July 1958. The fact that the publication has been reprinted twice since the appearance of the first edition as recently as June 1957, speaks of the immense need of and demand for such a source book. The *Guide* presents a selection of information sources in eleven West European countries and also includes a list of sixteen National Technical Information Centres in Europe, which are the best equipped to obtain and provide any desired information in their respective countries. Grouped under two broad divisions, namely the general sources and specialized sources of information, the scope of the activities of about 350 technical institutions and organizations of Western Europe is given. Indexes of subjects arranged in alphabetical order, names of organizations in their original language and a short bibliography of publications in the information field in the different countries, form valuable appendices to the *Guide*. The publication will be of great help to facilitate contacts amongst research institutions, productivity centres, technical information and documentation services, and industrial, trade and professional organizations and should find a place in every technical library.

Cerenkov Radiation

THIS MONOGRAPH, PUBLISHED IN November 1958 (Pergamon Press Ltd, London, New York, Paris, Los Angeles; price 65*s.* net), is the first monograph devoted exclusively to Cerenkov radiation and its applications. It provides an up-to-date review, by one of the experts on the subject, of the theory, experimental work and applications. On the theoretical side, the classical treatment of the normal Cerenkov effect in isotropic media is presented in detail, together with an account of the underlying physical basis of the phenomenon. The monograph, written primarily for the experimentalist, lays emphasis on the general properties and applications of counters of various types. Sufficient technical data are given to allow the working out of the design for an instrument for any particular purpose. It also includes a complete bibliography including most of the references to the considerable theoretical work carried out by Russian scientists and the extensive developments and applications of the techniques to high energy problems centred around the large particle accelerators in the U.S.A. The publication is of special interest and value to workers in several fields of applied physics, e.g. nuclear physics, health physics, optics, astrophysics, geophysics and high frequency radio techniques.

Higher technological institute at Madras

THE MINISTER FOR SCIENTIFIC RESEARCH & Cultural Affairs, Shri Humayun Kabir, disclosed in the Parliament that the Government of the Federal Republic of Germany have agreed to provide technical assistance in the establishment of a higher technological institute at Madras. The assistance to be given would be: (i) workshop and laboratory equipment and library (estimated at about Rs 1·8 crores); (ii) the services of 20 German professors to teach and guide research at the institute for a period of 4-5 years, and of 4 foremen to man the workshops, for a period of 2 years; and (iii) facilities for the training of Indians in German institutions. It is expected that the first batch of students would be admitted to the Institute in August 1959.

Engineering College at Delhi

AN ENGINEERING COLLEGE TO PREpare students for degree courses in engineering in the first instance, and later provide facilities for postgraduate and advanced work in selected fields, is being established at Delhi by the Government of India with the assistance of the British Government and the Federation of British Industries (FBI). The foundation-stone of the proposed college was laid by the Duke of Edinburgh on 27 January 1959.

The estimated expenditure to be met by the Government of India on the project is Rs 1·20 crores capital cost and Rs 13 lakhs annual recurring expenditure. The assistance to be given by the British Government and the FBI will be (1) equipment worth £ 2·5 millions and (2) services of 8 professors for a period of five years. The new college will take over the degree

courses of the Delhi University, at present available in the Delhi Polytechnic, and will have provision for admission of 250 students every year into the first year degree classes in civil, mechanical, electrical (including electronics), chemical and textile engineering.

Announcements

▪ *Indian Botanical Society* — The following office-bearers of the Society have been elected for the year 1959: Dr E. K. Janaki Ammal (*President*); Dr R. Misra and Dr P. Maheshwari (*Vice-Presidents*); Dr J. Venkateswarlu (*Hony Secretary*); Dr R. Misra (*Hony Librarian*); Dr T. S. Sadasivan (*Hony Treasurer*); Drs I. Banerji, S. N. Das Gupta, A. C. Joshi, T. S. Mahabale, P. Parija, V. Puri, S. Ranjan, R. P. Roy, Shri M. B. Raizada and Rev. Fr H. Santapau (*Councillors*); Drs B. P. Pal, A. C. Joshi P. Maheshwari and Rev. Fr H. Santapau (*Members of the Editorial Board*) and Dr T. S. Sadasivan (*Business Manager*).

▪ *The Annual Meeting of the Air Pollution Control Association, Pittsburgh, Pa, U.S.A.*, will be held during 22-26 June 1959 in Los Angeles, California. The meeting will include technical sessions and an exhibition displaying the latest equipment designed for the control of air pollution. At the end of the meeting, the proceedings, covering copies of all technical papers, will be available for sale.

▪ *Award of Doctorate Degrees* — The following have been awarded the Ph.D. degree of the Delhi University for the theses noted against their respective names in parentheses: Shri Vishnu Sahai Mathur (*Solution of Dirac equation and its application to scattering problems* and *Multiple production of photons in quantum electrodynamics and meson theory*); Shri Shivachandra S. Dube (*Electrochemical properties of some condensation polymers in relation to their structure*); and Shri Ravinder Nath Kapil (*Morphological and embryological studies in some Euphorbiaceae together with a discussion on the systematic position of the family*).

The University of Poona has awarded the Ph.D. degree to Shri Venkatesh Ananthrao Saraf for his thesis entitled *Studies in isomerization and conjugation of some drying oils.*

Shri K. M. Kotadia has been awarded the Ph.D. degree of the Gujarat University for his thesis, *Studies in ionospheric physics in low latitudes.*

INSTRUMENTS AND APPLIANCES

Evapor-ion pumps

AS CONVENTIONAL GETTER PUMPS are not efficient enough for some specialized research problems pumps known as 'evapor-ion' pumps have been developed. In one type of getter pump, the evaporation of the getter (titanium) is rendered difficult by the reactibility of molten titanium with refractory materials. In another model titanium wire is fed on an electron-bombarded anode made of carbon (later of tantalum-tungsten alloy). But due to limitations in the useful life of these materials and in the feed rate of the wire, attention has been directed to the design of vapour sources eliminating the use of refractory supports. To overcome this difficulty, an evaporation source has been designed in which the end of the tungsten wire is fed downwards into an electron beam and bombarded. By this means a molten globule may be easily formed on the end of a wire, but it is difficult to attain the necessary high temperature for rapid evaporation because the globule is taken out of the region of intense electron bombardment by melting back along the wire. Thus either higher feed rate of the wire or increased electron intensity only results in the enlargement of the metal up to a critical diameter while its temperature remains constant at the melting point (*c.* 1660°C.). Using a feed wire 1 mm. in diameter, molten titanium droplets can be supported up to a maximum diameter of 5 mm. which give an evaporation rate of 15 mg./min. at 1660°C. However, a globule of titanium may be raised to a very high temperature (2000°C.) if the wire is fed downwards through a water-cooled copper block into the electron beam and the metal is allowed to melt back and contact the cooled block. A hemispherical globule is then formed which hangs from a frozen zone adhering to the cooled surface. Should the globule become detached from the feed wire, it remains suspended from the cooled block and the size of the droplet is limited only by the area of the cooled zone. In this technique the exit of the tubular nozzle gets blocked by the freezing of titanium melting back into the tube.

Similar titanium vapour sources in which the wire is fed upwards on to the molten tip of a rod which is heated by electron bombardment have been used. However, it is found that in such a source the entry tube is blocked due to the liquid metal running backwards under gravity. In another source suggested, it is very difficult to transfer metal to a heated surface because of either the feed tube obstructing the emitted vapour or the feed wire melting backwards while traversing the electron bombardment zone.

To avoid this, the wire is fed down an inclined plane so that it is located at the edge of the anode block without being laterally restricted. If the wire feed is obstructed when the metal globule sticks to the anode, then the wire may bend sideways and continue to enter the beam, in which case more than one globule may be formed. The life-time of the vapour source is entirely dependent on that of the cathode filament which is eroded by ion bombardment. Using such a source inside a water-cooled vessel 18 in. in diameter and a feed wire $\frac{1}{25}$ in. in diameter, evaporation rates of up to 250 mg./min. at a power input of 1·25 kV. and 4 amp. have been achieved and pumping speeds for air of 100 litres/sec. at 10^{-5} mm. Hg have been attained. Reduction in the bombardment current due to positive-ion bombardment is overcome by using a cathode heater transformer which is insulated from earth potential at high gas pressures. The combined action of the evapor-ion pump using titanium with a hydrogen content of 0·008 per cent by weight results in evacuation to an ultimate pressure of 10^{-6} mm. Hg [*Nature, Lond.*, **182** (1958), 851].

A 150 kV. particle accelerator

A 150 KV. COCKCROFT-WALTON type particle accelerator has been

constructed and put into operation at the Department of Physics, Muslim University, Aligarh. The machine is a convenient source of mono-energetic neutrons of 2·8 and 14 MeV. energy respectively from the exothermic reaction D(d, n) He^3 and D(t, n) He^4.

The power supply unit used is Model No. 2150-2R(2-5-1) of the Beta-Electric Corporation, New York, based on a standard doubler circuit. Three 50 kV. transformers in series serve as the main high voltage transformers and two special X-ray tubes Eureka EV-3-75-T as the rectifier tubes. All the components of the h.t. power supply are placed inside a box, 30 × 30 × 30 in., filled with Burmah-Shell Diala-B oil. The high voltage can be varied from 0 to 150 kV. by means of a remote controlled variac in the control panel. Safety measures like automatic overvoltage and overload releases, interlocks to preclude any one approaching the high voltage side while it is live and spark gaps to remove momentary surges, are also incorporated in the design.

The ion source is the same as that of Moak, Reese and Good [*Nucleonics*, (1951), 9, 3, 18] except for a bigger diameter of the Pyrex envelope of the ion source. The base of the ion source is connected through a palladium tube to a cylinder containing the gas (deuterium) to be used in the ion source. By controlling the temperature of the palladium tube, the flow of the gas to the ion source is regulated. The discharge in the ion source is excited by a 100 Mc/s. oscillator of the type used by Moak *et al.* All the ion source accessories are placed inside an aluminium box (5 × 3 × 3 ft) with rounded exteriors.

The accelerating column consists of alternate conducting (made of steel plates with central holes) and insulating sections (porcelain cylinders with the two ends ground). The final accelerating column consists of 4 sections with an overall length of 11 in. The metal plates carry cylindrical electrodes at their centre. The electrodes which can be fitted from the outside shape the electric field along the tube axis, thus regulating the acceleration and thereby the focussing of the charged particles; they also shield the tube walls from stray ions. The box containing the ion source accessories is supported by 4 perspex pillars which also serve to insulate the box from the ground. An MCF-700 oil diffusion pump of 650 litres/sec. capacity with a backing Duo-Seal mechanical pump of capacity 380 litres/min. maintains a pressure of *c.* 10^{-6} mm. of mercury in the whole system, and is measured by a 507 ionization gauge. A standby d.c. battery set keeps the mechanical pump running in case of any mains power supply failure. The accelerator has been in operation for a few months using a proton beam. Beam currents of protons of more than 100 μa. have been obtained on the target *c.* 5 ft away from the ion source. The beam can be kept steady continuously for many hours. Possibility of insulation breakdown has been practically eliminated [*Indian J. Phys.*, **32** (1958), 468].

Transistor switching timer

A DEVICE FOR TESTING TRANSISTOR switching times, API 300, incorporating a new precision technique for measuring durations in the millimicrosecond region has been announced by Atronic Products Inc., Bala-Cynwyd, Pa.

In operation, the transistor under test is inserted into the input connector of the API 300. Self-contained transistor bias voltages are provided, and an extremely precise driving pulse is applied to the transistor. By sampling the portion of the output pulse to be measured with a pulse whose characteristics are known, time is essentially converted to a voltage whose amplitude is proportional to duration. This voltage is amplified and displayed on a meter in terms of millimicroseconds. Designed specifically for analysing the time characteristics of high speed transistors, the API 300 measures the switching time of the leading or trailing edge of the output pulse with an error of 3 millimicroseconds in the 3-100 millimicrosecond range. Direct meter reading featuring a pre-settable go-no-go level makes the unit adaptable to production testing as well as to laboratory application. The instrument is available either as a bench top unit or in a rack mounting version. Other models are available which will separate carrier storage time from fall time and provide measurements in different ranges of switching speeds [*J. Franklin Inst.*, **266** (1958), 251].

Progress Reports

CENTRAL RICE RESEARCH INSTITUTE

DEVELOPMENT OF HIGH YIELDING AND IMPROVED strains of rice, influence of the nature and quantity of fertilizer, cultural trials, hybridization, breeding for disease resistance, weed control, etc., were some of the research programmes in progress at the Central Rice Research Institute, Cuttack, during 1955-56. Besides the research activities, which are briefly reviewed below, an International Training Centre for Rice Breeding was organized at the Institute in collaboration with F.A.O. Trainees from 14 countries of South and South-eastern Asia participated in the programme of the centre. The Institute has functioned as an effective training ground for post-graduate students of the Indian Agricultural Research Institute, New Delhi, and for mycologists from different State Governments. Training in modern intensive cultivation methods was given to 200 students from Orissa.

In studies on the efficiency of eight nitrogenous fertilizers for rice over a period of 3 years it was noted that except with calcium cyanamide and sodium nitrate, in all other cases higher yield response was evident. The best results were obtained with ammonium sulphate, ammonium chloride and ammonium phosphate; no significant difference was observed between the three fertilizers. Fractional application of the fertilizer gave better yields than entire quantity applied in one dose; the highest response was obtained with sub-surface application of fertilizer in three doses, i.e. half at planting, one-fourth one month after and the other one-fourth before flowering, employing in all 40 lb. N per acre. From experiments designed to investigate the cumulative effect of continuous application of various fertilizers and manures on the condition and productivity of rice soil, no deleterious effect was observed in the plots to which ammonium sulphate alone was applied continuously. Lime application, either alone or in conjunction with N, had no effect on the yield of rice. Also, neither phosphate nor potash had any effect on rice yield, whether applied alone or in combination with organic or inorganic N. Similarly, the differences due to organic manures were not significant and nitrogen application gave significant increase in yield up to 40 lb. N level.

The possibility of growing three crops of rice in a year on the same land was explored. Results obtained show that with an assured irrigation supply, a total yield of about 9011 lb. of paddy per acre is possible by adopting the following sequence of cropping with judicious manuring: (i) first crop of a short duration variety planted by about the middle of March and harvested by first week of June, (ii) second crop of medium duration variety sown in the main season from July to December, and (iii) third crop of short duration, rice sown by middle of December and harvested in April. Cultural-cum-manurial trials showed that field manuring according to the Japanese method lowered the yield of grain by 965 lb. per acre.

Under the scheme for the improvement of green manure crops for rice, financed by the Indian Council of Agricultural Research, 99 green manure species were investigated of which *Gliricidia maculata* has been found to be a perennial source of green manure, capable of giving two cuttings every year and providing green matter both for the main and second season rice crops.

One of the five promising varieties, namely Ptb. 10, developed from the previous year's varietal trials, was found to be significantly superior to others, yielding 63·4 per cent more than *Benibhog* (yield for *Benibhog* was 1013 lb./acre).

Soil under water-logged condition was found to be more fertile from the point of view of phosphate availability (0·46 and 0·09 p.p.m. P_2O_5 in soil solution for 10 cm. depth and surface film of water respectively); soluble iron in corresponding soil solutions was 31·0 and 13·9 p.p.m. respectively.

THE WEIZMANN INSTITUTE OF SCIENCE, ISRAEL

IN HIS REPORT TO THE BOARD OF GOVERNORS OF THE Weizmann Institute for the year 1956-57, the Chairman, Dr Meyer W. Weisgal, has referred to the financial difficulties under which the Institute was functioning and pleaded for the drawing up of a sound financial policy so that the Institute continues its work and maintains the high scientific standards which have established for it a prominent position in the world of science.

Two international conferences, one on Nuclear Structure, and the other on Macromolecular Chemistry, were held under the auspices of the Institute during the period under review. A brief summary of the notable contributions made by the Institute in the field of applied mathematics, nuclear and reactor physics, physical, inorganic and organic chemistry, biology and biophysics is given in the following paragraphs.

Applied mathematics — The research programmes in this field were concerned with the solution of problems arising in statistical mechanics, wave propagation, geophysics, hydrodynamics and X-ray crystallography.

A mathematical approach to geophysical problems aimed at an elucidation of the internal constitution of the earth through a study of earth tides has shown that the reason for the relative smallness of the earth tides is due to the earth being out of tune with the moon. The moon pulls the earth with a period close to 12 hr whereas the natural period of the earth is only 1 hr.

A method has been developed for treating a radio transmitter wave pulse on the basis of the wave equation. The solution obtained is mathematically exact, and the minutest details of the pattern of the received signal can be predicted; the evaluation was made possible by the electronic computer constructed

in the laboratory. This method has been applied to the problems of propagation of electromagnetic, acoustic and seismic pulses. The investigation has brought out some new features of the signal wave pattern, which will prove helpful in the interpretation of seismic records. For the first time, a direct measurement of the proton transfer in water has been made. This has been made possible by assuming that longitudinal and transverse relaxation times (T_1 and T_2) in the case of proton transfer, in water, are not equal and that T_2 is a function of hydrogen ion concentration with a minimum at *p*H 7.

Nuclear and reactor physics — A general method for describing the superfluous degrees of freedom in particle systems has been developed, having the following features: (1) it is applicable to general types of collective co-ordinates, (2) the physical implications of the redundant variables is clear at all points, and (3) the assumptions underlying the use of shell-model wave functions to describe the intrinsic motion are clarified.

A three-crystal pair spectrometer has been constructed for detecting electromagnetic radiations from C^{12} decay. This spectrometer allows detection of low intensity gamma rays with high background. In the decay of second excited state of C^{12} no electromagnetic radiation except 4·43 MeV. gamma radiation was found. This leaves alpha radiation to Be^8 as the only mode of decay of the second excited state of C^{12}. A significant contribution has been made in the study of the direction and degree of polarization of beta rays from different nuclei which is of importance in understanding the theoretical implications of non-conservation of parity in beta decay. In particular, results obtained for the polarization of beta rays from Au^{198}, which are in disagreement with results obtained elsewhere, have been shown to be correct.

Chemistry — The bitter constituents of the plants *Ecballium elaterium* and *Citrullus colocynthis* have been found to contain crystalline compounds with strong anti-tumour activity against experimental tumours. The two new crystalline compounds isolated from the ether extraction of the juice have been named Elatericin A and Elatericin B. Citrostadienol, a new substance isolated from citrus oil, has been shown to be 4-monomethylated steroid, namely 4-methyl-$\Delta^{7,24(28)}$-stigmastadien-3-ol. The discovery of 4-monomethyl steroids in nature is of considerable interest, since they undoubtedly represent a missing link in the biosynthesis of the steroids from the tetracyclic triterpenes. The structures of two new alkaloids, casimiroin and edulein, isolated from *Casimiroa edulis* Llave at Lex, the fruit of which has been reported to possess hypnotic, sedative and hypotensive actions, have now been shown to be substituted 1-methyl-quinolones. The total synthesis of sphingosine, a powerful anti-blood clotting substance isolated from brain tissue, has been achieved. Application of the recently discovered Wittig reaction to steroidal ketones has resulted in a new way of preparing the methylene-steroids and has also provided a new synthesis of the cholesterol side chain, and a new isomer of cholesterol, 20-iso-cholesterol, has been prepared. A number of Δ^4-3-hydroxy analogues of progesterone and ethinyl-testosterone have been prepared and some of them have been found to have appreciable activity. 20-Methyl-1-decalone, an essential intermediate for the synthesis of the pentacyclic triterpenes, has been synthesized and the stereochemical stability relationship between *cis* and *trans* isomers has been determined. A new method for preparing large-ring polyacetylenes has been worked out involving the oxidative coupling of terminal diacetylenes. The method makes available in one step highly unsaturated large ring alicyclic hydrocarbons over a wide range of size. Another method developed for the preparation of α, β-diarylpropionic acids and the corresponding nitriles is based on the observation that α-phenylcinnamonitrile is readily converted to α, β -diphenylpropionic acid by hot benzyl-alcoholic potassium hydroxide. It has been shown that the reaction involves reduction of the ethylenic bond, followed by hydrolysis of the nitrile group.

Polymer research — A theory for the phase separation of solutions of charged colloidal particles has been worked out and it has been shown that, contrary to accepted views, the electrostatic forces alone may suffice to counteract thermal mixing effects and to bring about phase separation. From a consideration of the general grand partition for polyelectrolyte including all possible neighbour interactions, it has been concluded that buffering capacity should always be symmetrical with respect to the point of half neutralization. The nearest neighbour interaction in the case of polyampholytes has the effect of increasing the dissociation tendency of both the acidic and basic groups. Rapid anionic polymerization has been induced with metal imides and some solid hydroxides have been observed to induce heterogeneous polymerization of vinyl monomers whereas others are absolutely inactive.

Some new polyelectrolytes like the polyvinyl-piperidine and others containing high percentage of β-amino acid groups have been prepared, and their possible uses in metallurgy are reported.

The physico-chemical behaviour of high molecular weight ribonucleic acids indicates that ribonucleic acids exhibit the characteristic properties of highly flexible, highly charged long chain polyelectrolytes. Critical examination of the agglutination of red blood cells by polybases has been carried out. The dependence of agglutination on molecular structure and molecular weight suggests the need for further investigations on thrombos formation in blood vessels. It has been observed that agglutinates may be dispersed by non-toxic polyacids of a suitable molecular weight.

Biology, biophysics and biochemistry — The research activities of the Department of Experimental Biology included such diverse fields of study as (1) biological mechanism of tumour induction, (2) metabolism of urethane in relation to its tumour inducing activity, (3) the mechanism of deciduoma formation and its relation to placental implantation of the ovum, (4) problems of human genetics, (5) immunogenetics of tumour transplantation, (6) radiobiological aspects of tissue immunity, (7) biochemical and endocrinological aspects of sugar metabolism, (8) problems in neuro-pharmacology, etc.

Studies on the influence of adrenalectomy on skin carcinogenesis have indicated that adrenalectomized mice (dietetically corrected by continuous high saline plus glucose feeding) failed to respond to a single strong dose of carcinogen which in control mice yielded 27 per cent tumours. When adrenalectomized animals were subsequently treated with croton oil, they all developed tumours, suggesting thereby that inhibition of carcinogenesis by adrenalectomy operates specifically at the promoting stage.

Investigations on the role of histamine in the process of ovum implantation have revealed that histamine antagonists prevent the transformation of diploid cells to the giant polyploid cells of deciduoma. Intra-uterine antihistamines prevent implantation and curtail gestation, while histamine itself does not significantly interfere. An immunological analysis based on quantitative determination of (1) the capacity to elicit the production of haemagglutins and (2) the degree of cytotoxic immunity responsible for the homograft reaction, has shown that homotransplantable tumours do not have a lower antigenicity, as had previously been assumed. Also it has been found that successful homografts are associated with pronounced antigen synthesis enabling the tumour to grow progressively in foreign hosts despite the production of an immune response.

The nuclear sexing method for diagnosing human genetic abnormalities has been successfully applied to cells in the amniotic fluid for prenatal diagnosis from third month of pregnancy onwards. This has clinical value in severe sex-linked diseases. The finding of abnormal sex chromosomic constitutions and the study of a range of human intersexual syndromes have shown that genetic factors can change sexual development.

The Department of Biophysics was mainly concerned with work on synthetic poly-α-amino acids, and their use in the elucidation of various chemical and physical properties of proteins and of natural polypeptides; synthesis of polycystein and polyhistidine has been achieved. Studies have also been carried out on the structure and the biological activity of some proteins as well as on the mechanism of action of some proteolytic enzymes.

Investigations on the optical rotation, temperature dependence of rotation, sedimentation and viscosity of the two forms of polyproline in various solvents show that polyproline I exists in aqueous solution as a right-handed helix with peptide bonds in the *cis* configuration whereas polyproline II exists in aqueous solution as a left-handed helix with peptide bonds in the *trans* configuration. This study is of great help in clarifying the role of proline in the structure of collagen and gelatin.

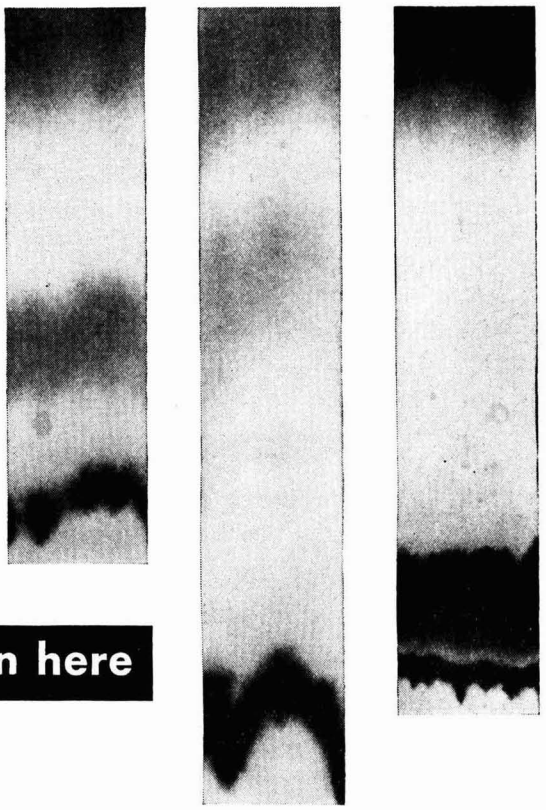
An improved design of the Zimm-Meyerson osmometer has been constructed using the principle of one-point central pressure for the sealing of the osmometer chamber. A diffusion cell for use with corrosive and/or grease dissolving solvents has also been constructed. It is an all-glass structure built in such a way that the solution does not come in contact with any joints.

A study of the nature of the forces holding the nucleic acid and protein together in ribonucleoproteins has shown that hydrogen bonds play an important part in linking the two moieties. It was found that nucleoproteins contain at least two enzymes, ribonuclease and deoxyribonuclease. The enzymes are present in latent form; they become active only when the nucleic acid is decomposed. From a cell-free extract of a prolineless mutant of *E. coli* an enzyme preparation was isolated, capable of hydrolysing poly-L-proline. The enzyme was shown to hydrolyse the N-terminal proline-arginine bond in salmine quantitatively, without liberating any other amino acid.

The mechanism of action of trypsin on lysine peptides has been investigated by using low lysine peptides as substrates. It is found that trypsin hydrolyses easily only bonds not adjacent to free carboxyl or amino groups. Otherwise transpeptidation leading to higher peptides occurs prior to hydroxytic breakdown.

Photochemistry and spectroscopy — Investigations on the reversible colour changes of some anils in their crystalline state under the influence of ultraviolet light have shown that in the stable form of the ortho hydro-anils the hydrogen of the hydroxyl group participates in an internal hydrogen bond with the nitrogen of the C=N group. Studies on the colour changes in bianthrone and spirophyrans series caused by bombardment with high energy electrons or with X-rays at low temperatures have shown that the compounds exhibit reversible colour changes similar to those obtained by irradiation with ultraviolet light. Similar results are obtained when these compounds are irradiated with gamma rays (emitted from Co^{60}).

In spectroscopic analysis, a new technique has been developed which enables absorption spectra to be taken under rigorous exclusion of air and hydroxylic contaminations from solutions in non-polar solvents. Side reactions involving oxygen or traces of water or alcohols are thus avoided, making results much more reliable and reproducible.



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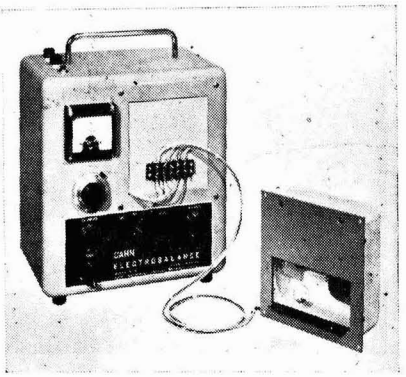

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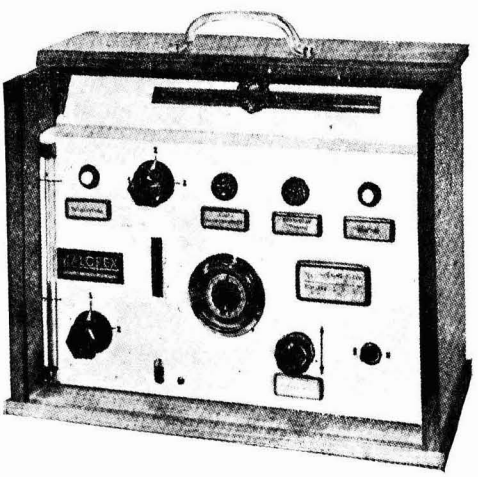

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