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COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH, NEW DELHI

NOTICE

It is proposed to appoint a Director for the Structural Engineering Research Centre at the Central Building Research Institute, Roorkee, under the Council of Scientific & Industrial Research. The general scope of work of the Centre will be advanced research in plain and reinforced concrete, prestressed concrete, steel structures, bridge structures, light metal structures, structural dynamics, prestressed light weight concrete, precasting and prefabrication and multi-storeyed buildings. The Centre will also develop a Design Unit for the application of the findings of research.

There is no standard form of application. Those who wish to be considered are invited to send their brief curriculum vitae to Dr S. Husain Zaheer, Director-General, Scientific & Industrial Research. Others who may wish to send nominations for this post may kindly forward their proposals to the Director-General.

All communications will be treated confidentially. Statements and proposals should be received by the Director-General on or before 28 February 1965 at the Council of Scientific & Industrial Research Office, Rafi Marg, New Delhi.

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Current Topics

International Organization for Standardization: Sixth General Assembly

OVER 500 experts from 41 countries, representing research, industrial and trade interests, participated in the deliberations of the Sixth Triennial General Assembly of the International Organization for Standardization (ISO) and its technical and administrative meetings held in New Delhi during 8-21 November 1964. Right since its inception in 1947, the Indian Standards Institution (ISI) has taken a prominent part in the activities of ISO. It is represented on 78 of its 108 technical committees and holds secretariat responsibilities for three of the ISO technical committees on lac, mica and pictorial markings for handling of goods, 4 subcommittees and 6 working groups. ISI has represented India on ISO Governing Council and its standing committees on (1) study of scientific principles of standardization, (2) planning, (3) atmospheric conditioning for testing, and (4) development. The ISI Director has been ISO Vice-President for two consecutive terms and is currently chairman of the planning committee and member of certain other administrative groups. Almost 60 per cent of the 365 ISO recommendations finalized so far have been introduced or are in the process of introduction in Indian standards. In view of this growing participation of ISI in the various activities of ISO, it was appropriate for it to play host to the Sixth General Assembly, the first international ISO meeting to be held in Asia. The election of Sir Jehangir Ghandy as ISO President for a 3-year term from January 1965, and the award of the Leo B. Moore Medal, instituted in 1963 by the Standards Engineers Society, New Providence (New Jersey), to Dr L.C. Verman, Director, ISI, for 'his highest achievements, extraordinary contributions and distinguished services in the field of standardization and its advancement through creative application and service to his own nation and to the international community', are two events which provide ample evidence of the recognition given to the significant role and valuable services rendered by ISI in the field of standardization, both national and international.

Besides the General Assembly, meetings were held of the ISO Council, its 7 standing working committees, viz. Development Committee, Planning Committee on Directives, Editing Committee, Finance Committee, Planning Committee and Supervisory Committee, and 27 technical committees, subcommittees and working groups. International standards were finalized in respect of 36 items. The fields covered include: Agricultural and food products including cereals and pulses, spices and condiments, and tea and coffee; Steel and steel sections; Iron and manganese ores; Aluminium; Light metals and their alloys; Screw threads; Bolts, nuts and accessories; Rubber and latex; and Vetiver oil. Of special interest to India were the recommendations regarding the basic reference methods for the determination of moisture content of cereals and their derivatives, and sampling and specification of specific spices and condiments, finalized by the Cereals and Pulses Subcommittee and the Agricultural and Food Products Technical Committee respectively. A draft proposal on a method of testing for infestation of cereals and pulses by X-ray examination was finalized. Separate working groups were set up to work on the sampling, test methods and packaging and specification for tea, coffee and cocoa. As a major producer of coal and coke, India's special interest lay in the seventh meeting of the Technical Committee on Solid Mineral Fuels which decided to create new working groups to deal with grindability test (WG 10) and size analysis of coal (WG 11).

A new international working group (R 68) to revise the existing ISO recommendation on screw threads was set up by the Technical Committee on Screw Threads to take account of the thread form with a large root radius required for horological work and other purposes. The Subcommittee on Procedures for Interconversion of Values from one System of Units to Another recommended that the ISO proposal on interconversion of values should be mainly based on the Indian standard (IS : 787-1956). The Technical Committee for Bolts, Nuts and Accessories finalized recommendations on tolerances on width across flats and width across corners for hexagonal bolts and nuts. Agreement was also reached on metric hexagonal bolts and nuts over 39 mm. thread diameter, hexagon socket head cap screws and cheese head screws and designation system for bolts, screws and studs. These agreements will allow international interchangeability of bolts, screws and nuts. The committee also set up a new working group to formulate proposals regarding the most usual types of slotted screws and tapping screws. New committees were set up to deal with (i) Measurement of liquid flow in open channels; (ii) Time measurement instruments; (iii) Test methods and acceptance tests for pumps; (iv) Performance testing of space heating appliances; and (v) Methods of testing industrial fans. A new coordinating committee named DATCO for standardization in the writing of dates was set up.

International standardization is a vital necessity for the promotion and growth of trade among different nations of the world, and is of particular significance to the developing countries. These countries are often faced with the problem of conforming their products to a host of standards and specifications from different consumer countries. A multiplicity of

standards for raw materials, spare parts, design features and even terms are not at all conducive to organized and rational growth and development of industries. In this context, the close association of ISI with the activities of ISO is a matter of commendation not only in respect of her own national interests but also as an example to other developing countries. By her active and effective participation in the finalization of ISO recommendations for agricultural products, equipment and other items of import and export relating to the tropical regions, ISI has played a significant role.

To give a more concrete shape to the important role of ISI in evolving standards for items for both domestic consumption and export, the ISI should be strengthened and provided with facilities for undertaking work on quality specification, including inspection and testing. These important aspects of standardization alone will ensure building up of confidence of the domestic consumer as well as of export market in Indian raw materials and finished products.

Teaching & Research in Cell Biology

THE Summer School in Cell Biology organized recently by the Ministry of Education at Ootacamund [see this Journal, **23** (1964), 451, for a detailed report] is a welcome indication of the growing interest among biologists and others in this important border-line subject in the country. This is perhaps the first occasion when botanists, zoologists, biochemists, biophysicists and others concerned with teaching and research in cell biology met to discuss the recent advances in the subject as well as to present papers dealing with researches carried out by them. More important, it enabled the participants to take stock of and exchange notes on the present status of teaching and research in cell biology in the country.

As the Director of the School, Prof. B. R. Seshachar, Department of Zoology, Delhi University, pointed out, cell biology is still in a rather poor state of development in this country, and he ascribed this to the inadequacy of specialized equipment available for research. It was also pointed out that there are a large number of trained scientists here in the country, and provided adequate facilities are forthcoming, the scope for developing the subject was bright. It was also stated that research in cell biology in such laboratories as it is being carried out is rather outmoded, and that it was necessary to modernize our outlook both in respect of teaching and research. In this context, the decision of the participants in the summer school to organize an Indian Society of Cell Biology is an opportune one. There is a great deal of spade-work to be done to put cell biology on a footing comparable to that of other interdisciplinary subjects like biochemistry. One of the important functions of the Society would be to achieve this by suggesting concrete measures. As a first step it would be necessary to survey the schools in the country doing research in cell biology, the areas of research, the facilities available both for teaching and research, so that an objective estimate of the requirements in terms of equipment and personnel can be made. A workshop in techniques in cell biology on the lines of ' biochemical techniques ' organized by the University Grants Commission at the Indian Institute of Science, Bangalore, would serve a useful purpose in pointing out areas which need to be strengthened, the type of equipment needed and the practical courses to be introduced.

A prerequisite to modernizing research and teaching in cell biology is a complete reorganization of curricula for biological sciences at all levels. Principles of biochemistry, biophysics, cytochemistry, physiology, etc., and the techniques employed in these fields should increasingly find a place in the teaching of biological sciences, so that the students are better equipped for research in cell biology and other allied interdisciplinary subjects.

Increasing attention is being paid at present to research in biological sciences in almost all the scientifically advanced countries of the world, and the National Biological Laboratory being planned by CSIR is an indication of the importance attached to stepping up research in biological sciences in India. The scientific personnel for such institutions must come from the teaching institutions. The University Grants Commission and the Education Ministry must go more deeply into the questions of not only the facilities in terms of equipment and recruitment of trained personnel available for teaching and research in cell biology but also into the fundamental question whether the teaching of biological sciences as obtaining at present in various universities and other teaching establishments at different levels has the required standard and modern bias.

Summer School in Chemistry & Technology of Oils & Fats

G. LAKSHMINARAYANA & K. T. ACHAYA
Regional Research Laboratory, Hyderabad 9

UNDER the auspices of the Council of Scientific & Industrial Research, a Summer School in the Chemistry and Technology of Oils and Fats was held during 15-27 June 1964 at the Regional Research Laboratory, Hyderabad (RRL, H), for the benefit of research scholars, scientists and technologists from universities, industry, national laboratories and other research centres in the country. The school was designed as a refresher course to cover recent advances in the technology, chemistry and analysis of vegetable and animal oils and fats, and of products derived therefrom. It comprised both oral and practical instruction; 22 one-hour lectures were given at 9 a.m. and 4.30 p.m. by 20 Indian scientists, of whom 11 were from the host laboratory. In the intervening period, practical instruction was imparted by the laboratory staff with regard to some 27 analytical techniques and pilot-plant operations to the 44 participants, divided into three batches.

Lectures

The participants were informed in advance by post of the topics that were covered in each lecture. Dr K. T. Achaya (RRL, H) prefaced the first lecture on 'Highlights of the last decade' with the remark that any selection would necessarily be personal. Sources of oil have altered little, tall oil being the only really new raw material. Genetic selection has led to the development of glandless cottonseeds, and of mustard seeds free alike of pungent sulphur compounds and erucic acid glycerides. Numerous unusual acids containing epoxy, hydroxy and cyclopropene groups have recently come to light, and the field of glyceride structure continues to be active. Advances in methodology have accelerated progress. Very small quantities of material now suffice for analysis by thin-layer and gas-liquid chromatography. Nuclear magnetic resonance constitutes a new weapon in the physico-chemical armoury. In technology, stress is now being laid on both protein and oil quality. Continuous processing has become commonplace in alkali refining, deodourization, and soap and margarine manufacture. Oleo-chemicals based on fats have greatly diversified.

Dr A. C. Chhatrapati (Vanaspati Manufacturers' Association of India, Bombay) discussed the 'Oilseeds economy of India'. The production of oilseeds has failed to keep pace with the growth in indigenous demand, as seen by the shortfall in the production target set for the Second Plan, and the even greater shortfall likely in the Third Plan target. The widening gap between supply and demand is reflected in the continually rising price, which reached record levels this year. Technology could play a significant role in alleviating fat shortage through optimum use of oil-bearing resources like cottonseed, rice bran, tallow and minor oilseeds.

'Milk, animal and fish fats' were dealt with by Dr K. T. Achaya (RRL, H). He first discussed the traditional and modern procedures for isolating the fat of milk as ghee, in the light of domestic and industrial suitability. Ghee, though mostly fat, carries numerous other minor constituents. The fat itself, when examined by sensitive techniques such as gas-liquid chromatography, reveals over 60 constituent fatty acids, which arose either from acetate, a product of rumen fermentation, or from dietary or liver-synthesized fat. Feed, season and breed could all influence the nature of ghee. Detection of adulteration is, therefore, not easy, though recent techniques, such as GLC of the sterols, show great promise. The constituents of ghee flavour and off-flavour were also touched upon. In the absence of a meat-packing industry in India, tallow production and quality are both uncertain, and the product is a scarce and valuable one. The nature of Indian animal tallows and the research efforts to obtain substitutes for it from vegetable oils were outlined. The quantity of available fish oil varies widely, and the quality remains low. Only immediate rendering of the oil on board the fishing vessel itself could hope to improve quality.

Prof. J. G. Kane [Department of Chemical Technology, University of Bombay, Bombay (DCT, B)] covered the field of 'Minor oilseeds and oils of India'. The country has a wide variety of minor oilseeds, a few of which are available in fairly large quantities. Oils from oilseeds like those of *mahua* (*Madhuca latifolia*), *neem* (*Azadirachta indica*) and *karanja* (*Pongamia glabra*) have long been used in the soap and leather industries. All these oils carry either a deep colour, a penetrating odour, an unpleasant taste or a high content of lipid associates. Some of the lipid associates have been identified, such as the bitter principles (nimbin, nimbidol, etc.) of *neem* oil and the colouring matter (karanjin, pongamol, pongapin, etc.) of *karanja* oil. These lipid associates render the minor oils inedible and complicate their refining. Specific reagents like alcohol, alcoholic alkali and sodium chlorite bring about a fairly good degree of refining and bleaching. Perhaps the best general way to use these oils would be to split them and to distil the fatty acids. A programme of extensive collection of the available minor oilseeds and of intensive cultivation of a few oil-bearing trees coupled with suitable processing methods will help to meet the present acute shortage of fatty oils.

Dr S. Raghavendar Rao (RRL, H) spoke on the 'Storage of oilseeds and oils'. Moisture is a critical factor controlling seed deterioration, which occurs rapidly beyond a critical moisture content. Wet atmospheric conditions during maturing and harvesting result in damaged oil with increased free fatty acid content. Moist seeds when stored in bulk also develop heat as a result of respiration of the seed, and this increases the colour of the oil. Pyramidal heap storage, rather than in irregular heaps, in a dry atmosphere is recommended. Colour fixation occurs

in cottonseed oil when it is stored at high temperatures.

Shri V. Krishnamoorthi (RRL, H) discussed the 'Utilization of oilcakes' which, though byproducts of the oil industry, are obtained in larger quantities than the oils themselves. Oilcakes are rich in proteins and can be used for human nutrition if properly processed. The harmful substances in the major oilseeds and the methods of removing them without damaging the quality and quantity of seed proteins were discussed.

Dr K. S. Murti (Department of Chemical Technology, Osmania University, Hyderabad) covered 'Recent advances in expelling and extraction of oils and fats'. The importance of size reduction, humidification, cooking and drying operations of the seed material prior to expelling was emphasized. Modern trends in expeller design towards larger capacities, higher shaft speeds, development of higher pressures and double pressing in a single step were described. Among the newer methods, the Skipin process, the integrated processing of groundnuts to yield oil, proteins and carbohydrate meal, and the Kraus-Maffei process for wet processing of fresh coconut were described. Modern trends in extraction, design and operation as incorporated in the Rotocel, De Smet, Filtrex, French, Andersons and Lurgi units were outlined. The use of acetone for the extraction of cottonseed and of mixed solvents (acetone, hexane and water) was also described.

Dr D. Rebello (DCT, B) presented 'Developments in the refining of oils and fats'. Developments in the continuous refining processes were traced from the beginning, when caustic was the only alkali used, to the soda ash process, then to the modified soda ash process and finally to the caustic-soda ash process, which have some advantages over the original caustic process. The refining of oils with ammonium hydroxide, particularly for obtaining good quality phosphatides and fatty acids, was briefly mentioned. The importance of refining cottonseed oil in the miscellar state and the advantages of using a weaker lye in this process were emphasized. The newly developed process of alcoholic-alkali refining of inedible oils, particularly with respect to *karanja* and *neem* oils and the possibility of its being industrially employed for the refining of these two oils were described.

Dr E. R. Saxena and Dr S. S. Joshi (RRL, H) spoke on the subject of 'Bleaching earths and carbons and the theory of bleaching'. The types of earths used for bleaching are naturally acid and active fullers' earths and bentonite, which has to be acid- and heat-treated prior to use. These earths usually contain clay minerals like montmorillonite, illite and attapulgite in various proportions. During acid treatment, the basic cations in the clay minerals are replaced by protons (H^+), which may then exchange with the pigment molecule. Adsorption being a surface phenomenon, the large surface created by the removal of alumina from earth has a part to play in bleaching. Although India is self-sufficient in the production of bleaching earths, these are still not the equal of imported earths for bleaching dark-coloured oils. Active carbons are prepared by carbonization of wood at 600-900°C. in the absence of air. The raw material is usually treated with soluble chlorides of zinc, calcium and magnesium prior to carbonization. X-ray studies have shown active carbon to consist of crystallites in which carbon atoms are arranged in a hexagonal lattice stacked in two or more planes one over the other. Hydrogen atoms attached to hexagonal plates are supposed to be responsible for the activity. While a bleaching earth removes all the yellow and a considerable proportion of red-colouring constituents, active carbon is very effective in removing the difficult residual red colour.

The physico-chemical characteristics of activated earths such as particle size, bulk density, acidity, moisture content, pore volume and surface area have a considerable influence on their decolourization, filtration and oil retention capacities. The decolourization of vegetable oil also depends on the nature of the colour constituents, such as carotenoids, isoflavone glucosides, xanthophyll and chlorophyll. Standard earths with a definite range of physico-chemical properties could be useful for standardization and other purposes.

Dr V. Kesavulu (RRL, H) discussed the 'Theory of catalysis' with reference to vegetable oils. The adsorption of the molecules of either or both of the reactants in an active form at the surface is a prerequisite for the occurrence of the reaction. Both geometric and electronic factors are important in catalysis. Most hydrogenating catalysts have interatomic distances between 2·5 and 2·8 A. which are favourable for the two-centre adsorption of the ethylenic carbons. Adsorption of ethylene on nickel, self-hydrogenation and dehydrogenation, multicentre adsorption, formation of acetylenic residues and polymerization were discussed. Dissociative adsorption of hydrogen on nickel films and the consequent changes in the electrical conductivity of the film were explained.

Dr B. Sreenivasan (Tata Oil Mills, Bombay) dealt with the 'Theory and practice of hydrogenation of vegetable oils'. Only a few *trans* isomers are formed in the absence of hydrogen. A mechanism of partial hydrogenation and dehydrogenation (atomic hydrogenation) explains the formation of both *trans* and positional isomers. In the case of linoleate, at high temperatures (>170°C.), formation and disappearance of conjugated isomers occur rapidly, while at low temperatures (90°C.) simple saturation is the predominant reaction. When one mole of hydrogen is added, the resulting monoenes have double bonds from 6- through 14-positions. Hydrogenation in solvents occurs at a faster rate, with lower *trans* isomer formation. Castor oil can be hydrogenated in ethanol without any dehydroxylation. Palladium is a commercially feasible catalyst for the hydrogenation of oils as only very small amounts (0·0005 per cent) of the catalyst are needed and hydrogenation occurs at low temperatures (100-120°C.), but the high agitation speeds (800 r.p.m.) necessary tend to reduce the formation of *trans* isomers. In conjugated hydrogenation using ethanol as hydrogen donor, hydrogenation of linoleic acid occurs to the full extent and of groundnut oil terminates at an iodine value of 64. With isopropyl alcohol as donor, the limit is reached at an iodine value of 24 and there is no selectivity. Homogeneous catalytic hydrogenation of soyabean oil is

possible using iron pentacarbonyl as catalyst with similar isomerization and migration of bonds as with nickel catalysts, but is complicated by the difficulty of freeing the product of catalyst.

Shri R. K. Bhatnagar (Shri Ram Institute for Industrial Research, Delhi) discussed the various ' Chemical modifications of oils and fats ', such as alcoholysis, acidolysis, glycerolysis, interesterification and sulphonation, and industrial utilization of such products.

Dr P. K. Banerjee (RRL, H) dealt with ' Materials of construction in the oil and fat industry '. Fatty acid corrosion and metal contamination are usually overcome by the use of stainless steel. Mild steel and cast iron are satisfactory for milder operations dealing with materials of low acidity. Of the non-ferrous metals, aluminium is the most widely used as a material of construction. Storage tanks in oleine- and stearine-producing plants and condensers for fatty acids and glycerol are often fabricated from aluminium. For cheapness lead-lined vessels can advantageously be used in soapstock acidulation and sulphation of oil. Where costs permit, nickel-clad vessels are ideal for soap-kettles, soap-cooling frames, etc., in which alkalinity is encountered. Metals coated with corrosion-resistant synthetic resins, plastics, rubber or paints are being widely used for the manufacture of storage tanks for fatty acids and for other purposes.

Shri M. A. Sivasamban (RRL, H) discussed ' Recent advances in surface coatings '. In the case of drying oils, recent research has aimed at upgrading the properties by styrenation, maleinization and epoxidation of the oils. The most important contribution towards the improvement of the properties of coatings has been from synthetic resins. Newer resins, like the epoxies and polyurethanes, have unique properties of resistance to various deteriorative influences. Finishes based on soluble and thixotropic resins are very popular for ease of application. In the evaluation and testing of coatings, new methods of measurement of adhesion, surface analysis of films, chromatography and techniques like infrared, ultraviolet and nuclear magnetic spectroscopic techniques are being extensively used to obtain a clearer picture of the fundamentals underlying the performance properties of paints.

The field of ' Surfactants ' was next dealt with by Dr K. T. Achaya (RRL, H) who outlined the methods of manufacture of typical anionic, cationic, non-ionic and water-repellent products. Basic concepts concerning surfactant action were then discussed, such as surface, bulk and interfacial orientation, and the balance of forces in a molecule. These concepts were illustrated with practical operations, in particular the phenomenon of detergency, which combined wetting, emulsification, foaming, and several interfacial and displacement effects. Since a stepwise two-carbon mechanism was involved in microbial biodegradation, the trend is towards production of benzene sulphonates carrying a straight alkyl chain, derived frequently from α-olefins.

Dr D. Rebello (DCT, B) discussed the processes for the ' Recovery of products from oil industry wastes '. The old methods for the recovery of nickel from spent nickel catalyst such as incineration, hydrolysis of fat and acid digestion were reviewed. A new method of promise is the acid digestion of the spent catalyst directly in the presence of a non-polar solvent so that both nickel and fat are recovered in a single step. Soapstock acidulation with sulphuric acid by batch and continuous methods was described, especially that in which a Polbielniak centrifugal contactor is used. The recovery of oil from spent bleaching earths using the old alkali treatment and the new solvent extraction procedure was described.

Dr S. Venkob Rao (RRL, H) reported a solvent extraction procedure using hexane and acetone for the recovery of phospholipids from groundnut oil storage tank sludges.

In another lecture, Dr S. Venkob Rao (RRL, H) dealt with ' Phospholipids '. He described the chemistry of the phospholipids which occur in nature, both in plant and animal cells, as complex mixtures associated with proteins and carbohydrates. Various fractionation methods were reviewed. The synthesis of phospholipids was also covered.

Dr V. R. Bhalerao (National Dairy Research Institute, Karnal) spoke on ' Rancidity and autoxidation '. The modern theory of autoxidation involving hydroperoxides was discussed in relation to the oxidation of oleic and linoleic acids by initiation, chain propagation and termination of free radicals. The biological and technological significance of autoxidation in the edible fat industry was also discussed.

Dr M. R. Subbaram (RRL, H) surveyed ' Methods other than chromatography for the separation of fatty acids and derivatives ', namely low temperature solvent crystallization, urea adduction, vacuum distillation, and countercurrent distribution involving repeated partition between two immiscible solvents.

Dr G. Lakshminarayana (RRL, H) dealt with ' Chromatographic analysis of fats '. Various chromatographic procedures were classified, and their principles and operations discussed. The advances made by column or thin-layer chromatography (TLC) using silicic acid impregnated with silver nitrate for the separation of *cis* and *trans* isomers and critical pairs were stressed. Gas-liquid chromatography (GLC) was discussed in detail. Alteration of compounds that could occur in chromatographic procedures was cautioned against.

Dr M. R. Subbaram (RRL, H) discussed the physical, chemical and biochemical methods used for the ' Determination of the glyceride structure of natural fats '. The physical methods include countercurrent distribution, thermal gradient elution, and TLC and GLC procedures. The chemical methods include oxidation of fat with potassium permanganate in acetone or acetone-acetic acid media, with periodate together with catalytic amounts of permanganate in *t*-butanol medium, and by ozonization. The oxidized fat is thereafter fractionated and analysed. Pancreatic lipase, which specifically cleaves fatty acids in 1,3-positions of triglycerides, is used to obtain data for calculating isomeric glyceride types.

Dr A. R. S. Kartha (Indian Agricultural Research Institute, New Delhi) traced the development of ' Concepts of glyceride structure ', namely ' simple monoacid ', ' even ', ' random ' and ' restricted random ', and critically evaluated those which explain

the major features of glyceride structure. The Restricted Random Distribution (RRD) Rule is based on the assumption that the *in vitro* specificities of lipase are the same as their *in vivo* specificities. Investigations on the biogenesis of fats have shown that this assumption is probably not justified and the Specific RRD Rules have been developed taking into consideration all possible specificities of lipase. The Specific RRD Rules account for all structural aspects as satisfactorily as the RRD Rule, but make possible some configurational changes. The configurations determined by oxidation techniques show that most probably the Specific RRD Rule B prevails in the formation of natural fats, and the bio-esterification takes place by an α-β lipase mechanism in conjunction with fatty acid specificity. It was indicated that the recently postulated mechanism of quantum synthesis for bio-esterification may possibly lead to further refinements in the Specific RRD Rules.

Dr K. Venkata Ramaiah (Osmania University, Hyderabad) discussed 'Spectroscopy and its applications in the field of oils and fats'. The band at 10·36 μ arising out of the CH wagging mode of vibration is used for the identification and estimation of isolated *trans* bonds in acids, esters and triglycerides. The bands at 10·55 μ and 10·18 μ can be used to estimate conjugated *cis-trans* and *trans-trans* materials in mixtures. The combination band at 2·14 μ in the near infrared region is due to *cis* unsaturation. Infrared evidence showed that the hydrogen bondings in various isomeric hydroxystearic acids and their esters were different. *Cis*-oxirane compounds showed an absorption at 12 μ against absorption at 11·2 μ in the corresponding *trans* epoxy isomers. The theory and practice of ultraviolet and nuclear magnetic resonance spectrometry were also discussed. Determination of the structure of sterculic acid with the aid of proton resonance spectrum was cited as an example.

Demonstrations

The following analytical techniques and pilot-plant operations were demonstrated and discussed.

Analytical techniques — Ester fractionation, urea adduction and countercurrent distribution for the separation of fatty acids or their esters; reversed-phase partition chromatography on column, paper and thin layer for the separation of fatty acids or their esters; paper chromatography of tocopherols; TLC of polyhydroxy fatty acids, polyhydroxy fatty alcohols, triglycerides, phospholipids, and tocopherols separately; column and thin-layer silicic acid-silver nitrate chromatography for the separation of fatty acid esters or triglycerides; GLC of fatty acid esters; electrophoretic separation of proteins and nucleic acids; visible spectrophotometric techniques for the estimation of carotene, chlorophyll and gossypol; ultraviolet for polyunsaturated acids; infrared for *trans*, epoxy and hydroxy fatty acids; use of radioisotopes in lipid research; nitrogen and phosphorus content of oilcakes and vegetable oils respectively; detection and determination of aflatoxin in groundnuts and groundnut meals; and AOCS cup refining method for refining of cottonseed oil.

Pilot-plant demonstrations — Continuous refining of cottonseed oil; high pressure fat splitting without catalysts; fatty acid distillation; glycerine recovery; solvent crystallization of fatty acids; hydrogenolysis of fatty acids to alcohols.

Literature on each technique, covering its principle, practice, advantages, limitations and bibliography, was distributed to the participants in advance.

Immense interest and keenness was shown by the participants both in the lectures and in the demonstrations as judged by their free discussions. A day and half was kept free for the participants either to repeat any technique, or to analyse their own materials using them. Some demonstrations, such as cottonseed pilot-plant processing, were arranged on specific request.

Conclusion

On the closing day, comments and suggestions were called for. There was general appreciation of the conduct and organization of the summer school, and some suggestions were given for the future. The subject matter assigned to some lecturers was considered too vast to be covered in an hour without sacrifice of detail or lucidity. Some participants regretted the absence of visits to industries. In conclusion, Dr Lakshminarayana said that a general coverage was attempted in this first Summer School in Oils and Fats, and perhaps specialization could be considered in the future schools, which could well be conducted at different centres at least once in two years.

Summer School on Pharmaceuticals

TAPAN DUTTA, B. K. MOZA & S. P. DUTTA
Bengal Immunity Research Institute, Calcutta 16

A SUMMER School on Pharmaceuticals was held at Shillong from 10 to 20 June 1964 under the auspices of the Ministry of Education, Government of India. The summer school, which was inaugurated by Shri D. K. Barooah, Minister for Education, Assam, was organized with a view to enabling research workers and teachers to meet together and hold discussions on the recent advances in the field of pharmaceuticals so that they could do a better job of educating and training young workers. The lectures and seminars were held under the general guidance of Dr U. P. Basu, Director, Bengal Immunity Research Institute, Calcutta. The participants included research workers from the National Chemical Laboratory, Poona; Central Drug Research Institute, Lucknow; School of Tropical Medicine, Calcutta; Hindustan Antibiotics, Pimpri; Haffkine Institute, Bombay; and Bengal Immunity Research Institute, Calcutta; and the universities of Panjab, Rajasthan, Saugor and Bombay.

In his inaugural speech, Dr U. P. Basu referred to ancient remedies against disease and observed that a great deal of modern knowledge in pharmaceuticals originated from ancient folk medicine. Dr. Basu also dwelt on modern techniques employed in the study of drugs, newer concepts in the evaluation of drugs and the difficulties encountered by research workers in the field of pharmaceuticals.

The proceedings of the summer school were organized under the following four sessions: (1) Plant Products, (2) Chemical Congeners, (3) Advanced Topics, and (4) Group Discussions.

Plant Products

Prof. R. N. Chakravarti (School of Tropical Medicine, Calcutta) spoke on the importance of steroids in the production of steroid hormones from plant sources and the difficulties encountered in the work on steroids. He emphasized the importance of employing proper storage and extraction procedures in the case of plant materials, citing the example of *Dioscorea deltoidea*, a rich source of diosgenin. For example, *D. prazeri* and *D. deltoidea* when kept soaked in water for a long period yield on extraction *epi*-smilagenin and smilagenone instead of diosgenin. One of the stumbling-blocks in carrying out research on steroids is the existence of numerous stereoisomers. He discussed the use of Raney nickel for the conversion of a number of inactive isomers of hormones into the active isomers.

Dr A. S. Rao [National Chemical Laboratory, Poona (NCL)] in his lecture dealt with the chemistry of podophyllum. He gave an account of the earlier work on podophyllum and then described the structure and synthesis of podophyllotoxin. The Indian variety, *P. emodi*, yields more podophyllotoxin than the American variety, *Podophyllum peltatum*. Podophyllotoxin is biologically active against tumors, whereas the isomeric product (picro-podophyllotoxin) is inactive. The maximum tolerable doses as well as the minimum effective doses of some of the isolated and degraded products were also described.

Various transformation products of santonin and their stereochemistry were discussed in another lecture by Dr A. S. Rao. Recent investigations on the stereochemistry of *l*-α-santonine by X-ray crystallography have revealed the configuration of the molecule at C-11 to be α, which was earlier stated to have β-configuration. The C-11 β-isomer is also found in nature but has no physiological activity. From costus root oil a lactone, costunolide, has been isolated which has been converted to a number of interesting compounds such as Δ^3-santenolide, $\Delta^{4(14)}$-santenolide, saussurea lactone, tetrahydrosaussurea lactone, santanolide A, santanolide C, junenol and dihydrojunenol. All these compounds have been synthesized starting from santonin.

Dr B. K. Moza [Bengal Immunity Research Institute, Calcutta (BIRI)] spoke on recent trends in the isolation and structural elucidation of plant constituents with special reference to the alkaloids of *Vinca rosea*. He described the isolation of three new alkaloids, vindorosine, catharosine and lochnerinine, from *V. rosea* obtained from USSR, which was grown there with the seeds obtained from India. The structures of these three new alkaloids and that of another known alkaloid, lochnericine, have also been established on the basis of chemical reactions and spectral evidence. Dr Moza referred to the technique of mass spectrometry and its application in the elucidation of the structure of these and other alkaloids.

Dr C. R. Narayanan (NCL) in his lecture reviewed the work carried out on veratrum alkaloids. He gave an account of the alkaloids veracemine, cevine and cevagenine and afforded proof for their existence and described their stereochemistry. The structure-activity relationships of some of the ester alkaloids were discussed and it was indicated that esterification at the carbon atoms 3, 7 and 15 gave highly potent ester alkaloids. In another lecture, Dr C. R. Narayanan described the isolation of three active principles, viz. β-sitosterol, α-stachydrine and rutin, from *Capparis moonii* (Hindi: *Rundanti*).

Shri Tapan Dutta (BIRI) described the isolation and characterization of a triterpene-saponin, monnierin, from *Bacopa monniera*. He described the pharmacological action of several triterpenes, e.g. glycerrhetic acid as mineralocorticoid, and isothankuniside and its degraded product as hypotensive agents.

Chemical Congeners

Dr K. D. Kulkarni (Haffkine Institute, Bombay) gave an account of his studies on *p*-alkoxydiphenylthiocarbamides as tuberculostatic agents. The replacement of one of the alkoxyphenyl with substituted thiazole, pyrimidine or pyridinophenyl group

increases the *in vitro* tuberculostatic activity of the corresponding thiocarbamides, e.g. *p*-alkoxyphenyl-*p*-4-(2,5-dialkyl) thiazolophenyl thiocarbamide has the same order of *in vitro* activity as that of isoniazid.

Shri M. H. Shah (Haffkine Institute, Bombay) described the synthesis of some 1,2,4-triazole and 1,3,5-triazine derivatives as possible oral diuretics. In the case of 2-amino-6-phenylamino-1,3,5-triazines, substitution in *meta* position of the benzene nucleus increases diuretic activity. 5-Substituted-phenyl or 4'-pyridyl-1-alkyl-2-sulphydryl-1,2,4-triazoles have been found to possess good diuretic activity.

Dr H. Singh (Panjab University, Chandigarh) gave an account of azasteroids with special reference to their antibacterial, antifungal and hypotensive properties. Considerable interest has been evinced recently in azasteroids following the discovery of anticancer agents in this field. In order to introduce nitrogen in the steroid molecule, appropriate steroid ketones are subjected to Beckmann rearrangement and Schmidt's reaction.

Dr S. F. Boyce (Bombay University, Bombay) gave an account of the work done on the biological activity of steroids having substituents in C-3 and C-17 carbon atoms. Steroids substituted at these positions possess biological activities different from those of parent steroids.

Shri P. C. Jain [Central Drug Research Institute, Lucknow (CDRI)] described the synthesis and biological activity of some imidazopyridine analogues of various naturally occurring purines as also of β-*d*-ribofuranosides of imidazo- and triazolo-2-(α-hydroxybenzyl) imidazopyridines and their corresponding imidazo- and triazolopyridines. Many of these compounds have diverse types of pharmacological activity.

Dr S. P. Dutta (BIRI) in his lecture dealt with the degradation products of nicotine. Potassium permanganate in alkaline medium oxidizes γ-picoline not only to isonicotinic acid but oxalic acid, ammonia, carbon dioxide, nitrous acid and nitric acid are also formed. He referred to the isolation of isoniazid from a reaction mixture of ethyl isonicotinate and hydrazine hydrate. The first crop isolated from this reaction mixture is of pharmacopoeial purity, but the second crop is found to be contaminated with *sym*-di-isonicotinyl hydrazine, hydrazodicarbon amide and 1-carboxyhydrazino-3,5-(4')-pyridyl-1,2,4-triazole. In another paper, Dr Dutta described the chemical congeners of papaverine such as 1-(4'-methoxyphenyl)-3-methylisoquinoline and N-N-bis-3-methylisoquinolyl-1-methylamino-α-methyl-β-phenylethane which have papaverine and atropine like action. Some quinolyl-isoquinoline and isoquinolyl-isoquinoline derivatives with specific pharmacological actions were described.

Advanced Topics

Dr P. Gundu Rao (Division of Pharmacy, Birla College of Science, Pilani) presented an up-to-date review on microbial transformations of natural products. He discussed in detail and with specific examples as to how hydroxylation and dehydrogenation can be brought about by microbes even in such cases where the alternative chemical methods have not proved useful. He further stressed on the possibilities and potentialities of utilizing such techniques in our country on a wider scale.

Dr P. N. Kaul (Hindustan Antibiotics, Pimpri) elaborated on physiological disposition of drugs with regard to their absorption, distribution, biotransformation and elimination. This study is of interest in determining the duration of action and the dosage schedule of administration of drugs. This, he pointed out, could lead to the discovery of new drugs or to a new use of a known drug. He also discussed his work on the mechanism of action of Hemycine and that of apomorphine and the interesting phenomena which occurs on the autoxidation of apomorphine to a nitrogen-free product having no emetic property.

In his lecture on metal chelates, Shri R. L. Khare (Saugor University) dwelt on the mechanism of chelate formation and the methods of studying such systems. He reviewed and discussed in detail the implications of chelation in arriving at the mechanism of action of a number of pharmaceuticals.

Discussing the chemotaxonomy of some alkaloid-bearing plants, Dr B. K. Moza (BIRI) pointed to this modern trend of classifying plants broadly on the basis of their chemical constituents. He pointed out the advantages of this approach and then presented his work supporting the grouping of six tribes of Liliaceae under the subfamily Wurmbaeoideae for the reason that the plants of these tribes contain the tropolone alkaloid colchicine or its some other naturally occurring derivative which may be considered as the chemotaxones of this subfamily. How this method of classification could be of great help to botanists was evident from the fact that out of 18 plants studied those which had some contradictory reports in the existing literature regarding their botanical classification could be definitely shown by their chemotaxonomic criteria whether they belonged to this subfamily or not. He, however, emphasized that a single constituent or a single type of constituent may not represent the chemotaxone of a group and for this it was reasonable to consider a combination of constituents as the chemotaxones. This he explained by presenting his work on some papaver plants grouped in the sub-section Scapiflora on the basis of their possessing either one or more from the alkaloids of muramine, rhoeadine and xanthopetalline types.

Shri Jain (CDRI) gave a talk on antimetabolites and reviewed the historical development of the concept of chemotherapy and the modern trends in the field with particular reference to antagonists. He discussed the implications of selective toxicity of antagonists and how it could be achieved. He also dealt with the various mechanisms of action of some known antimetabolites, a thorough understanding of which would lead to better designing of antimetabolites.

Group Discussions

A number of group discussions dealing with general topics and focusing attention on some problems of pharmaceutical education and profession in India were held. One of the discussions in which most of the participants took active interest was on the standardization of pharmaceutical preparations, particularly those listed in *Indian Pharmacopoeia*. Many of the participants were of the

opinion that a number of preparations had no suitable analytical controls. There was a general feeling that universities, the control laboratories of the government, and the research units of industries should take more interest in evolving suitable methods of analysis for those preparations which have no specific pharmacopoeial standards. It was decided that the Government of India should be approached for providing more facilities and for initiating specific schemes on standardization in the existing laboratories.

Another related topic that came up for discussion was concerned with ways and means of dealing with malpractices in pharmaceuticals industry. This led to an interesting suggestion that state trading should be taken up in pharmaceuticals. After considering the pros and cons of the suggestion, it was concluded that the present system of manufacture and distribution, in principle, was all right. However, it was felt that further advancement in pharmaceutical education and stricter measures for controlling the production and distribution of pharmaceuticals would rid the country of nepharious practices in the drug trade.

Finding ways and means of providing suitable facilities for the teaching of physical pharmacy in various universities formed the topic of another group discussion. Participants representing the universities were of the opinion that at present necessary measures are being taken in bringing the curriculum and teaching pharmaceutical subjects to standards comparable to those existing in other countries. The participants were of the opinion that there was a dearth of properly qualified teachers for teaching the subject. One of the suggestions was that the Government of India should depute teachers for further studies in physical pharmacy to foreign countries.

The last group discussion was mainly devoted to an assessment of the achievements of the summer school. Dr U. P. Basu, Director of the School, stressed the advantages of such summer schools where experts from universities, government laboratories and research institutes got together and discussed their work and problems in an informal manner. He emphasized the need for proper education of students in pharmacy colleges so that all aspects of the subject were adequately taught.

Council of Scientific & Industrial Research: Meetings of the Board & the Governing Body

THE Board and Governing Body of the Council of Scientific & Industrial Research in their meetings held in New Delhi on 28 and 29 September 1964 respectively accorded approval to plans regarding the establishment of a National Biological Laboratory and a Technical Information and Industrial Liaison Centre for the chemical industry at Bombay, and the taking over of the Shri Ram Institute for Industrial Research. The National Biological Laboratory is to be set up at an estimated cost of Rs 3 crores in a 1300-acre site near Palampur in Kangra Valley, Panjab. The laboratory will carry out both fundamental and applied work in different aspects of biology. The broad programme of work proposed to be undertaken would cover the fields of microbiology, genetics, cell biology, molecular biology, environmental biology, comparative biology, biology of higher animals and human biology.

The main functions of the Technical Information and Industrial Liaison Centre at Bombay, to be jointly financed by CSIR and the Indian Chemical Manufacturers' Association, will be to disseminate information on research on chemicals carried out not only in the national laboratories and other research centres in the country but also in other countries. The centre will arrange for systematic and regular visits of chemical manufacturers and channellize their problems to laboratories for investigation and also serve as a feedback of problems of the industry to the national laboratories.

Approval was also accorded to the taking over by CSIR of the Oil Technological Research Institute, Anantapur. The programme of work of the institute as well as staff and equipment will be partly shifted to the Regional Research Laboratory, Hyderabad, and partly to the Department of Chemical Technology, Bombay.

Low Temperature Physics: Some Highlights of the Ninth International Conference

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THE Ninth Biennial International Conference on Low Temperature Physics (LT9), sponsored by the International Union of Pure & Applied Physics (IUPAP), was held at Columbus, Ohio, USA. The five-day meeting (31 August to 4 September) was attended by over 750 scientists. Nowadays it has become fashionable in some quarters to question the usefulness of such large gatherings: Cynics point out that people usually spend more time outside the lecture halls than inside and that small talk claims as much attention as formal lectures. All this is perfectly true, but exactly the same impromptu exchanges form a strong argument for the conferences. How very often it is that airing unabashedly one's perplexity in a calculation or an experiment elicits a possible solution from a totally unexpected corner? An example of this in LT9 was the informal gathering of the workers studying the behaviour of ions in liquid helium. Details of information which are rarely published in scientific papers were freely exchanged. Many of them were concerned with minor, apparently trivial, aspects of experimentation and yet in at least two cases they were making all the difference between unsuccessful and successful experiments.

Complementary to the problem-solving aspect of a meeting is the genesis of a host of fresh problems. Here LT9 had a spectacular example. Before the conference there was a brief publication from Prof. Peshkov (Moscow) that he had beaten others in the race to discover the superfluid phase transition in liquid ^{3}He. He reported a specific heat anomaly at about 5×10^{-3} °K., a region of temperature which offers a challenge even to well-equipped laboratories. Following Peshkov's presentation of the details of his work, Prof. Wheatley (Illinois) stood up to dispute the claim. The experiments of his group, performed in a different manner, had failed to exhibit any such anomaly in heat capacity. The matter rests there, giving a new lease of life to all those who had lavished considerable amounts of time and labour in searching for a phase transition in liquid ^{3}He.

The organizing committee, headed by Prof. Daunt (Ohio), had given an excellent account of their job. The IUPAP, with the evidence of the utility of low temperature conferences right before it, deemed it worth while to accept the invitations of USSR (1966), Scotland (1968) and Japan (1970) to hold the later conferences. There was lobbying for even LT13, eight years hence! Organizing such large conferences has its pitfalls. LT9 was characterized by the absence of name badges for the delegates. Prodigious feats of memory in pairing faces with names and locations were called for and not many were equal to the task.

London Memorial Award

Of special interest to Indian scientists was the award of the London Memorial Prize to Dr S. Shoenberg, Director of the Mond Laboratory, Cambridge (UK). In his speech of acceptance, Dr Shoenberg recalled how he began his 30 year-long association with de Haas-van Alphen effect after a fruitful remark by the late Dr K. S. Krishnan. The methods used earlier to study the oscillations in magnetic susceptibility were rather cumbersome and during the course of a conversation Dr Krishnan suggested the use of the torque method, which he was using so successfully in the study of molecular magnetism. The method worked very well and many of Dr Shoenberg's early results were obtained with that technique. Later use of pulsed fields and r.f. techniques has made the de Haas-van Alphen effect a powerful tool in the study of Fermi surfaces in metals.

The London Memorial Prize has been donated by Arthur D. Little Inc., the well-known manufacturers of cryogenic equipments, as a tribute to the late Fritz London. With remarkable foresight he saw that superfluidity and superconductivity are quantum effects on a bulk scale and laid the foundations for an understanding of these complicated phenomena. Some of his uncanny predictions have been verified only recently. Dr Shoenberg joins the select company of Kurti, Landau and Bardeen, the previous winners of the award. The fourth London medal is a richly deserved honour for a lifetime of devotion to low temperature research. Those who have the privilege of knowing him will also cherish his sincerity and humility.

Over 250 papers were presented during the conference and little more than an outline of the current activity in the various topics can be attempted here. The presentation of so many papers necessitated 4 parallel sessions for all but a few invited talks. By judicious and frequent jumps from one parallel session to another some delegates could hear most of the papers that interested them. This gave rise to considerable shuffling of feet whenever lights were switched off for projecting a slide. Some speakers probably imagined that people were coming in.

Superconductivity

The phenomenon of superconductivity was for many years the vexing area in theoretical physics. While all other phenomena could be explained on the basis of fundamental atomic calculations, it steadfastly refused to reveal its microscopic foundations. It was, therefore, a great achievement of Bardeen, Cooper and Schrieffer to construct in 1957 a simple theory of superconductivity, drawing as

its central theme the correlation of electrons into Cooper pairs. On the whole, the theory has been extremely successful in explaining a variety of observations made on simple superconductors. In the conference there were several papers describing ultrasonic absorption, r.f. and microwave measurements and thermal properties, all of which could be interpreted within the framework of the BCS ideas. A more recent phenomenon is the tunnelling between superconductors, first observed by Giaever about 4 years ago. If the insulating junction between two superconductors is narrow enough, the superconducting electrons can tunnel through the junction. Because the density of states in superconductors is peaked near the energy gap, the current-voltage characteristics of such tunnel junctions reveal regions of negative resistance, very similar to those in Esaki tunnel diodes. From the positions of these regions the superconducting energy gaps are easily deduced and as a matter of fact one of the first applications was to check the temperature variation of the energy gap predicted by the BCS theory. It also turns out that from the fine structure observed in the tunnelling characteristics, information about electron-phonon interactions can be extracted. Further, as Josephson pointed out in 1962, there is the possibility that the Cooper pairs themselves may tunnel through. This results in somewhat more complicated phenomena, which have been verified to a surprising extent. .

Another group of ingenious experiments concern the flux quantization in superconductors. As early as 1950, F. London pointed out that the magnetic flux in a superconductor should be quantized in units of hc/e. When sufficiently sensitive experiments were done a few years ago, by Doll and Nabauer and by Deaver and Fairbank, it was found that the period was $hc/2e = 2{\cdot}07 \times 10^{-7}$ gauss cm.^{2}. This is immediately understood in the BCS theory, because the Cooper pairs, which are responsible for superconductivity, have an effective charge $e^* = 2e$, whereas London had set $e^* = e$. The experiments on flux quantization were succinctly reviewed by Prof. W. A. Fairbank. The effect has found immediate application in other problems, for instance, measurement of penetration depths and tunnel currents in superconductors and creation of truly zero magnetic fields, which were also discussed in the conference. As a byproduct of the techniques of measuring very small magnetic fields, three independent groups of workers reported the observations on magnetic fields created by rotating a superconductor at an angular velocity ω. The observed fields confirm the law $B/\omega = 2mc/e = -1{\cdot}14 \times 10^{-7}$ gauss sec., predicted by F. London in 1950.

The ' hot ' subject in the field of superconductivity is, of course, the study of type II superconductors, with vistas of giant superconducting magnets just in horizon. The papers presented in LT9 were restricted to some fundamental questions and a separate conference on type II superconductivity was held at Cleveland, Ohio, on 28 and 29 August. The two-day meeting, organized by Prof. B. S. Chandrasekhar, was attended by over 300 people with about 50 communications, a measure of the timeliness and popularity of the meeting. By and large, LT9 was concerned with the behaviour of quantized fluxoids in type II superconductors. In 1957 Abrikosov showed that the solutions of the Ginsburg-Landau equations predict the existence of an array of quantized magnetic fluxoids in the mixed state between H_{C1} and H_{C2}. Since then these fluxoids, which can be pinned by the defects in the material, have been widely used to interpret a variety of observations on type II superconductors. Some of the experiments to study individual fluxoids using micro-geometries were reviewed by Prof. Parks, while a number of papers dealt with the behaviour of aggregates of fluxoids. Another phenomenon which attracted lively attention was the surface superconductivity which can exist above H_{C2}. The predictions of de Gennes and coworkers in France were verified in several different types of experiments discussed during the conference.

Fermi Surfaces

In the study of Fermi surfaces of metals investigators were having for some time several tools at their disposal, de Haas-van Alphen and similar oscillations, cyclotron resonances, microwave surface impedance, magneto-resistance and magneto-acoustic effects to mention a few. They were admirably reviewed by Professors Kip and Shoenberg on the experimental side, while band structure calculations were covered by Heine. At the risk of oversimplification, it may be said that the papers presented in LT9 employed these techniques to elucidate in detail the Fermi surfaces of several metals and that there is gratifying agreement among the different measurements.

Three new techniques, namely magnetic breakdown in galvanomagnetic properties, helicon waves and r.f. size effect, have been recently added to the repertoire of investigators in this field and they came in for critical examination. In the presence of magnetic fields electrons travelling on one band of the Fermi surface can tunnel through small gaps to a second band of the surface. Naturally the process is favoured only along certain directions, where the energy gaps are small, and this magnetic breakdown causes new oscillations in many galvanomagnetic phenomena. Helicon waves are transverse circularly polarized electromagnetic waves which can propagate in metals and semimetals placed in magnetic field. The magnetic field gives a rigidity to the metallic plasma just as in magneto-hydrodynamic Alfven waves. Indeed helicon waves have a classical analogue in the hydrodynamic waves propagating in media with vorticity. The properties of helicon waves, especially their interactions with phonons, form a field of study which is being actively pursued now. The new r.f. effects are in the measurement of surface impedance of thin plates in magnetic fields. When the diameter of the cyclotron orbit becomes equal to the thickness of the plate, transmission peaks occur and, therefore, a direct measurement of the size of the cyclotron orbit is possible. Several papers were presented on the study of Fermi surfaces by using these new techniques.

Liquid and Solid Helium

Liquid helium, both ^{4}He and ^{3}He, continues to fascinate many investigators and there were no less than 5 sessions devoted to the two quantum liquids. In liquid ^{4}He, turbulence, rotational states, films and the behaviour of ions were the current areas of interest. A number of papers were read on various aspects of turbulence in helium II. They served to highlight the complexity of the phenomena and there is clearly room for a substantial improvement of our knowledge. The investigations on rotating helium II were on the whole in consonance with the Onsager-Feynman picture of quantized vortices. Perhaps the only dark cloud in the horizon was the study of Pellam using Rayleigh discs to probe the rotating liquid. The experiment set out to measure the normal fluid density, but the results gave almost exactly its complement, the superfluid density in liquid helium II ! It is in the field of ions in liquid helium that some exciting results have been obtained. Prof. Reif surveyed the experiments of Rayfield and himself in which energetic ions below $\sim$0·6°K. get coupled to vortex rings. Because of the peculiar energy-momentum relationship of a vortex ring, the more energy is given to the ion the slower it moves, a very surprising result indeed. Somewhat similar results at $\sim$0·9°K. were reported by Prof. Careri and his coworkers.

In liquid ^{3}He many experiments now show clearly that below $\sim$0·2°K. the Fermi liquid theory is applicable. One of the bold predictions of Landau is the existence of zero sound at sufficiently low temperatures, in which information about pressure and density fluctuations in a region are communicated to other regions not by collisions, as in ordinary sound, but by the quantum correlations existing among the atoms. Evidence for the probable observation of zero sound at $\sim 10^9$ c.p.s. and $T < 0{\cdot}09$°K. was put forward by Wilks and coworkers. The combination of very high frequencies and very low temperatures makes experimentation very difficult, but the results leave little doubt that the onset of zero sound regime has been reached. Another set of interesting experiments concerns the possible magnetic ordering in thin adsorbed layers of ^{3}He at low temperatures, but the evidence for this is not so conclusive.

There were many other papers about the theories of liquid helium and about the properties of mixtures of ^{4}He and ^{3}He in both solid and liquid states.

Phase Transitions

Realizing the need for concentrated studies on cooperative transitions, the organizers of LT9 had devoted a full session to the review of the present state of the subject, while papers bearing on the problem were scattered in different sessions. A bird's-eye view was presented first by Prof. Montroll, who went to the extent of showing how day-to-day traffic jams are examples of cooperative behaviour. Then Professors Brout and, in particular, Domb undertook the task of correlating available experimental and theoretical data. The C_p data of Buckingham, Fairbank and Kellers near the Λ-transition in liquid ^{4}He and the C_v data of Voronel and coworkers near the critical point of argon and oxygen, which indicate logarithmic infinities, were naturally analysed in detail. New results were also forthcoming in the conference. Little and Moldover reported a logarithmic singularity in the C_v of ^{4}He at its critical point. The ultrasonic measurements of Chase and Williamson, again on ^{4}He near its critical point, suggested a singularity in the adiabatic compressibility which is thermodynamically consistent with the specific heat data. Friedberg and coworkers have observed a similar logarithmic behaviour in the heat capacity of antiferromagnetic $CoCl_2.6H_2O$ at its Néel point. The comprehensive analyses of these experiments will be of interest, because theoretical studies appear to indicate a logarithmic infinity of the form $A \log (T_c - T)$ in the specific heat below the transition point T_c but a power law infinity of the form $B(T-T_c)^{-\alpha}$ above T_c ($\alpha \approx \frac{1}{5}$). The experiments appear to indicate logarithmic singularities in both regions.

At the moment the only cooperative phenomenon for which a reasonably complete and satisfactory microscopic theory is known right up to the transition temperature is the superconductivity of electronic systems. It is naturally of interest to study whether any phase change occurs in the other Fermi system available, namely liquid ^{3}He. Soon after the development of the BCS theory, several authors suggested this possible phase transition. The present theoretical estimates of T_c are in the millidegree K regions, low enough to discourage most laboratories in the world. Even so, a few laboratories have invested large sums of money in the race to find the phase change, if present. As mentioned earlier, there was a lively discussion following the report by Peshkov of a specific heat anomaly at 5×10^{-3} °K. and the statement of the Illinois group that they have not been able to find any anomaly. It is possible that LT10 may have something to clarify the issue.

Other Topics

Since magnetism gets an international conference of its own once in two or three years, only one session was devoted to magnetic materials. It is, however, obvious that magnetism and cryogenics have innumerable ties, whether they be in demagnetization to produce very low temperatures or in the use of magnetic fields to study other phenomena. As an instance of this, one may cite the considerable interest evinced in the properties of dilute alloys, especially of transition metals. The weak magnetic interactions in these materials reveal themselves in almost all transport, thermal and magnetic properties. The experimental situation was surveyed by Dr van den Berg, following the theoretical picture given by Professors Friedel and Daniel. There were several other papers on the subject.

For very similar reasons general properties of dielectric and metallic solids were given only limited attention. They have special gatherings of their devotees. The papers in LT9 emphasized the properties of liquefied and solidified gases. The interatomic forces among simple molecules like

H_2, D_2, CH_4, A and Ne are reasonably well known and attempts were made to correlate them with the observed properties of the condensed phases.

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Eleventh International Congress of Applied Mechanics

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THE International Union of Theoretical & Applied Mechanics (IUTAM) holds an international congress once in four years. The last one was held in Stressa, Italy, in 1960. Between two congresses a number of symposia on live subjects like Boundary Layer, Shell Theory, Nonlinear Elasticity and Plasticity, Gas Dynamics, and Continuum Mechanics are sponsored by it in various parts of the world to highlight their importance.

The eleventh congress was held in Munich from 30 August to 5 September 1964, and was sponsored by IUTAM and 21 German organizations. A number of young participants were given financial assistance by IUTAM. G. Colonnetti, President of the Executive Committee of the International Committee for the Congress of Applied Mechanics, and R. Grammel, Honorary President of the German Organizing Committee, were absent due to illness. G. Temple and H. Görtler respectively performed their functions.

More than 1200 delegates from 35 countries attended the congress. They were divided into speakers and participants. The number of speakers was kept to a low figure of 154 and the rest were participants. This was intended to give each speaker at least 45 min. Unfortunately, a number of papers presented were either poor or too descriptive to raise any live discussion. There were nine general lectures to review the present state of subjects like New Models in Continuum Mechanics, Thermodynamics of Deformation, Shell Theory, Rotating Fluids, Wave Propagation, and Flow with Flexible Boundaries. The concept of transition in irreversible processes like Elastic Plastic Deformation, Creep, Relaxation, Boundary Layer and Shocks claimed a number of papers.

From India there was one speaker and two participants. The latter happened to be on the continent and so they could easily attend the congress. B. R. Seth was the speaker, specially deputed by the Government of India to attend the congress and the General Assembly of IUTAM.

The congress was held in the famous Deutsches Museum. Arrangements for the presentation of papers were satisfactory. Distinguished participants were requested to be chairmen of various sessions at which not more than three papers were read at a time. The speakers included L. I. Sedov, G. I. Taylor, I. N. Vekua, N. J. Hoff, H. W. Liepmann, B. R. Seth, J. N. Goodier, W. Prager, W. Olszak, G. F. Carrier, E. Reissner, P. M. Naghdi, C. Truesdell, A. C. Eringen, H. Neuber, H. Ziegler, K. Magnus, R. Lgendre and T. Benjamin.

Next to Germany, the largest number of delegates came from USA, USSR and UK. The USSR delegation was led by L. I. Sedov. But for Japan, countries from the Middle East, Near East and Far East had hardly any representatives. This reflected the state of scientific development and research in them.

Each day there were two general lectures and 32 invited addresses, which were divided into five parallel sessions. The subjects treated were Continuum Mechanics, Elasticity and Plasticity, Creep, Failure Vibration, Jet Flow, Boundary Layer, Shell Theory, Magnetogasdynamics, Heat Transfer, Hydrodynamic Stability and Shock Waves.

Twenty-two papers dealt with irreversible problems like Elastic Plastic Deformation, Creep, and Fracture. Even though transition concepts were presented in a number of papers on Fluid Mechanics, in Solid Mechanics B. R. Seth was the only one to develop it. Combined with that of generalized strain he showed how to do away with semi-empirical conditions like yield conditions and creep strain laws. His paper on generalized strain and transition concepts for Elastic Plastic Deformation, Creep, and Relaxation aroused a lot of interest among delegates from various countries. In fact, a large number of them kept on discussing the subject with him for more than one hour after the presentation of the paper. They also expressed a desire to receive reprints of papers published by him on the subject. Workers like G. K. Batchelor from Cambridge, England, expressed the opinion that the paper contained new concepts, which could be exploited in a number of fields.

The designing of new models for continuum media was stressed by L. I. Sedov. High speed structures, rheological materials, anistropic, heterogeneous, porous and random media, turbulent plasma, elastic-plastic deformation, creep, fatigue, linear and non-linear interaction fields, low and high

temperature effects and transition phenomenon are some of the examples for which new models are required. All such models should ensure the symmetric concept of elementary particles through tensorial representation. At present simple tensor systems have been established for all such groups of the complete orthogonal group. For non-holonomic systems it is pointed out that the free energy should be taken as a function of the stress and strain tensors, temperature and response coefficients.

Internal couple stresses are introduced to explain high stress gradients in fatigue. A. C. Eringen showed how they may be used for treatment of anistropic fluids. R. A. Toupin and H. Neuber also dealt with similar problems. Neuber's attempt to make the strain tensor asymmetric by adding the rotation terms to the classical linear strain components is of doubtful validity. In continuum mechanics the strain tensor should be symmetric. If it is not truncated, it contains square of the rotation terms and hence does not require any further modification.

The fracture at the neck of a cylindrical piece was treated by N. Alberti with the help of Stassi yield condition of the type

$$(\tau_{11}-\tau_{22})^2+(\tau_{22}-\tau_{33})^2+(\tau_{33}-\tau_{11})^2 +k(\tau_{11}+\tau_{22}+\tau_{33})=Y$$

in which the material has different yield points in tension and compression. This is an arbitrary condition and the phenomenon should be explained on the basis of transition treatment, which requires no yield condition.

N. J. Hoff's attempt to improve the agreement between theoretical and experimental values of the buckling stress for thin-walled cylindrical shells under axial compression by suitably changing the boundary conditions was criticized by a number of participants. In fact, we can get any critical buckling load by altering the boundary conditions in a problem. S. A. Ambartsumyan and S. M. Durgar'yan pointed out that thermal effects can considerably change, both qualitatively and quantitatively, the vibration and stability characteristics of shells. The singular points of shell equations were identified with concentrated force and hot spots by W. Flügge. Lur'e's work on stress concentration round circular holes was extended to all values of curvature parameter by J. G. Lekkerkerker. Stress concentration round elliptic, square and equilateral shapes under physically non-linear and geometrically linear formations (and vice versa), both for elastic and plastic deformation, were treated by G. N. Savin. E. Reissner and P. M. Naghdi gave reviews of the linear theory of shell bending. I. N. Vekua described new analytical methods in shell theory.

G. I. Taylor showed how disintegrating drops of fluid develop conical surfaces when they are torn by strong electric fields or by the motion of surrounding fluid of higher viscosity. Both theoretical and experimental considerations show that equilibrium conditions can be satisfied at a conical surface when the cone has a semi-vertical angle of 49·3°. The Boltzmann's equation was the subject of a number of papers. H. W. Liepmann dealt with its modified form based on the Krook model. He showed that such an approximation gives good results for the shock structure problem.

Rotating fluids tend to rotate rigidly when the container speed is suddenly changed. This and similar problems in the formation of weather fronts and ocean currents were discussed by G. F. Carrier. The instability of rotating compressible fluids was used by J. W. Miles to show that zonal wind in the middle latitude were unstable for almost all wavelengths, and that the corresponding disturbances derived their energy from 'overturning' and from the mean flow through a Reynolds stress-like mechanism in the 'critical layer'. In like manner, N. Rott and W. S. Lewellen related the tornado problem to the interaction of the boundary layer and the outer flow in rotating fluids. R. C. Di Prima and J. T. Stuart gave a non-linear analysis of the stability of the Taylor vortex and wavy modes of motion, and extended this analysis to the explanation of the occurrence of a second critical speed and non-symmetric wavy motion.

I. A. Kibel pointed out that a marked improvement in short-range weather forecast for large territory as well as in local forecasts can be achieved by using the full hydrodynamic equations in place of 'filtering equations' now in use. The non-linear and three-dimensional effects in the instability of shear flows and their transition to turbulence were emphasized by C. C. Lin and D. J. Benney.

L. Van Wijngaarden used the analysis of the collective collapse of a large number of gas bubbles in water to explain the bending of blades of ship propellers at the trailing edge towards the pressure side. The 'double wave' type of solutions in gas dynamics and their isentropic nature was explained by L. V. Ovsyannikov with the help of partly invariant solutions of the equations admitting a group in the Lie-sense. Linearized Stokes equations were employed by St I. Gheorghitza to discuss the steady fluid motion in porous inhomogeneous media with cavities. Such problems are encountered in flow through rocks and other multi-layered systems.

In a number of other papers both in fluid and solid mechanics the transition state was confused with that of unstable equilibrium. Non-linearity is particularly important at transitions where effects dove-tail into each other. One should be careful that transitions from one state into another in continuously deformed media are not mistaken for instability.

It was difficult to attend all the 150 lectures given at the conference, particularly when they were squeezed into five days along with programmes of visiting other institutes in the neighbourhood. Of particular interest are the Max Planck Institute of Physics and the Institute of Plasma Physics. The latter was visited by L. I. Sedov, M. J. Lighthill, G. K. Batchelor, B. R. Seth, N. J. Hoff and H. W. Liepmann. It is doing very good on plasma instability and young workers can profit from training at the institute.

At the General Assembly meeting held on 2 September two new adhering organizations were

accepted: (1) National Research Council of Canada; and (2) National Australian Committee for Mechanics and the Academy of Sciences of Australia.

The Federal Institute of Zürich communicated its desire to pass from Category 1 to Category 2 from the next financial year.

It was reported that the extraordinary General Assembly adopted new statutes to modify the Executive Committee so that it now comprises 14 representatives of Union and 10 National members.

The General Assembly elected for the next 4 years M. Roy of France as the President, H. Görtler as the Secretary and W. T. Koiter of Netherlands as the Treasurer. It also accepted the invitation conveyed by N. J. Hoff of the National Society of Applied Mechanics of USA and of the Stanford University to hold the 12th International Congress at Stanford University in the last week of August 1968.

The next symposium to be sponsored by IUTAM will be held in Paris from 20 to 24 April 1965.

The next meeting of the General Assembly will be held in Vienna in 1966 close to the Symposium on Irreversible Aspects in Continuum Mechanics.

It was also agreed that the IUTAM be approached for additional funds to hold a Symposium on Boundary Layer in Kyoto, Japan, in 1966.

The International Committee for the Congress of Applied Mechanics dissolved itself and became a standing committee of IUTAM to strengthen its position in the International Council of Scientific Unions. It was also agreed that the adhering organizations may be requested to increase contributions to IUTAM which may range from 50 to 80 per cent of what they are paying now.

Prof. J. B. S. Haldane — Obituary

We regret to record the death of Prof. J. B. S. Haldane, F.R.S., at Bhuvaneswar on 1 December 1964. In the death of Haldane, the world of science, in general, and the Indian science, in particular, has lost a scientist of eminence who revolutionized the biological thought. Endowed with a humanistic education, Haldane kept up with his researches on genetics to the last day of his life.

Born in 1892, John Burdon Sanderson Haldane obtained First Class Honours in Mathematics and Litterae Humaniores at Oxford in 1914. In 1919 he became a Fellow at New College, Oxford. From 1922 to 1932 he was Reader in Biochemistry in the University of Cambridge and for part of this period he was Professor of Physiology at the Royal Institution, London. In 1933, he became Professor of Genetics at the London University, the chair having been created for him. From 1937 to 1957, he was Professor of Biometry at London University. In 1957, on his shifting to India, Prof. Haldane joined the Indian Statistical Institute, Calcutta, as Research Professor. After serving the Council of Scientific & Industrial Research for a short period, he went to Bhuvaneswar to take charge of the new Biometry and Genetics Laboratory set up by the Orissa Government. In 1961, he became a citizen of the Indian Republic.

Prof. Haldane's most important biochemical discovery was the demonstration of the presence of cytochrome oxidase in a vertebrate, an insect and a higher plant. In the field of genetics, he discovered linkage in vertebrates and in tetraploid plants. He was the first to measure mutation rate in human beings. He was responsible for the generally accepted theory of genetic determination of the antigens and for the rule as to the sex of hybrid animals which bear his name. Prof. Haldane is also known for his mathematical theory of natural selection. He applied statistical methods to many branches of biology, including bacteriology, demography and animal behaviour. His other contributions to mathematics include the first general expressions of the cumulants of the binomial distribution and a theory of the composition of random vectors. A unique feature of Prof. Haldane's biological work has been his frequent use of his own body for experimentation.

Prof. Haldane was the author of about 300 papers and 25 books. He was elected Fellow of the Royal Society in 1932. He received the Society's Darwin Medal in 1933, and the Linnean Society's Darwin-Wallace Commemoration Medal in 1958. The United States National Academy of Sciences awarded him the Kimber Medal for his work in genetics in 1961. The same year the Pontifical Academy of Sciences awarded him a £11,500 prize for biology.

Mechanism of Flame Propagation

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IN fluid dynamics we come across two types of flow — laminar and turbulent. In the laminar flow, the fluid particles move in a regular and stationary pattern such that the neighbouring layers are parallel and separate from one another all along the flow path. The flow becomes turbulent when the border line of the different neighbouring layers of fluid cannot be well defined due to a chaotic and irregular movement of the fluid particles. Unlike in laminar flow the velocity at any point in this type of flow changes irregularly with time. Laminar flow has been well studied both experimentally and theoretically. But in the case of turbulent flow, the laws which govern the movement of particles are not yet revealed completely, though in practice this type of flow is most commonly met with. It is well known that the flow becomes turbulent when *Re* (Reynolds number) becomes more than 2300 (for round commercial pipes). But till today, no satisfactory physical interpretation has been provided in support of this fact which was established only by experiments.

Flame Propagation in Combustion

Depending upon the regime of flow in which the combustion takes place, burning may be either laminar or turbulent. The problem of flame propagation under laminar conditions has been studied for a long time. The classical works of Lewis and von Elbe[1] and Zeldovitch and Frank-Kamenetski[2] have given a clear mathematical picture of the process. However, it is difficult to find the exact analytical solution of the differential equation, which is obtained by combining two physical processes at the flame front, i.e. the process of heat transfer and diffusion. The equation thus obtained is a non-linear one and hence the exact solution could not yet be obtained. Some attempts have been made to solve this equation analytically with the help of some approximations and the results so obtained coincide fairly with the experimental results on the value of the burning speed as well as the structure of the flame (temperature distribution and the rate of chemical reaction in the flame front).

In industrial units the process of combustion, as a rule, takes place under turbulent conditions, and investigations on the laws of turbulent flame propagation assume a great practical importance. This is borne out by the large number of investigations carried out on the subject, though the study of the problem of flame propagation in turbulent flow has been taken up quite recently. But in these investigations no clear mathematical picture of the process has yet been obtained, unlike in the case of laminar flames. Experimental investigations have revealed that the burning speed under turbulent conditions of the mixture is much higher than that in the case of laminar flow.

A few hypotheses have been advanced from time to time for explaining the mechanism of flame propagation in combustion, though not completely satisfactorily. The present review surveys the important current theories in the field and makes an attempt to unify the two main mutually contradictory theories and to put forward a single theory in which the Reynolds number is taken to be the factor determining the mechanism of burning. Some experimental work in connection with elucidating some aspects of the theories has been carried out by a team of scientists including the author at the Department of Boiler Design, Moscow Power Institute. An account of this work has also been included.

'Surface Combustion' Theory

The first attempt to explain the nature of flame propagation in turbulent mixtures was made by Mallard and La-Chatalier[3]. They measured the burning speed of stationary mixtures under certain conditions of turbulence and found out that the burning speed showed a significant rise. Even at that time it was thought that the burning in the combustion chambers of the engines is completed only due to the presence of high turbulence.

Damkohler was the first to put forward a basic theoretical explanation about the effect of turbulence on flame propagation. In his pioneering work[4], he showed that if the mechanism of combustion is taken to be 'surface combustion' type, there may be two types of turbulence, viz. fine-scale and large-scale turbulence, and their effect on the flame propagation is different. Large-scale turbulence takes place when the scale of turbulence is greater than the flame width of laminar flame and in the case of fine-scale turbulence it is less. In fine-scale turbulence the surface of the flame remains smooth, but the process of mass and heat transfer at the flame front is to a great extent intensified. Damkohler found out the following expression for the burning speed in the case of fine-scale turbulence:

$$u_T \sim u_l \sqrt{\frac{\epsilon_T}{\nu}} \quad \ldots\ldots\ldots (1)$$

where u_T is the velocity of flame propagation (burning speed) in turbulent flow; u_l, the velocity of flame propagation in laminar flow; ϵ_T, the coefficient of turbulent kinematic viscosity; and ν, the molecular kinematic viscosity.

The physical significance of Eq. (1) arises out of the fact that, in small-scale turbulence, the acceleration of the burning speed takes place due to the intensification of the processes of mass and heat transfer as the pattern of flow becomes turbulent instead of molecular.

As the quantity ϵ_T is approximately proportional to *Re* (Reynolds number), expression (1) can be written as

$$\frac{u_T}{u_l} \sim \sqrt{Re} \quad \ldots\ldots\ldots (2)$$

Damkohler largely confirmed the validity of expression (2) by his experimental data obtained from a turbulent flame in a bunsen burner.

In the case of large-scale turbulence the appearance of the flame becomes completely different. Damkohler and even earlier Mallard and La-Chatalier assumed that large-scale turbulence destroys the smooth surface of the flame, which becomes wavy and even breaks into a number of small parts. In that case, naturally the average burning speed will increase, according to the above workers, due to the increment of the surface area of the flame. In Fig. 1 two types of flame front are represented.

In the case of large-scale turbulence we may consider that the flame surface becomes as if covered with innumerable number of bunsen cones, which have a base diameter equal to the scale of turbulence l and height equal to the pulsating velocity u'.

If we assume that the scale of turbulence l does not change with the variation of u', we get

$$u_T \sim u' \quad \ldots\ldots\ldots (3)$$

or putting the relation between u' and ϵ_T and Re

$$u_T \sim \epsilon_T \sim Re \quad \ldots\ldots\ldots (4)$$

Shelkin[5] in his work made a significant contribution to the theory of flame propagation by extending the concepts of Damkohler and simplifying his formulae. According to Shelkin, the processes of mass and heat transfer (turbulent and molecular) take place simultaneously in the process of burning under turbulent conditions. Shelkin gave the following expression for burning speed in fine-scale turbulence:

$$u_T = u_l \sqrt{1+\frac{a_T}{a_M}} \quad \ldots\ldots\ldots (5)$$

where a_T is the coefficient of turbulent transport, and a_M the coefficient of temperature conductivity.

In the case of intensive turbulence, when the coefficient of temperature conductivity is much lower than the coefficient of turbulent transport, formula (5) is transformed into

$$u_T = u_l \sqrt{\frac{a_T}{a_M}} = u_l \sqrt{\frac{lu'}{a_M}} \quad \ldots\ldots (6)$$

Bollinger and Williams[6] confirmed the theoretical basis advanced by Damkohler and Shelkin. They carried out their experiments on the measurement of burning speed in bunsen burners; the burning speed was calculated by the formulae of Mikhelson, which is expressed as follows:

$$u_T = \frac{V}{S}$$

where V is the velocity of gas expressed in volume, and S the average surface area of the cone.

On the basis of the experimental results obtained, they found out relations between the following sets of parameters: (1) variation of mean height of the flame with change in Re, (2) variation of the flame width with Re, (3) relation between u_T and composition of the fuel-air mixture, and (4) relation between u_T and Re.

Working on the above relations, Bollinger and Williams found out the following empirical formula:

$$u_T = 0{\cdot}1761\ u_l \cdot d^{0{\cdot}2564} \cdot Re^{0{\cdot}238} \quad \ldots\ldots (7)$$

where d is the diameter of the burner.

Another experimental work by Bowditch[7] also supported the mechanism of turbulent combustion as suggested by Damkohler and gave a relation between burning speed and pulsating velocity u', which can be expressed as follows:

$$u_T = u_l . e^{(1{\cdot}15u'/u_l)} \quad \ldots\ldots (8)$$

In all the above-mentioned studies — theoretical as well as experimental — an attempt has been made to explain the phenomenon of increased burning speed in turbulent combustion on the basis of 'surface combustion' theory. Theoretical hypothesis and the results of the experimental studies carried out by the supporters of this theory show that in large-scale turbulence, the factors determining the burning speed are the velocity of pulsation u' and the coefficient of excess air α (to a less extent). It is assumed that α affects the burning speed u_T not directly but through u_l the burning speed in laminar flow.

Experimental results are normally generalized in the form

$$u_T = A(u')^n . (u_l)^m \quad \ldots\ldots (9)$$

where A is some constant which is greater than unity; n and m are constant coefficients, such that $n \gg m$ and $n+m = 1$.

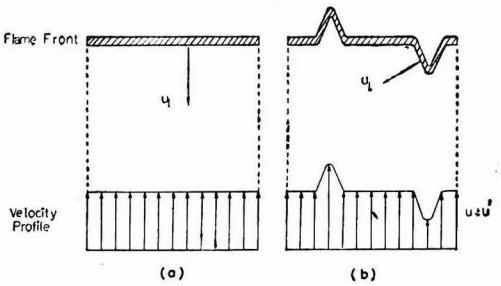

Fig. 1 — Effect of turbulence on flame structure (after Damkohler) [(a) Fine-scale turbulence; and (b) large-scale turbulence]

Theory of 'Flame Self-turbulization'

In comparatively recent times a new theory on flame propagation in turbulent flow was put forward by Karlovitz and his colleagues[8]. According to this theory, the self-generated turbulence or auto-turbulization plays an important role in the process of flame propagation and it is even assumed that, compared to that, the natural turbulence of the flow can easily be neglected. From theoretical considerations they found out a mathematical expression, which will give the magnitude of turbulence, generated by the flame itself. This is given as follows:

$$u' = \frac{1}{\sqrt{3}} \cdot \left(\frac{\rho_u - \rho_g}{\rho_g}\right) \cdot u_l \quad \ldots\ldots (10)$$

where ρ_u and ρ_g are the densities of the mixture before and after the flame front.

Some experiments carried out by them showed a positive result and the effect of self-generated turbulence was graphically represented.

However, the question of self-generated turbulence has not yet received unanimous support and some scientists in USSR hold opinions contrary to this theory. The experimental studies carried out by Prudnikov[9] at the Academy of Sciences Laboratory, USSR, do not show that self-generated turbulence has any appreciable effect on flame propagation. It is true that from theoretical standpoint one cannot reject this theory, but the effect of self-generated turbulence on flame propagation still remains doubtful. It can be settled only with extensive investigations on actual measurements of the pulsating velocity before and after the flame front.

'Volume Combustion' Theory

Another reasonable theory has recently been envisaged by Summerfield *et al.*[10] and Longbell[11] in USA and subsequently supported by Shetnikov[12] in USSR. In this theory, which differs sharply from the 'surface combustion' theory, it is assumed that the turbulent flame is a zone of intensive chemical reaction which takes place in volume. Longbell[11] showed that at intensive turbulence the process of burning approaches towards a homogeneous condition. Under such conditions, the flame front no longer exists and the rate of heat release in volume is determined only by the rate of kinetics of chemical reaction.

This view is supported by the work of Shetnikov[12] wherein it has been suggested that the process of combustion under turbulent conditions does not take place through the mechanism of 'surface combustion' but through the process of mixing of the fresh gas mixture with the products of combustion. The chemical reaction which takes place in such cases is of the homogeneous nature taking place in volume. According to the model of Shetnikov, the turbulent 'moles', which consist of burnt and half-burnt fuel mixtures, are thrown out from the zone of burning by the pulsations of the turbulent flow and ignite the neighbouring fresh 'moles'. In some cases these 'moles' may burn from the surface or partly from the surface. If $u' \gg u_l$, the original 'moles' do not find sufficient time for complete burning and break into parts by the pulsations. After this the process of diffusion starts inside these 'moles' and the temperature and concentration are gradually equalized. Under such conditions, it is quite reasonable to assume that the general surface in which the combustion takes place gradually increases in course of the process due to the formation of new 'moles' from the original 'moles' in the process of burning. As we go deep along the flame front, the mean temperature of the 'moles' formed there will increase, so also the rate of volume reaction and a point will be reached when the rate of surface reaction may be neglected. In this way, Shetnikov suggests that 'surface combustion' takes place in the front position of the burning zone; 'volume combustion' takes place in the rear position.

However logical this may be, it should be kept in mind that, in the absence of sufficient experimental data, it is extremely difficult to frame such a 'model', where 'surface' and 'volume' combustions take place simultaneously. For simplification, we can either neglect the rate of volume reaction and consider that the main portion of the gas mixture burns through the mechanism of 'surface combustion', or alternatively assume that the volume reaction plays the main rôle and the mechanism of 'surface combustion' does not exist. However, the author is of the view that under conditions of weak and moderate turbulence, the mechanism of combustion may be considered to be a combination of the two mechanisms, i.e. 'surface' and 'volume' combustions. It is well known that under pure laminar conditions burning takes place only according to the 'surface mechanism'. This has been well established by adequate experimental data, i.e. temperature profile, concentration of atoms and radicals (energized). Under ordinary conditions of turbulence, the temperature profile is sufficiently extended, the temperature gradient falls and the width of the flame front increases. It is quite likely that as we go on increasing the Reynolds number *Re*, which denotes nothing but the intensity of turbulence of the flow, a moment may arise when there will be no more burning through the 'surface mechanism' and combustion will be taking place only through the 'volume mechanism'. It is still only a plausible suggestion; the limiting value of *Re*, after which the combustion will take place only through 'volume mechanism', has yet to be established experimentally.

Differential Equations

Recently a theory has been put forward by Russian workers[13,14] that the differential equations of heat transfer at the flame front for turbulent and laminar flows are identical, if we take into consideration the coefficient of turbulent and molecular conductivity of heat in the significance of the parameter λ. The approximate solution of these differential equations was achieved with the help of the theory of Zeldovitch and Frank-Kamenetski[2] and by using the approximate solutions of Banderenko[15] two equations were obtained for expressing the velocity of flame propagation in laminar and turbulent mixtures:

$$u_l^2 = \frac{\lambda_M . q}{\rho^2 C_p^2 (T_F - T_i)} \phi(T_B) \quad \ldots\ldots (11)$$

$$u_T = \frac{l_A . q (\epsilon_T / u l_A)}{\rho C_p (T_F - T_i)} \phi(T_B) \quad \ldots\ldots\ldots (12)$$

where $\phi(T_B)$ is the rate of chemical reaction at the temperature of ignition; ρ, the density of the fluid mixture; $\lambda_{M,T}$, the coefficient of thermal conductivity molecular and turbulent; q, the calorific value of the fuel (cal./mole); ϵ_T, the coefficient of turbulent transport, $\epsilon_T = lu' = (\lambda_T / \rho C_p)$; u, the velocity of flow; l_A, the linear dimension of the apparatus; C_p, the specific heat of the fluid mixture; and T_i, T_F and T_B, the initial, final and ignition temperature respectively.

In other words, it was assumed that due to the presence of a relation between λ_T and the velocity of flow through the criteria $\epsilon_T / u l_A$ the laws of mass and heat transfer are not determined by u' or by the scale of turbulence l but by the said criteria. Therefore, to find out the relationship between u_T and *Re*,

it is necessary to obtain a relation between ϵ_T/ul_A and *Re*, which is different for different canals or even for different cross-sections of the same canal, as shown in the experiments by a team of workers including the author at the Moscow Power Institute. The criteria ϵ_T/ul_A which determine the burning velocity u_T in turbulent flow consist of two factors in the open form as given by

$$\frac{\epsilon_T}{u.l_A} = \frac{u'}{u} \cdot \frac{l}{l_A} = \text{Karman's number} \times \text{ratio of } l \text{ to } l_A$$

Experimental work in the field of aerodynamics gives us very little information about these two factors and hence at the present moment it is almost impossible to evaluate the criteria ϵ_T/ul_A for a given value of *Re* or *u*. Further investigation in this regard is contemplated.

Experimental Equipment

For carrying out experimental studies on these aspects of the problem an equipment was constructed for producing one-dimensional flat flame in the Department of Boiler Design, Moscow Power Institute. The equipment consists of a cone (Fig. 2) with a small angle of opening, which assures a continuous flow of the mixture. During the process of combustion, which takes place in this cone, the flame front is established in a plane perpendicular to the cone axis, such that variation of all the parameters approaches very closely that in the case of a one-dimensional problem. The one-dimensional nature of the problem was verified by means of temperature and velocity profiles measured across different sections of the cone under conditions of burning and cold blowing as well. These experimental data, as obtained by us, give evidence that the one-dimensional nature of the problem is maintained only in the first few sections of the cone from the narrow end, but as the diameter goes on increasing the velocity profile gradually becomes parabolic in nature, naturally destroying the flatness of the flame.

In this context a few remarks on the method of experimental studies, as carried out by the previous scientists, are relevant. In its own time, the use of bunsen burner for studying the flame characteristics made a great contribution to the theory of flame propagation. But from the point of view of present times, it allows some serious errors. The primary source of error lies in the fact that while it is assumed that the burning speed remains constant all over the surface of the flame, actually its value is to a great extent determined by the temperature of the gas mixture before the flame front. In the vertex of flame cone the value of burning speed is greater than

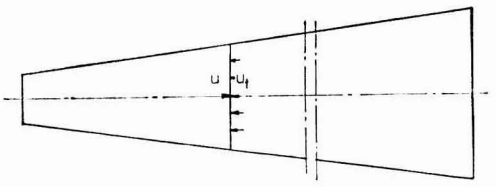

Fig. 2 — Profile of the combustion chamber

that in the other parts of the flame. As a result of this non-uniformity, we can determine only the average burning speed. There is another source of error, and this is affected by the surrounding medium. In the case of coefficient of excess air being more than unity, this effect does not play any role, but when its value is less than unity, the effect becomes more prominent. Thus the need for producing one-dimensional flat flame for experimental studies instead of conical flames, which were being used previously, is evident.

As observed in the experimental study at the Moscow Power Institute referred to earlier, the conical profile of the combustion chamber could not give very satisfactory results for producing a one-dimensional flame, specially in the region of the cone, near the broader end and needs improvement. Hence some alternative method should be devised for achieving a flat flame. A flat flame for laminar flow has been achieved by the well-known Egerton-Powling burner, which is being widely used for experimental studies in UK. But for turbulent flame, such a burner is not yet known and we should think of one that will give a rectangular velocity profile for obtaining a one-dimensional flame.

The equipment, as constructed and used by us in the Department of Boiler Design, Moscow Power Institute, if modified suitably, is of universal type and can be used for studying various problems. Apart from being useful for a full-fledged study of the problem of flame propagation in homogeneous fuel mixtures, the equipment can also be used for studying flame propagation characteristics in heterogeneous mixtures, i.e. pulverized coal mixtures and also the burning of coal particles in the flame condition.

Summary

Existing theories on the explanation of the mechanism of flame propagation such as ' surface combustion ', ' volume combustion ' and ' self-turbulization ' theories are presented. An attempt has been made to unify these two main theories, i.e. ' surface combustion ' and ' volume combustion ' theories, which though contradict each other have been verified experimentally by their respective supporters. Thus a single theory has been suggested wherein the Reynolds number (*Re*) is taken to be the factor, which will determine the mechanism of burning. Accordingly, the pure ' surface mechanism ' prevails in the laminar regime, beyond which, under weak conditions of turbulence, both ' surface ' and ' volume ' mechanisms are present and a limiting value of *Re* should be found after which the burning should take place only through ' volume mechanism '. The theory of ' self-turbulization ' can be fully established only after experimental verification of the magnitude of the pulsations in the actual flame condition.

An assumption that the differential equations of heat transfer for laminar and turbulent flows are identical has led to a mathematical expression for the burning speed of turbulent flame. Hitherto, such an analytical expression is not available. Here again, due to the presence of a relation between λ_T, a coefficient which takes into account both molecular

and turbulent conductivities and the velocity (u) of flow, through a determining factor ϵ_T/ul_A where ϵ_T is the coefficient of turbulent transport, the laws of mass and heat transfer are not determined by the pulsating velocity u' or by the scale of turbulence, but by the factor ϵ_T/ul_A. Therefore, the relation between u_T and Re is different for different canal profiles or even different cross-sections of the same canal.

Advantages of conducting experimental studies in the flat-flame burner have been pointed out and the construction of such a burner for turbulent flame has been suggested.

Acknowledgement

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Determination of Glyceride Structure of Natural Fats—A Review

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ANIMAL and vegetable fats consist essentially of triglycerides. The physical properties and performance of a fat depend on the number and nature of fatty acids as well as their manner of distribution among the triglyceride molecules. Almost all fats contain four or more different fatty acids and the chemically distinguishable triglyceride that could be formed from n fatty acids is $(n^3+n^2)/2$. The elucidation of glyceride structure is thus not an easy task. Further, the differences in the properties of component fatty acids, viz. carbon chain length, and type and degree of unsaturation, cannot be exploited in the separation of triglycerides as effectively as in fatty acids, because the former are often made up of different fatty acids.

A number of monographs and reviews have appeared which deal with the methods employed in the determination of glyceride structure and the concepts of fatty acid distribution[1-14]. Rapid strides have recently been made both in methodology and in concepts. The concepts are briefly outlined here and the methods critically reviewed with an indication of the future trends.

Concepts of Fatty Acid Distribution in Triglycerides

Even distribution — Hilditch and coworkers determined the glyceride composition of a large number of natural fats using the low temperature solvent crystallization procedure[1] and an oxidation method[1,15] for the estimation of GS_3*. From this wealth of data, Hilditch formulated the rule of even distribution, according to which the fatty acid location leads to heterogeneous individual glycerides, yet a homogeneous glyceride mixture, viz. the total fat[1]. This rule defines that any fatty acid will occur not more than once and not at all in many triglycerides at *c.* 15 per cent (mole) or less concentration, at least once and more frequently twice between *c.* 35 and 65 per cent, and thrice at 70 per cent or higher concentration but only after forming mixed glycerides with the other acids.

Random distribution — This concept arose mainly from the observation that proportions of GS_3 in some fats (particularly body and milk fats of ruminants and also a few vegetable fats) are higher than those obtained by the even distribution rule, but nearly the same as those required by mathematical probability[3,16]. When S and U are the molar fractions of saturated and unsaturated acids, the four glyceride types that would be formed by chance are the terms in the binomial expansion of $(S+U)^3$. Thus, a larger number of individual glycerides are formed making the fat as a whole heterogeneous, despite the formation of greater proportions of simple glycerides.

*The following abbreviations are used in the text: G, glyceryl; S, saturated acid; U, unsaturated acid; and A, azelaic acid radicals.

Partial random distribution — The glyceride composition of corn oil, determined after intensive fractional crystallization, is the basis for the partial random scheme proposed by Doerschuk and Daubert[17]. According to this, a fatty acid can occasionally form diacid-triglycerides when its concentration is below 33 per cent (mole) and need not occur at all in any glyceride between 33 and 67 per cent concentration. No other oil has been similarly studied to provide further support to this theory.

The even, random and partial random schemes are empirical and do not suggest any mechanism for the biosynthesis of glycerides.

Restricted random distribution — Kartha put forward this concept on the basis of the glyceride compositions of a number of natural fats, determined by his acetone-acetic acid-permanganate oxidation method[18-20]. According to this, lipolytic esterification occurs in the liquid state. All the glycerides are produced on a random basis, because of the reversible dynamic equilibrium, except in the cases where a restriction on the formation of solid GS_3 occurs. This synthesis is controlled by the solubility of GS_3 in the substrate and the melting points of saturated acids. When the formation of GS_3 is limited to below its chance value, the other glyceride types will be different from chance values. Based on this hypothesis, Kartha formulated a rule for calculation of glyceride type composition of any natural fat, irrespective of its fatty acid composition and biological source, from only the molar proportions of S and GS_3[20].

'Specific random' distribution — The next milestone in the elucidation of glyceride structure was the discovery that pancreatic lipase is specific towards the fatty acids attached to the primary positions of the glycerol under controlled conditions[21-29]. Tattrie *et al.*[30] have further shown that the enzyme hydrolyses the esters linked to the 1- and 3-positions at the same rate and the mechanism of hydrolysis is random and not stereospecific. Mattson, Desnuelle and Coleman and their coworkers used pancreatic lipase for hydrolysis of a large number of animal and vegetable fats[31-39]. The data demonstrated specificity rather than randomness in fatty acid distribution. The saturated acids are preferentially attached to the primary positions except in pig depot fat. To accommodate the results obtained by pancreatic lipase hydrolysis within the random or restricted random concepts, Vander Wal put forward 1,3-random, 2-random hypothesis, on the basis of Richardson's suggestions[40]. He developed a set of calculations to compute GS_3, GSSU, GSUS, GSUU, GUSU and GU_3 from a knowledge of the percentage of saturated acids in the whole fat and in the 2-monoglycerides liberated by pancreatic lipase hydrolysis. Two assumptions are involved in these computations: (i) whatever the proportions of S and U which are dispersed among the 1-, 2- and 3-positions respectively of the triglycerides, they are distributed therein at random; and (ii) that the 1- and 3-positions are occupied by identical proportions of S and U. These calculations are applicable only to fats containing predominantly C_{16} and C_{18} fatty acids. Coleman and Fulton[36] also developed a similar set of computations.

Hilditch (cited in ref. 8) believes that the 2-position is esterified first preferentially by oleic and other C_{18} unsaturated acids leaving the 1- and 3-positions to the other acids. Gunstone[8] developed this idea whereby the secondary hydroxyl is preferentially acylated by unsaturated C_{18} acids and the primary hydroxyls are acylated subsequently by the remaining acids, including any C_{18} unsaturated not required at the secondary hydroxyl. Within these limits the distribution of acyl groups at each position is statistical.

Kartha[9] recently modified his restricted random distribution theory by incorporating two more ideas: (i) that ripening seeds contain two lipases, viz. α- and β-lipases, the former promoting the reversible esterification of fatty acids with the 1-hydroxyl and the latter irreversible esterification of only higher fatty acids with the 2-hydroxyl; and (ii) that these lipases may or may not have fatty acid specificity. He, therefore, proposed two specific restricted random distribution rules A and B. Rule A is applied when only the α-β lipase mechanism acts and Rule B when it acts in conjunction with fatty acid specificity.

Savary and Desnuelle[35] postulated the existence of two different enzymes in the biosynthesis of phospholipids and triglycerides in plants starting from 1-glyceryl phosphate. One enzyme specifically esterifies oleic, linoleic and linolenic acids in the 2-position, whereas the other esterifies any fatty acid in the 3-position. The latter enzyme or some other enzyme with similar lack of fatty acid specificity then esterifies the 1-position after dephosphorylation.

According to Mattson and Volpenhein[34,39], who hydrolysed a variety of natural fats with pancreatic lipase, the 1- and 3-positions of glycerol are esterified first only by palmitic, stearic and any other acid having more than 18 carbon atoms. Oleic, linoleic and linolenic acids are then attached at random among all the unoccupied positions of glycerides.

Methods for Determination of Glyceride Structure

Since fats are complex mixtures of a large number of triglycerides, it is necessary either to segregate them by suitable means into simpler mixtures or to modify them to such derivatives as are amenable to fractionation and analysis. At one stage or other, the fatty acid composition is determined. Low temperature solvent fractional crystallization developed by Brown and coworkers[41] and urea-inclusion[42] separate according to the degree and types of unsaturation, and ester-fractionation[1] under high vacuum in an electrically heated and packed column by chain length. Conjugation of methylene-separated double bonds with alkali and measurement of the absorption developed in the ultraviolet region[43] is used for the estimation of individual polyunsaturated acids, and of total saturated acid content[44]. Various chromatographic[45] (column[46], thin layer[47-49], paper[50] and gas-liquid[51-54]) procedures are available for either segregation into simpler mixtures or quantitative separation of fatty acids and their esters. Reversed-phase partition column chromatography[55-57] is particularly useful in the absence of a gas-liquid chromatographic unit.

Methods for the determination of glyceride structure may be classified here under three heads: physical, chemical and enzymic. Many procedures may be included under more than one category. The reason for such a classification is that segregation into simpler components or modification of complex glycerides is the most important step.

Physical Methods*

Low temperature fractional crystallization — Repeated crystallization of a fat or oil from suitable solvents like acetone or ether at temperatures ranging from *c.* −70°C. upwards results ultimately in the separation of fractions having a lesser number of component glycerides than the original fat. From the fatty acid composition of each fraction the component glycerides are computed on the assumption that the final crystallized fractions contain not more than two adjacent glyceride types[1]. Usually a separate estimation of GS_3 by the oxidation procedure[15] is also made when dealing with saturated fats. The efficiency of the procedure depends mainly on the intensiveness of the crystallizations, i.e. repeated crystallizations until no further change is noticed in the characteristics of the fraction.

Crystallization, being a physical procedure, does not destroy the glycerides. Another advantage is that individual glycerides can be computed from the detailed fatty acid composition. However, this procedure needs large amounts of the sample (*c.* 0·5 kg.), involves repeated and tedious crystallizations, and yet does not provide information about positional isomers. Autoxidation of highly unsaturated glycerides during repeated working is likely but could be minimized by the addition of antioxidants[58]. The main limitation arises from intersolubility effects, invalidating the assumption that only two adjacent glyceride types are present in the final fractions[18]. Despite occasional criticisms levelled against this procedure[7,18,59,60], it continues to be a useful tool for preliminary fractionation into simpler mixtures though not perhaps for complete and direct determination of glyceride structure.

Before the advent of the pancreatic lipase hydrolysis technique, purely physical means, namely melting point, cooling curves and X-ray diffraction data, were employed to obtain qualitative evidence regarding the nature of positional isomers of glycerides. Quimby *et al.*[61] deduced from such studies on pure triglyceride types and their hydrogenation products isolated by crystallization that lard is composed largely of 2-palmityl glycerides.

Kartha[62] improved Coffey and Spannuth's[63] procedure for the estimation of GS_3. Neutral fat was twice crystallized from acetone (1 g./3 ml.) at 25°C. for 3 days and the final precipitate was assumed to comprise GS_3 and GS_2U. This method is applicable only to natural fats containing C_{16} or higher fatty acids.

Reiser and Dieckert[64] determined GS_3 by crystallizing fat (*c.* 10 g.), to which ^{14}C carboxyl-labelled tripalmitin was added from an acetone solution until iodine value is reduced to a minimum, and then determining the radioactivity. Theoretically, this principle could be extended to determine other glyceride types, but the nature of these should be known in advance so that suitable labelled glycerides can be added. The criticism of mutual solubility is valid in this case also.

Thermal gradient crystallization — Similar to sorptions and desorptions in a chromatographic column, repeated crystallizations are carried out in a thermal gradient column packed with glass beads as an inert support. Solvents of increasing power of solubility are used as eluants. Magnusson and Hammond[65] studied this approach of Baker and Williams[66] using synthetic triglycerides, e.g. tripalmitin, oleodipalmitin and trimyristin. Jones and Hammond[67] applied the technique to determine the glyceride structure of cocoa butter (using only *c.* 0·5 g.) the results of which support Vander Wal's 1,3-random, 2-random concept. Van den Tempel *et al.*[68] also critically examined this fractionation procedure. The separation is effected on the basis of solubility which depends on molecular weight, and degree and type of unsaturation. Though the method is now in an exploratory stage, it has potentialities. Large number of fractional crystallizations in one operation, simplicity of apparatus used and physical nature are the apparent advantages of this method. This procedure will be useful more for preliminary fractionation than for total analysis in one step.

Countercurrent distribution — Depending on their degree of unsaturation and consequently their polarity and partition coefficients, glycerides are resolved by repeated distribution between two equilibrated solvent phases of differing polarity[69,70]. The more unsaturated fractions go into the polar phase. The raffinates and extracts are weighed and analysed for fatty acid composition either by the alkali-isomerization method or by gas-liquid chromatography. Dutton and his associates have determined the glyceride structure of linseed[71], soyabean[72], safflower[73], cocoa[74] and corn[75] oils using an automatic 200-tube countercurrent distribution apparatus. Pentane-hexane was used as the nonpolar phase and furfural-nitroethane as the polar phase. Except for cocoa butter, which seemed to fit in with a 2-oleo, 1,3-random distribution, these oils appear to conform to a random scheme.

Separation of geometric isomers of fatty acid esters was achieved by partitioning between hexane

**Added in Proof*: Gunstone *et al.*[140] have crystallized *Jatropha curcas* seed oil into 3 fractions from a mixture of acetone and methanolic silver nitrate at −10° to −70°C., thus combining metal-olefin complex formation with crystallization. The fractions were further resolved by silver nitrate-silica gel chromatography. Though unsatisfactory for highly unsaturated and conjugated fatty acid esters[90], this technique, in column[141] or on thin layer[140,142–47] and on an analytical (5-50 μg.) or preparative (50-100 mg.) scale, is preferred by many in conjunction with gas chromatography for fatty acid and glyceride separations and lipase hydrolysis for positional isomers. Glass fibre paper using pyridine-water (4 : 1) was employed to separate triglycerides on a microscale (5 μg.)[148]. The glyceride fractions were transesterified *in situ* and the methyl esters were developed in second dimension using isooctane. The glyceride compositions, as determined by gas chromatography[99], of both natural and interesterified butter and coconut fats differed from random distributions, variation being more in the case of the former[149].

and 90 per cent methanol containing 0·2*M* silver nitrate[76]. The greater the number of double bonds in a molecule or larger the number of methylene groups that separate them, the stronger is the argentation. For the separation of esters according to the number of double bonds, acetonitrile and hexane were found to be more useful. Linseed oil was fractionated using furfural-nitroethane (1:1) as the lower phase and petroleum ether as the upper[77]. Countercurrent distribution of loose π-bonded complexes of metals with unsaturated glycerides appears to be a promising method.

As in the crystallization procedure an assumption is made in countercurrent distribution that any fraction does not contain more than two adjacent glyceride types. But the behaviour of a glyceride is more predictable in countercurrent distribution than in crystallization. Although individual glycerides can be computed, no information on positional isomers can be obtained. About 10 g. of the sample is enough for the analysis. The applicability or otherwise of this technique has to be examined for various types of fats. The high cost of the apparatus and the tediousness of the procedure are handicaps for its widespread use.

Liquid-solid column chromatography — In the chromatographic procedures developed for the separation of glycerides, the sample size varies from a few milligrams to a few grams and can be scaled up or down.

Walker and Mills[78] fractionated linseed oil on an alumina column into glyceride classes containing 4-9 double bonds. Alumina is usually not employed, because of the risk of chemical changes.

Silicic acid column chromatography has been employed to fractionate model glyceride mixtures and natural oils (*c.* 20 g.) by Sahasrabudhe and Chapman[79]. Lower molecular weight and more unsaturated glycerides are adsorbed more strongly than the higher molecular weight and less unsaturated glycerides.

Metals like silver form weak π-complexes at the double bond of olefins[80-82]. Recently, more and more investigators are combining this property with chromatography; this may be termed ' metal-olefin complex chromatography '.

Mercuric acetate adducts[83] are used to separate fatty acid esters on alumina[84] and silicic acid[85] columns. Inkpen and Quackenbush[86] extended this to the separation of triglycerides on an alumina column with ethyl ether-acetic acid as an eluant. The degree of unsaturation, i.e. the number of addition sites for the formation of adducts is the basis for separation. de Vries[87,88] separated on silicic acid-silver nitrate columns methyl esters (of stearic, elaidic and oleic, linoleic, and linolenic acids) and triglycerides (tristearin, oleodipalmitin, stearodiolein and triolein) using benzene-petroleum ether mixtures. Stability of alkene complex increases with its free energy content. Silver complexes with *cis* isomers are more stable than with *trans* isomers and those with linoleic ester are more stable than with oleic ester. The lesser the stability of the complex, the faster it migrates. Litchfield *et al.*[89] separated *Cuphea miniata* seed fat on a silver nitrate-silicic acid column and analysed the fractions for glyceride composition by gas-liquid chromatography. Subbaram and Youngs[90] fractionated lard into five fractions of differing unsaturation (0-4 double bonds) by the method of de Vries. Each fraction was analysed by gas-liquid chromatography of esterified azelaoglycerides; 24 glycerides could be computed from the data. The analysis on a fraction of a gram (*c.* 150 mg.) could be completed in a few hours.

Wurster *et al.*[91] and Emken *et al.*[92] separated fatty esters (2-4 mg.) by the number and configuration of double bonds on a column of cation-exchange resin saturated with silver. The use of resin instead of silica gel to support Ag^+ facilitates the use of polar solvents such as methanol-water mixtures to separate polar as well as non-polar lipids without the risk of elution of silver. This procedure may also find use in the separation of polar lipids, such as phospholipids and partial glycerides by using suitable mixtures of polar solvents. By appropriate changes in solvent systems this approach could be extended to triglycerides. Other metal complexes might be discovered in the near future.

Liquid-liquid partition chromatography — Reversed-phase partition column chromatography has also been explored for the separation of glycerides using swollen polymerized soybean oil[93] or rubber powder[94] as a stationary phase and acetone-water or acetone-methanol mixtures respectively as a mobile phase. Separations of simple triglycerides (trilaurin and trimyristin) and also cocoa butter glycerides (*c.* 15 mg.) were attempted by Black and Hammond[95] on a column of Celite treated with silane and equilibrated with the mobile phase, viz. lower layer of a mixture of acetone, heptane and water. In reversed-phase chromatography lower molecular weight and more unsaturated components are eluted first.

Gas-liquid chromatography — Although this technique[51-54] has become a routine tool in the determination of fatty acid composition, only a few investigations are concerned with its applicability to glycerides as such because of their lower volatility. In this technique the sample is vaporized and carried by means of an inert gas such as argon, helium or nitrogen through a column packed with an inert material (e.g. diatomaceous earth) coated with a stationary phase (e.g. silicones, polyesters). By a series of partitions between the gas phase and the stationary liquid phase separation is achieved. By using a thermally stable stationary phase (e.g. silicone gum rubber) and high programmed temperatures (*c.* 200-400°C.), glycerides varying in number of carbon atoms are separable. Although it has been applied to lard, butter, palm kernel, coconut and safflower oils, this procedure seems at present more suitable for fats containing low molecular weight fatty acids and for ' finger-printing '[96-101]. Kuksis *et al.*[101] separated butter fat triglycerides varying in number of carbon atoms from 24 to 54 on a silicone oil (SE-30) column using a hydrogen flame detector. From the computed data they concluded that non-randomness prevails in the intraglyceride as well as in interglyceride distribution of fatty acids. With the development of more thermally stable and selective stationary

phases and with improvements in apparatus (particularly detectors) suitable for high temperature work, the method may find use in the direct elucidation of glyceride structure of many other fats. Youngs and Subbaram[102] were able to chromatograph azelaoglycerides after methylation because of the reduction in molecular weight. For quantitative work, it is necessary to determine response factors for each compound and use internal standards. Incorporation of suitable thermally stable complexing agents into the stationary phase, as in ' metal-olefin complex chromatography ', is likely to help the separation of unsaturated glycerides.

Paper chromatography — Reversed-phase paper chromatography[50] has been used for the separation of synthetic glycerides and natural oils[103-5]. Vereshchagin[105] determined the glyceride composition of poppy seed oil by ascending chromatography on petroleum hydrocarbon-coated paper with acetone-acetic acid (85 : 15) as mobile solvent. The separated components were detected with Sudan Black B and quantitatively estimated by photodensitometry. The brominated triglycerides were separated using hexane as mobile phase. The glyceride spots were eluted and the fatty acids rechromatographed. The use of paper chromatography is likely to diminish as it is more time-consuming, and also because quantitative analysis may not be accurate, since the spots are not as sharp and rounded as in thin-layer chromatography.

Thin-layer chromatography — In thin-layer chromatography[47-49], a suitable adsorbent (silica gel, alumina, etc.) is coated in a thin layer on glass plates with or without a binder (e.g. calcium sulphate) and the plate dried, spotted and developed in a solvent chamber. These plates as such could be used for adsorption (or partition, if the plates are wet[106] or prior development is carried out with a polar solvent) chromatography, or the plates could be impregnated with a non-polar material for reversed-phase partition chromatography. Kaufmann and coworkers[107,108] separated synthetic glycerides and natural oils on silica gel-G plates as such or impregnated with a petroleum fraction or undecane. The solvents used were ethyl ether, isopropyl ether or dichloroethane for direct silica gel-G plates and acetic acid or acetonitrile-acetone for impregnated plates. For similar purpose, Barrett *et al.*[109,110] used silica gel-G impregnated with silver nitrate. Carbon tetrachloride-chloroform mixture containing traces of acetic acid and ethanol was used for developing, and dibromo R-fluorescein to give fluorescent spots in ultraviolet light. Quantitative analysis was effected by photodensitometry of the spots charred by orthophosphoric acid with an error not exceeding 3 per cent. Even positional isomers of triglycerides (e.g. 2-oleodistearin and 1-oleodistearin) were separated. However, a suitable wide range of standards is needed for identification and quantitative analysis. Kaufmann and Wessels[111] employed thin-layer chromatography first on silver nitrate-impregnated silicic acid and then on reversed-phase plates to fractionate natural oils, in conjunction with gas-liquid chromatography to determine the fatty acid composition of fractions and pancreatic lipase hydrolysis technique to elucidate the positional isomers. Thin-layer chromatography using silica gel impregnated with silver nitrate is an advance in microfractionation of triglyceride classes for further analysis by other means.

*Chemical Methods**

Acetone-permanganate oxidation — Hilditch and Lea[15] first developed a method for quantitative determination of GS_3 by oxidizing fat (*c.* 100 g.) with potassium permanganate in acetone. Unsaturated glycerides are converted to dicarboxylic acid-glycerides (e.g. azelaoglycerides: GS_2A, GSA_2 and GA_3) by cleavage at the double bond while GS_3 are unaffected. By repeatedly washing an ether solution of oxidized fat with aqueous potassium carbonate solution, the GS_3 are freed of acidic products and estimated. The method is shown to give erroneous estimates because of the hydrolysis of azelaoglycerides[18,19,112]. Hilditch and Saletore[113] attempted to extend this oxidation method to estimate the other glyceride types as well, but failed for the same reason.

Lakshminarayana and Rebello[112,114] replaced the troublesome carbonate-washing procedure by chromatography of the oxidized fat on an alumina column to adsorb the acidic and hydrolysis products. The GS_3 are eluted with chloroform or ether. This procedure needs only a small sample (0·5-10 g.) and is suitable for both natural and hydrogenated fats.

Acetic acid - acetone - permanganate oxidation — Kartha maintained 3-6 per cent acetic acid concentration during acetone-permanganate oxidation to prevent hydrolysis of azelaoglycerides[18,19]. The oxidized fat is divided into two fractions through magnesium salts, viz. (i) insoluble azelaoglycerides, comprising GS_2A together with a part of GSA_2 and total GS_3 and (ii) the soluble azelaoglycerides comprising the remainder of GSA_2, GA_3 and monocarboxylic acids. From the yield of the insoluble azelaoglycerides, the saturated acid contents of insoluble and soluble azelaoglycerides and also the GS_3 content (as determined independently by the crystallization procedure[62]), the glyceride type composition is calculated. The residual unsaturation of the acids from the insoluble azelaoglycerides is accounted as due to unoxidized GS_2U. Five grams of sample is sufficient for analysis.

Lakshminarayana and Rebello critically studied the oxidation methods of both Hilditch and Lea[15] and of Kartha[19] using glyceride concentrates[112,115,116]. They confirmed the extensive hydrolysis of all azelaoglycerides in the former and considerable hydrolysis of GSA_2, though not of GS_2A, in the latter procedure. Further, some neutral saturated products, presumably ketoacetoxy compounds, were

**Added in Proof*: Kartha[150] developed a method for the estimation of GSUS by preferential hydrolysis of azelaic acid from insoluble azelaoglycerides and subsequent permanganate oxidation to yield neutral products. However, standardization of the procedure was not reported. Subbaram and Youngs[151] determined compositions of 7 animal and 7 vegetable fats using their method of gas chromatographic separation of oxidized glycerides[102] and compared them with those calculated according to Vander Wal[40]. The agreement is satisfactory except for human and more saturated vegetable fats.

shown to be formed particularly in Kartha's oxidation from unsaturated acid groups, which increases the GS_3 content and the yield of insoluble azelaoglycerides. The accuracy of Kartha's method could be affected by errors from these two sources. Additional evidence in support of these observations was obtained by using pure methyl oleate and synthetic triglycerides (Holla, K. S., Padmanabhan, M. R. & Rebello, D., personal communication). That new esters are synthesized from methyl esters of unsaturated acids has also been shown independently by Eshelman and Hammond[117].

Other modifications of acetone-permanganate oxidation procedure — Yakubov[118] recommended bubbling of carbon dioxide during Hilditch and Lea's oxidation. Glycerol liberated from GA_3 during the recovery of oxidized fat is estimated by the periodic acid method. The GS_3 are separated from the remainder of the oxidation products by crystallization from acetone. Nonanoic acid is removed at 250°C. in a current of inert gas. From the acid value of the mixture, GS_2A and GSA_2, thus left behind, the proportion of each is calculated. In view of the findings of Eshelman and Hammond[117] and also Lakshminarayana and Rebello[112] this method is unlikely to be accurate.

Haighton *et al.*[119] separated GS_3 and GS_2A from GSA_2 and GA_3 by countercurrent distribution between isooctane and methanol. These workers also fractionated the oxidation products of fat by reversed-phase partition chromatography on rubber columns using acetone as mobile phase. Jurriens[120] chromatographed azelaoglycerides on a polyethylene column. These procedures have to be investigated further.

Mercaptoacetic acid adducts — Eshelman *et al.*[121] reacted fat (*c.* 5 g.) with mercaptoacetic acid and separated the ammonium salts of adducts from the unaffected GS_3 on a diethyl aminoethyl cellulose column. This procedure is, however, tedious requiring recycling of fat in the eluate because of rather ready hydrolysis of adducts to the original glycerides. Estimation of other glyceride types as well by this method has been suggested but no results have been reported.

Periodate-permanganate oxidation — Even before the existing oxidation methods were found unsuitable for glyceride structure studies, Lemieux and von Rudloff[122-25] had developed a specific and quantitative method based on periodate-permanganate oxidation, in which the former is the actual oxidant and the latter acts as a catalyst. This was employed by Youngs[126] in proposing a new method. A *t*-butanol solution of fat (*c.* 250 mg.) is added to a mixture of solutions of sodium periodate, potassium permanganate, potassium carbonate and *t*-butanol, and refluxed. After evacuating free short-chain acids, the oxidized fat is resolved into two fractions, viz. (i) GS_3 and GS_2A and (ii) GSA_2 and GA_3, by partition chromatography on 90 per cent ethanol-saturated silicic acid using Skellysolve B and ether as the eluants respectively. After esterification each fraction was hydrolysed with pancreatic lipase and the products re-esterified for gas-liquid chromatographic analysis. The glyceride type composition, viz. GSSS, GSSU, GSUS, GSUU, GUSU and GUUU, is calculated. The compositions of lard, chicken fat, rat fat, linseed oil and cocoa butter agreed with those expected on the basis of Vander Wal's theory[40]. The method has to be tested on a larger number of fats. The procedure involves many steps. Hydrolysis of azelaoglycerides may not be ruled out, since oxidation is carried out in an alkaline medium. The data obtained by pancreatic lipase hydrolysis cannot yet be considered on a quantitative basis without hesitation. Free fatty acids liberated, rather than 2-monoglycerides, have been analysed in this procedure which does not give a true picture, since it is known that 2-monoglycerides are isomerized to 1-monoglycerides and subsequently hydrolysed to free fatty acids and glycerol[38,127].

Youngs and Subbaram[102] improved the above procedure. The oxidized fat was esterified and injected into a temperature programmed (260-350°C.) column of 1 per cent silicone (SE-30) coated on an acid-washed, base-washed and silanized diatomaceous earth (Anakrome ABS). Hydrogen flame detector and helium as carrier gas were used. Analysis on a 20 mg. sample can be completed in about 4 hr. Individual unsaturated (e.g. oleo-, linoleo-) glycerides cannot, however, be estimated by this method alone. The presence of unknown positional isomers of unsaturated acids could cause errors. Not only have the response factors for each of the esterified azelaoglycerides to be determined, but also the eluted components analysed to make sure that no alterations are taking place.

Ozonolysis — Privett and Blank[128,129] carried out ozonization of unsaturated glycerides at *c.* −60°C. in pentane. The ozonides are reduced to aldehydes by hydrogenation using Lindlar lead-poisoned palladium catalyst. The ozonides as well as the aldehyde cores are separated on silica gel-G thin layer plates using mixtures of ether and petroleum ether. The spots are charred and quantitative estimations carried out by photodensitometry. The method has been standardized with synthetic glycerides and applied to corn oil, cocoa butter, olive oil and lard. Alternatively, the spots are scraped off and the saturated acids analysed. One striking feature of this method is that 2-4 mg. sample is sufficient. However, care has to be exercised as some by-products, e.g. esters, can be formed in the reduction of ozonides[130].

Enzymic Method*

This procedure[25-39,127] involves emulsification of fat (25 mg. to 1 g.) after the addition of bile salts and

**Added in Proof*: Short-chain or highly unsaturated fatty acids affect the positional specificity of pancreatic lipase to some extent[152]. In coconut oil, lauric acid does not follow the general pattern of saturated acids in vegetable fats[153]. Palmitic acid was predominantly found in the 2-position of the fats of wild boar and peccary and all over or more at the 1- and 3-positions of the fats of other even-toed animals[154]. Elaidic[155] and epoxyoleic[156] acids are hydrolysed as easily as other acids. According to Kartha[157], a triglyceride molecule once attached to the enzyme is released only after its hydrolysis to monoglycerides. Experimental observations on trivernolin[156] support this concept.

(*Continued on L.H. col. of next page*)

a suitable buffer, and hydrolysis with lipase from pancreas of pig, sheep or rat at a *p*H around 8. Usually calcium chloride is also added to activate the enzyme and to minimize re-esterification of fatty acids[24,127]. When about two-thirds of the fatty acids have been liberated, the *p*H is brought down so as to inactivate the enzyme. The hydrolysis products (free fatty acids, mono-, di- and triglycerides) are separated on ion-exchanger and silicic acid columns[131-34] or silica gel-thin layer plates[135]. The fatty acid compositions of the original fat and the liberated 2-monoglycerides but not the free fatty acids[38,127] are determined. Various 'specific random' concepts of different investigators that arise from these data have been discussed earlier.

Although pancreatic lipase hydrolysis is undoubtedly useful, particularly in the elucidation of positional isomers, undue emphasis cannot be laid on quantitative analysis. The specificity or otherwise of pancreatic lipase towards fatty acids of unusual structures, unlike commonly occurring even-numbered straight-chain acids, has not yet been examined, an aspect which is being explored in this laboratory. Recent reports indicate that all fatty acids do not hydrolyse at the same rate[135]. For example, short-chain acids are preferentially split off[28,29,136]. Re-esterification and inter- as well as intra-acyl migration are two other aspects deserving attention[24,25,29,137]. The reproducibility of the results may also be a problem, since the activity of the enzyme and other side reactions (esterification, etc.) probably vary according to the degree of purity of lipase[138]. The nature of hydrolysis also varies according to the conditions of experiment. Foreign substances that are present in lipase, fat sample or other reagents also influence the course of hydrolysis[139].

Conclusion

In the analysis of fats, the reduction in the quantity of sample required from kilograms to milligrams, and in time involved from months to hours has been achieved largely because of the recent developments in quantitative chromatography. Combination of different principles (e.g. metal-olefin complex formation with either countercurrent distribution or chromatography) is the major contributing factor responsible for the improved efficiency of present-day fractionation procedures. Techniques like crystallization, countercurrent distribution and chromatography are extremely useful for fractionation of glyceride mixtures into simpler mixtures, which could then be subjected to periodate-permanganate oxidation, ozonolysis and pancreatic lipase hydrolysis.

(*Continued from R.H. col. of previous page*)

Vernonia anthelmintica seeds contain an enzyme with specificity for the 2-position[156,158]. Of 82 microorganisms screened for the production of extracellular lipase, only 13 showed some activity; majority of these (e.g. *Pseudomonas fragi*) are specific for outer positions, whereas that from *Geotrichum candidum* hydrolysed oleate esters regardless of their position[159]. These lipases can be used at a neutral or slightly acid *p*H, thereby reducing acyl migration which may occur at a *p*H of *c.* 8 used in pancreatic lipase hydrolysis.

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REVIEWS

SKEW PLATES AND STRUCTURES by L. S. D. Morley (Pergamon Press Ltd, Oxford), 1963. Pp. xi+128. Price 45s.

This short monograph on *Skew plates and structures* provides the basic theory on this subject with a few selected worked examples.

The fundamental equations for plane stress are given in the rectangular and oblique Cartesian coordinate systems for an isotropic plate which is reinforced by one or more systems of parallel straight members uniformly distributed over the surface. A brief account is given of plane stress in polar coordinate system for an isotropic plate with special emphasis on their application to the investigation of the local behaviour at the junction of edges having various homogeneous boundary conditions. The general method of trigonometric series solution is indicated in the various coordinate systems to a few elementary problems.

Small deflection theory of bending of plates is presented in oblique and polar coordinate systems. The bending behaviour and the buckling of parallelogram-shaped plates are considered. Finite difference approximations are developed in oblique coordinates.

A formal analysis is given for a swept box structure using the theory of plane stress for anisotropic structures in oblique coordinates.

About eighty references are given to the published literature in this field. This book is a valuable addition to the existing books in this field.

B. BASAVA RAJU

MATHEMATICAL THEORY OF X-RAY POWDER DIFFRACTOMETRY by A. J. C. Wilson (Philips Technical Library, Holland), 1963. Pp. ix+128. Price Rs 24.00

The X-ray powder diffraction method has justly remained a popular tool for the X-ray analysis of materials, because of its simplicity and convenience. On the practical side it has reached a stage of high accuracy and precision, which is possible especially with the modern counter diffractometers. It is, therefore, imperative that a proper mathematical analysis of the various effects should be available if one has to make the best use of the available results for interpretation. The book under review fills just this gap. A companion volume on the experimental aspects by W. Parrish is expected to be published shortly.

The subject matter falls broadly under two headings: (i) The effects on the positions and line profiles due to geometrical factors such as the finiteness of the size of the slits, and other geometrical factors limiting the beam; and (ii) Causes of physical origin such as the nature of X-radiation, effect of crystal imperfection, etc.

The basic statistical tools required for analysis, such as the mode, the median, the centroid of the line profile, the variance as a measure of dispersion, are introduced in Chapter I. After discussing the geometry of the diffractometer in Chapter II, the different types of geometrical aberration such as equatorial and axial ones are discussed in Chapters III and IV, and their effect on line profiles in Chapter V. The physical aberrations are treated in Chapter VI. As pointed out by the author, a chapter is included, more due to its importance, on the effect of these factors on the accuracy of the parameters determinable using the powder diffractometer. Fourier methods for analysis of line profiles are discussed in Chapter VIII, while Chapter IX deals with the diffraction broadening due to particle size and also due to crystal lattice defects.

On the whole, the book is a welcome addition as it gives a self-contained and coherent account of the mathematical theory of powder diffractometry.

R. SRINIVASAN

DEVELOPMENT OF THE BLUE STREAK SATELLITE LAUNCHER — Proceedings of the Second Space Engineering Symposium, Hertfield College of Technology, Hertfordshire, 22 February 1963 (Pergamon Press Ltd, Oxford), 1963. Pp. xv+128. Price 60s.

This book contains the details of the six papers read at the Second Space Engineering Symposium organized by the Department of Mechanical Engineering and Aeronautical Engineering at Hertfield College of Technology, Hertfordshire.

These papers deal with the various aspects of the Blue Streak Satellite Launcher, viz. performance, autopilot design, instrumentation, structural design, engine and propellant systems, and the development and operation of the launching site. Each of these papers has been presented by a member of the design and development team of the De Havilland Aircraft Co. and all aspects of the subject concerned have been fully dealt with to the extent possible within the limitations of a paper.

The book as a whole gives a detailed and comprehensive picture of the complexity and extent of the work involved in a project of such a magnitude. It also throws light on the contribution made by Britain to the subject of space technology.

M. A. RAMASWAMY

VACUUM AND SOLID STATE ELECTRONICS — AN INTRODUCTORY COURSE by D. J. Harris & P. N. Robson (Pergamon Press Ltd, Oxford), 1963. Pp. ix+254. Price 20s.

The authors have set before them the objective of "writing an introduction to the subject of modern electronics which does not demand a high degree of mathematical sophistication and yet provides a sound foundation upon which specialist knowledge can be built". The book has been suggested for engineering students in universities and technical colleges.

There are eight chapters in the book and these have been supplemented by five appendices. The first three chapters — one introductory and two on vacuum electronics — have been written in a 'tale-tell'

fashion. Thus, the magnitude of the Avogadro's number has been impressed on the mind of the reader by saying that it would take 100 million years to take out the molecules from an electric lamp at the rate of a million per second (p. 7). It is open to doubts whether such a style should be adopted in scientific and technical text-books. One must, however, admit that lot of mathematical sophistication has been avoided in these chapters.

The next three chapters on fundamentals of solid state electronics, diode and transistor, and transistor as an amplifier entertain good deal of mathematical derivations without which perhaps it would have been impossible to explain the basic ideas. The grounded base and grounded emitter configurations have been discussed in the chapter on transistor as an amplifier, while the grounded collector stage does not find a mention. Only earlier forms of equivalent circuits have been considered for analysis.

The chapter on electronic circuits is limited to describing briefly the principles of rectification, amplification and oscillation. At the outset the preface makes it clear that the emphasis is on devices and not on circuits. All may not agree that a book titled *Vacuum and solid state electronics*, howsoever introductory it may be, should dispose off circuits and applications in such a cursory manner.

The chapter on cathode ray tubes, following appendices and problems with solutions, are all useful additions.

As stated, the emphasis is on devices. The book does not go beyond explaining the basic principles and constructions of earlier devices in a popular way. It does not even mention the recent and most interesting devices and their applications.

The book can at best serve as a good supplementary reading for physics students (in very early stages) and pre-engineering students in Indian universities.

K. S. BALAIN

THE PROPAGATION OF ELECTROMAGNETIC WAVES IN MULTICONDUCTOR TRANSMISSION LINES by P. I. Kuznetsov & R. L. Stratonovich; translated from the Russian by R. F. Kelleher (Pergamon Press Ltd, Oxford), 1964. Pp. xvi+190. Price 70*s*.

The book is based upon the papers published by the authors in different journals over a period of about eight years (1947-55). It starts with the description on the electromagnetic wave propagation in multiconductor transmission lines in terms of Maxwell's equations in the entire space surrounding the conductors. The boundary conditions at the conductor surfaces include the effect of finite conductivity and the e.m. fields are derived in powers of the skin-effect parameter. Under certain restrictions that are determined, the equivalent Kirchhoff's equations can be used, for which the generalized impedance and admittance matrices are derived. The theory is then applied to the specific case of general two-wire systems. The electromagnetic fields are described in terms of two modes: a symmetric mode, and an antisymmetric mode.

In Chapters III-V, some new methods of analysing and designing non-uniform lines are presented in terms of the equivalent four-terminal networks (a, b, c and d parameters) of these lines. Most restrictions, on the manner in which the parameters of such lines must vary in order to affect a closed form solution in terms of elementary functions, are avoided.

The sixth chapter deals with the transient effects in a multiconductor system, with particular reference to the two-wire system; the waveforms are expressed in terms of contour integrals, which are in subsequent chapters described in terms of cylindrical functions of one and two variables. Recurrence relations for these functions and their derivatives are given and the above results are applied to the specific case of a semi-infinite Lecher wire system.

The book uses a lot of high powered mathematics and should prove of great value to the active worker in this field.

O. P. GANDHI

MODEL ANALYSIS of STRUCTURES by T. M. Charlton (E. & F. N. Spon Ltd, 22 Henrietta Street, London), 1964. Pp. xii+142. Price 21*s*.

The title of the book is somewhat misleading since model tests for stress analysis are conducted on a wide variety of structures such as gravity, arch and buttress type of dams, for bridges of arch and other types and also for structural members such as continuous beams, portals, trusses, etc. The scope of the book, however, is limited to the model analysis of structural members and frames only.

It is to be mentioned that analytical methods of solution for structural members do exist, whereas model analysis offers an alternative tool, which is considered to be quite handy for design engineers, furnishing solution of required degree of accuracy and in a less time than by the analytical methods. The methods described in the book are such that the equipment required could be provided in a design office without special laboratory facilities.

The mathematical concepts of the model analysis which are based on the principle of similarity are clearly presented. Model analysis is classified broadly into (i) indirect methods and (ii) direct methods. The former is more popular since it enables influence lines for both linear and statically determinate structures to be obtained by applying prescribed displacements to their models and observing the resulting deformation curves. The latter, however, involves strain or force measurements on models from which corresponding values from the respective prototypes can be found by scaling. The indirect methods are based upon Müller-Breslav's principle for statically determinate and linear indeterminate structures. Three classical indirect model techniques due to Beggs, Gottschalk and Rieckhof are described briefly.

Model analysis can be employed for three-dimensional structures as well as for plane frames, but here the indirect method becomes too complicated for design office use unless it is justifiable to analyse the structure by treating its component plane frames separately.

A practical example of the analysis of the equipment utilized for same, such as compensating balance, moment indicator and 'isodynamometer' invented by the author, is discussed.

The book serves as a text to engineering students and as a reference book to design engineers on the topics referred to.

The reviewer feels that the type of problems referred to in the book could be all solved very satisfactorily by the use of Beggs' deformeter itself. A more detailed description of this equipment and its application would have enhanced the usefulness of the book.

J. V. RAO

AERO-SPACE AUTOMOTIVE DRAWING STANDARDS (Society of Automotive Engineers Inc., 485 Lexington Avenue, New York), 1963. Pp. xxxi+358. Price 140s.

These standards are intended for the promotion of wider uniformity of drafting practice for both aero-space and automotive industries. Chapters E and F deal exclusively with the terminologies and standards for automotive and aero-space industries respectively. The remaining chapters are devoted to the drafting standards of drawing sheet sizes and format, drawing titles, components and features, materials and processes, dimensioning and tolerancing, abbreviations and pictorial drawings, and tables and charts.

To suit the requirements of mass production and interchangeability, considerable attention has been paid on dimensioning and tolerancing of drawings to reflect the latest advances in theory and practice.

Although prepared for the instruction and guidance of draughtsmen engaged in aero-space and automotive industries, this manual will serve virtually the needs of drafting standards for any engineering industry. These standards are also useful for teachers and students of engineering. The chapters are indexed and arranged so that any revision or addition can be incorporated as and when they are made available. Care has been taken to present these standards in a manner that will promote orderly study.

The manual, which is well illustrated with figures and line diagrams, reflects the latest advances in drafting standards and, therefore, is a welcome addition to engineering libraries.

NINGAIAH

PHYSICAL CHEMISTRY by E. A. Moelwyn-Hughes (Pergamon Press Ltd, Oxford), 1964. Pp. vii+1334. Price 84s.

Dr E. A. Moelwyn-Hughes of Cambridge University is a leading teacher of physical chemistry. The book, popular since it was first published in 1957 and now in its second revised edition, is based on the author's lectures to undergraduates in their last year of study at that university.

The subject matter is presented on refreshingly new lines. The first four chapters are devoted to experimental foundations and mathematical formulation of the kinetic-molecular and the quantum theories followed by chapters on the chemical elements, thermodynamics, intermolecular energy, and partition functions. The physical chemistry of molecules and of the states, solid (crystalline and metallic), gaseous, liquid, dissolved (ionic and non-ionic), and interfacial are next considered. The last chapters of the book are devoted to chemical equilibria and kinetics. Throughout, the approach is from the standpoint of the partition function, and when this is not known, recourse is taken to the standard procedure of thermodynamics. Both experiment and theory are equally emphasized. There are eleven appendices, a name index and a subject index. A number of useful examples follow each chapter.

There is no doubt that this book is an outstanding text-book on physical chemistry. The treatment is admirably clear though at places it departs from the conventional, and the mathematics is simple. The book is of considerable value to both the student and the teacher of physical chemistry.

S. R. MOHANTY

THE SCIENCE AND TECHNOLOGY OF TUNGSTEN, TANTALUM, MOLYBDENUM, NIOBIUM AND THEIR ALLOYS — Proceedings of an AGARD Conference on Refractory Metals, Oslo, 23-26 June 1963 (Pergamon Press Ltd, Oxford), 1964. Pp. xiii+588. Price £7

The book is based on the AGARD Conference on Refractory Metals held at the Oslo University Centre in Norway last year. It is one of the most valuable and unusual publications in having departed from the beaten track in the presentation and discussion of highly technical and complex subjects and in bringing together the specialized features of the applied technology and fundamental basic theory of the science of refractory metals and their alloys. The publication has endeavoured to bring together an intimate intellectual partnership of two different fellow travellers, viz. the pure scientist and the pure engineer.

The publication presents rapporteurs' interpretative comments and detailed discussions in each chapter. International authorities in different specialized fields of the subject have presented their contributions based on practical experience gained from the application of refractory metals in relation to theoretical hypotheses. There has been no single publication dealing with such a vast subject such as the one under review. The explanation why so much emphasis is currently laid on the refractory metals has been clarified to the engineers in terms of peace-time pursuits and emergency requirements arising in the wake of World War II. Purely theoretical aspects on the electronic structure and alloying characteristics of the transition metals have been adequately dealt with. A new subject dealing with the micrometallurgy or the metallurgy of minute additions such as rare earth to refractory metals has received due attention. The physical properties and metallurgical characteristics of refractory metals have been highlighted.

Each chapter contains its own purely theoretical papers in the respective field followed by discussion on applied technological aspects and concluding with a review of the applications of refractory metals and their alloys including their service performance in this jet age under the most rigid conditions.

In a separate chapter on 'Primary fabrication', the production of flat products and shape forming of refractory metals have been discussed. Another chapter on 'Secondary fabrication' covers machining, forming, joining and flow turning of refractory metals and their alloys.

The publication is all the more stimulating and technically informative in going through the discussion given in each chapter covering the use of tungsten, tantalum, molybdenum, niobium and their alloys.

It is indeed a prize book — a book of reference — a book of daily use — an authoritative publication well produced and excellently presented. Undoubtedly it will find a place in all the international libraries, engineers' shelves and research bureaux each one engaged in contributing to a mighty effort to produce still better refractory alloys in this modern jet age conforming to rigid standards of performance and service requirements.

The editor of this publication is to be complimented for having brought an unlimited field covering the science and technology of refractory metals in one publication, the benefits of which will be ever lasting and would be spread far and wide by technical research and development and industrial organizations of the world over. The get-up of the publication, printing and reproduction are flawless.

B. R. NIJHAWAN

THE THEORY OF RECYCLE PROCESS IN CHEMICAL ENGINEERING by M. F. Nagiev; translated from the Russian by R. Hardbottle; translation edited by R. M. Nedderman (Pergamon Press Ltd, Oxford), 1964. Pp. xvi+278. Price £ 5

The extent to which a chemical process can be carried out is limited by thermodynamic and kinetic considerations. These limitations can be overcome by the use of recycling, thus enabling almost complete utilization of raw materials to finished products. The theory of recycling is not limited to any particular unit in a plant but can be adopted to an entire plant. The coordinated performance of the individual units comprising a plant can be described mathematically by the theory of recycling, and optimum plant layout and conditions can be determined. Prof. Nagiev in his book has presented the entire theory of recycling processes in chemical engineering in a logical sequence and has treated the subject in a very rigorous manner. Equations have been derived which cover a variety of operations. The use of recycling, together with a knowledge of the kinetics of the chemical reactions involved, so necessary in the determination of optimum reactor size, has been clearly explained.

The different aspects of recycling, some of which have been cited above, have been covered in the book in seven chapters. Each chapter has several well-defined sections. Although the theory of recycling can be used in almost any chemical engineering operation, it appears that the book considers largely the application of this principle to the optimum design of chemical reactors.

Although the use of recycling is implicit in many designs, Prof. Nagiev's book is perhaps the first attempt to treat this subject separately. The chemical engineer is now in a position to examine the utility of recycling operations and to use the several equations derived by Prof. Nagiev. Except for the simplest of reactions, it seems necessary to employ electronic computers to calculate the steady state parameters involved. Worked out examples, such as propylene hydrochlorination, butane dehydrogenation and propane dehydrogenation, add greatly to the value of this excellent treatise. This reviewer has no hesitation in recommending this book to students of chemical engineering as well as those who are actively engaged in the practice of this profession.

L. K. DORAISWAMY

LIGHTING PROBLEMS IN HIGHWAY TRAFFIC edited by Erik Inglestam (Pergamon Press Ltd, Oxford), 1963. Pp. 151. Price 70s.

This volume contains the proceedings of a symposium held at the Wenner-Gren Centre, Stockholm, in October 1962, organized by the Swedish Council for Road Safety Research. Some of the subjects covered are glare effect from the standpoint of physiological optics, research and visual problems in night driving, adaptation time after glare, and how polarized headlighting might be introduced. Along with the papers read are also included the discussions that followed. These discussions have revealed some very useful information.

Discussing Arnulf's paper on 'Visual problems in night driving', Prof. Schöber explained the Bavarian new law which requires that all applicants for driver's licences should have a visual screening by a special apparatus constructed by the Institute of Medical Optics and used by the Technische Uberwachungsdienst engineers. The discussions revealed also the necessity of adopting a uniform level of luminance for headlights and parking lights which varies very largely in European countries.

Van Zwet commented on a typical good road lighting installation and also described a portable luminance meter for testing street lighting installations.

Jehu, Ingelstam and Kjellburg in their papers discussed problems and their findings with polarized headlights. Jehu suggested the possibility of gradual adoption of polarized headlighting, starting with polarization of lower passing beams only.

Prof. Wright in his paper pointed out the need for more work on subjective brightness and contrast scales which, as applied to street lighting problems, is being carried out in his laboratories.

Most of the papers read were concerned with vehicle lighting in relation to glare and seeing distances. Since fixed road lighting to produce adequate seeing conditions at night is equally important, the benefits of this symposium would have been greater, if this aspect had also been discussed in more detail.

Some of the papers have been presented in languages other than English. Nevertheless, a commendable effort has been made to bring out the proper translations though at places some concentration is needed for understanding especially by those who are familiar with English only. Also a coordinated effort should have been made to adopt the international vocabulary of CIE thus avoiding the ambiguous usage of, e.g., 'glare'; physical, physiological and psychological; absolute, relative or adaptive; disability or discomfort.

The book will be of great interest to those interested in physiological optics and the lighting, automobile and highway construction industries.

K. S. SARMA

EFFECT OF IONIZING RADIATION ON THE REPRODUCTIVE SYSTEM edited by William D. Carlson &

F. X. Cassner (Pergamon Press Ltd, Oxford), 1964. Pp. xii+478. Price £ 5

This book is a collection of papers presented at an international symposium held in 1962 at the Colorado State University and was supported by US Atomic Energy Commission. The importance of research on the effect of ionizing radiation on the reproductive system and the growing knowledge in this area necessitated the convening of a special symposium.

The effect of ionizing radiation has been implicated in a large number of problems. For a long time interest and concern has been expressed about possible damage to reproductive capacities and especially male sexual competence when personnel are exposed to substantial amounts of radiations. Further, the dangers of an atomic explosion and the possible continuous exposure of human populations to low doses of radiation warrants the study of this important field and makes it quite imperative and useful. On the other hand, it has been known that many men and women have only marginal fertility and information has been lacking concerning the levels of environmental radiation required to change a substantial number of individuals from fertile to infertile categories in both human and domestic animal populations. At the same time, question on which attention has been drawn in the past is the effect of ionizing radiation on parental instincts and sex drive and the problem of fertility control. Besides the above, there has been the question of gamete and zygote banks. Since artificial insemination is now highly developed using both fresh and stored semen for the development and maintenance of high quality breeds of domestic animals, the possibility has been put forth to store ova and even zygote for future use. Because of the fears of genetic damage in case of nuclear war that could affect the quality of germplasm, some people have advocated storage banks for crop seeds and for gametes and zygotes of domestic and wild animals and even man. Among other things these are only some of the large number of problems which have been commonly posed.

The symposium at Colorado, on which the book under review is based, discussed many of the problems mentioned above and numerous other aspects of reproduction which are affected by ionizing radiations. The book is divided into four sections. Sections I and IV deal with general and related aspects of the effect of ionizing radiation on the reproductive system, while Sections II and III are exclusively devoted to the effect in the male and the female respectively. Each section contains a series of papers. All the sections conclude with panel discussion in which distinguished contributors participated. Among the eight very informative papers in Section I may be mentioned a paper by Janice Stadler and John Gowen which is of great interest. The authors have studied the effects of continuous irradiation over ten generations on reproductivities of different strains of mice. This is followed by a set of very interesting papers on the effect of ionizing radiation on reproduction in the male. Each paper in this section deals with an effect of radiation on certain aspects of testicular function or male reproduction in general. Two papers in this section on the rate of spermatogenesis and mechanism of fertilization may be pointed out for their novel approach. The third section dealing with female reproduction contains eight very informative papers. In this set the last three papers (Glasser, Anderson and Diczfalusy *et al.*), dealing with placental dysfunction, syndromes affecting reproduction and the influence of ovarian irradiation on urinary estrogens, give a lot of new information and data on these points. In the last section, the banquet address on ' Cancer induced by single doses of irradiations ' by Charles Huggins is very interesting to read. Lastly, Paul Henshaw has summarized the proceedings of the symposium in which he has concluded that the changes in reproductive functions induced by ionizing radiation are in no way different from changes that occur spontaneously or changes induced by other kinds of agents. However, some degree of hazard is involved whatever be the exposure and the amount of hazard increases with dose on exposure.

The symposium proceedings, particularly the panel discussions, have been carefully recorded. There are hardly few printing mistakes. The book forms a most valuable reference text for all universities or other educational institutions of comparable academic standard engaged in courses or research in the field of radiation biology or nuclear science. It will be found extremely useful to those engaged in research in radiation biology, reproduction and endocrinology.

K. R. LAUMAS

COMPARATIVE NEUROCHEMISTRY — Proceedings of the Fifth International Neurochemical Symposium, St Wolfgang, Austria; edited by D. Richter (Pergamon Press Ltd, Oxford), 1964. Pp. xi+491. Price £ 5

The recognition of species differences in metabolic pathways and body constituents is on the increasing abundance in literature. Of particular importance is the recognition of the fact that the central nervous system of different species of animals may differ in their neurochemical mechanism. This book which contains the proceedings of the Fifth International Neurochemical Symposium held at St Wolfgang, Austria, deals with the integrated data derived from various fields on the nervous mechanisms in various animal species. The data include, in addition to the general aspects of structure, chemical composition, metabolism and drug action in different species, also studies on the enzyme distribution and behavioural patterns.

The book is divided into seven sections. The first section deals with the structural aspects of brain and its relationship to the functional organization in the nervous system in different species. The second section deals with the distribution and metabolism of proteins, lipids, lipoproteins and ribonucleic acid in the nervous system of different species. The third section describes the aspects of amino acid metabolism, the distribution of amino acids including N-acetyl-aspartic acid and the uptake of amino acids by brain in various species. In Section IV, carbohydrate metabolism and consideration of energy production in several species are included. The distribution studies of ions, considerations on the blood brain barrier system and effect of β-irradiation form part of this section. Section V deals with neurosecretion,

the distribution of neurohypophysial peptide hormones and hormonal control mechanisms. The main theme of Section VI is the action of transmitter substances with special emphasis on the distribution and metabolism of acetylcholine, 5-hydroxytryptamine and catecholamines in the brains of various species. The last section gives an account of the pharmacological action of drugs on the nervous system of various species and the differences in the response to these drugs by different species.

The book is profusely illustrated and has an excellent get-up. This book will be very useful not only to biochemists, pharmacologists and physiologists but also to research workers in the field of comparative biochemistry.

B. K. BACHHAWAT

OSMOTIC AND IONIC REGULATION IN ANIMALS — International Series of Monographs on Pure & Applied Biology, Vol. 19, by W. T. W. Potts & Gwyneth Parry (Pergamon Press Ltd, Oxford), 1964. Pp. xiii+423. Price 60s.

Claude Bernard (1878), to whom we owe the oftenquoted aphorism in physiology — " La fixité due milieu intérieur est la condition de la bie libre " — was the first biologist to realize that the internal environment of an organism is not merely something produced in metabolism but also a kind of medium in which activities of the tissues can be regulated. The full significance of this regulation came to be appreciated only much later, when Walter Cannon (1932) spoke of the ' Wisdom of the body ' and gave currency to what is now an important central concept in biology, ' *homoeostasis* '. This concept has an abstract, theoretical foundation. The physiologist, however, arrives at this concept as an induction of a great number of empirical facts, and adopts the ideas of steady state, open system, feedback, etc.

The book under review illustrates this approach with reference to the physical and chemical equilibrium between the animal and its environment in relation to water and electrolytes. This is an aspect of homoeostasis which has received increasing attention not only in physiological but also in ecological studies during the last twenty-five years.

The pioneer publication on this subject is *Osmo regulation in animals* by Krogh, published in 1938. There have since been considerable advances in the investigation of osmoregulation and ionic regulation in animals. This progress has been greatly catalysed by the new techniques for microdeterminations of the electrolytes, and, as in many other fields, by the use of radioisotopes. The papers bearing on osmoregulation and ionic regulation have been numerous and scattered in various journals, and the publication of the present monograph is, therefore, very welcome. It summarizes a considerable volume of work, illustrated by select examples of diverse animal types. A commendable feature of the work is the special emphasis on biophysical basis of regulation in the treatment of the subject. An introductory chapter provides the foundation for appreciating the biophysical bearings of osmoregulation and ionic regulation.

A good account of the role of the excretory organs in osmoregulation is presented in the second chapter, and this is followed in subsequent chapters by accounts of ionic regulation in marine animals, osmotic regulation in brackish water, freshwater and terrestrial animals. The regulation of the salt concentration below that of the environment in sea and inland waters and the investigation of electrolytes in relation to respiration are dealt with in Chapters VII and VIII. The last chapter deals with the control of electrolyte metabolism. This is explained with reference to vertebrates on the analogy of a regulating system which includes a closed loop and is capable of recovering stability by rapid response to any misalignment.

The book does not claim to be comprehensive but is packed with a considerable number of details relating to over 250 different animal types and a bibliography of over 650 titles. The monograph is on the whole a very useful publication.

However, one would wish that the matter in the book had been presented in a more interesting and readable manner by a better ordered sequence and interrelation of the numerous facts in it. A critical appraisal of the present status of the subject, its future possibilities, and an evolutionary outline of the homoeostatic mechanisms in relation to salt and water balance, might have been included to add to the usefulness of the book. The book is practically free of typographical errors; however, on page 77, in the legend to Fig. II.10 — ' *Pontin* ' is evidently a misprint for ' *Pantin* ', and ' *homoeostasis* ' is not consistently spelt in the book. These are negligible and do not detract the value of the book as a mine of information on osmoregulation and ionic regulation in animals.

R. V. SESHAIYA

THIRST — Proceedings of the First International Symposium on Thirst in the Regulation of Body Water, Florida State University, May 1963; edited by Matthew J. Wayner (Pergamon Press Ltd, Oxford), 1964. Pp. viii+570. Price £ 7

The book is based on papers presented at the First International Symposium on Thirst in the Regulation of Body Water. Thirty papers presented were based on investigations on human subjects and on laboratory animals such as rats and dogs. The present concept on thirst in the regulation of body water, as revealed from the conference, may be summarized in the following lines.

The deficit in body water leads to diminished circulation through the salivary glands and as a result the quantity of salivary secretion is reduced. Buccal mucous membrane becomes dry giving a sensation of parchedness in the throat which results in the stimulation of the nerves. When the impulse reaches the brain we become aware that we are in the need of a drink and feel thirsty. There is no special organ to arouse thirst. But the peripheral mechanism does not always depend on water deficit. Patients with gastric fistula complain of thirst even if the fluid balance is maintained by intravenous transfusion. Subjects complain of thirst after ingestion of sweets or sugar solution. A person drinks less if the water is ice-cold as compared to water at room temperature. Intense thirst is induced by intravenous injection of hypertonic saline. The total drinking of water is

related to the drinking habit pattern. In many subjects it may be a desire for coffee or milk and not thirst which dictates the daily drinking pattern. Thirst can be quenched by introducing water directly into the stomach. The distension of the stomach with a balloon reduces the water intake in spite of water deficit. Gastric factors, therefore, are also important in the arousal of thirst. The defects in the peripheral mechanism lead to the possibility of a central regulation of thirst. Subjective sensation of thirst can be elicited by manual stimulation of the third ventricle; by the injection of hypertonic saline in the diencephalic blood supply; by the osmotic, electrical or cholinergic stimulation of the lateral hypothalamus; by the stimulation of subcommissural organ, a modified ependymal structure in the root of the cerebral aqueduct just ventral to the posterior commissure; and by the stimulation of the dorsal longitudinal fasciculus. The thirst centre might be situated in these structures which might contain osmoreceptors sensitive to osmotic pressure of the blood.

Contributions also related to water intake as regulated by drugs, hormones and arid conditions; adaptation to water deprivation; influence of restricted water intake on food intake and random activity, etc.

In spite of all the presentations, the physiology of thirst in the regulation of body water has still to be elucidated. The articles are well presented and discussions at the end of each article are thought-provoking. Research workers interested in this field will find new ideas for future work. The book is recommended for teachers of physiology and applied psychology.

SACHCHIDANANDA BANERJEE

PLANT METABOLISM by H. E. Street (Pergamon Press Ltd, Oxford), 1963. Pp. ix+238. Price 30*s*.

Since the last two decades the science of biology has seen many important discoveries which have rapidly changed the age-old concepts of biological thought. The accelerated pace of research aided by new instruments and techniques has imparted to biology a new character. A complete and popular presentation of this dynamic growing science is a difficult task and Prof. Street has achieved this in his admirable book.

The book has been divided into nine well-written chapters. The various metabolic activities have been grouped under the following heads: (i) Cell structure and function, starts with the enunciation of cell theory by Robert Hook (1665) and covers the great strides that have been made to arrive at the modern concept of cell structure, as observed under the electron microscope; (ii) Enzymes — The catalysts of metabolism, deals with the chemical nature and functional aspects of enzymes; (iii) Catabolism, deals with the energy yielding process; (iv) Anabolism, deals with the energy conserving, biosynthesis of carbohydrate, fat and protein; (v) Absorption, secretion and translocation, the absorption of salts and the linkage of metabolism with salt absorption have been discussed in a simple and interesting manner; (vi) The regulation of metabolism; (vii) Growth and differentiation; and (viii) A further dimension, the inclusion of this chapter, a novel feature, in this book points out the importance of interdisciplinary nature of modern biology.

Throughout the book the author has rightly stressed that, in order to understand the basic biological phenomena, the biologists of today must be familiar with the latest developments in physics and chemistry.

The presentation of the book is excellent. It is a short, well-written and illustrated book. It should provide a valuable text for the undergraduate and graduate students in plant physiology.

K. SATYANARAYANA

READINGS IN PHARMACOLOGY by B. Holmstedt & G. Liljestrand (Pergamon Press Ltd, Oxford), 1963. Pp. x+395. Price 50*s*.

To understand and appreciate the progress in science, there is no better method than studying the biographies of the notable scientists. A vivid picture of the scientific climate of the times, the odds — superstitious, religious and cultural thoughts of the day — against which the men of science had to contend, can be understood only by a perusal of their writings.

Pharmacology in particular had to face and overcome the beliefs and the empirical methods of treatment of diseases. In this process, pharmacology has undergone a remarkable evolution. While utilizing the significant discoveries of other scientific disciplines for its progress, pharmacology has at the same time influenced physiology, chemistry, biochemistry and other branches of medicine.

The present volume attempts at bringing into focus the personalities who influenced the growth of pharmacology from the ancient to the modern times and their teachings. By presenting a brief life sketch followed by excerpts from their significant writings, the authors have successfully traced the 'sequential progress' of pharmacology in general and also of some specialized fields like autonomic nervous system, psychopharmacology and chemotherapy. The topics covered include anaesthetics, technical advances, chemical aspects and toxicology.

The volume makes a delightful reading and is the equivalent of an anthology of outstanding achievements in literature.

M. SIRSI

QUALITY IN TRANSLATION — Proceedings of the International Congress on Translation; edited by E. Cary & R. W. Jumpelt (Pergamon Press Ltd, Oxford), 1963. Pp. xiii+544. Price £ 10

It is in the fitness of things that the Pergamon Press, which since the last few years has launched upon an extensive programme of translations of science books and journals, particularly from Russian and Slavonic languages into English, as well as of compilation of multilingual technical dictionaries, should have undertaken the publication of the proceedings of the Third Congress of the International Federation of Translations (FIT) held at Bad Godesberg in 1959. In keeping with the tradition of this eminent publishing house, the volume has been presented, got-up and printed in a manner that leaves nothing to be desired.

The book begins with a preface written by P. F. Caille outlining the genesis and the development of the FIT. It dwells on the aims and objects of the

FIT, the constitution of which is reproduced in full at the end of the book. Its deep understanding of the translation climate in India and its genuine desire to help Indian translators to unite and surmount their special difficulties find a sincere expression in the preface. In this connection, mention must be made of the Indian Scientific Translators Association, which would never have come into being but for the encouragement and support given at every step by the FIT.

The papers presented at the conference have been grouped into two sections, depending on whether they have a bearing on literary or technical translation. But whether it is literary translation or technical translation that is under discussion, accent is always and invariably placed on quality — that subtle entity which eludes a precise definition. For confining the discussion on literary translating within well-defined limits, the organizers of the conference had circulated beforehand a questionnaire to prominent translators, writers, universities, critics, etc., in various countries and the replies received were placed before the meeting of literary translators. From India nine persons replied to the questionnaire, among whom we find the names of Humayun Kabir, Prabhakar Machwe and C. P. Ramaswami Aiyar.

In the science section, in addition to the question of quality, several other problems such as terminological aspect in science translation, training of translators, mechanical translation, etc., have been dealt with. Scientific and technical translations have attracted considerable attention during the past decade, for the literature of science is growing so rapidly that in most countries the problem of making it accessible through translation has become unusually acute. In view of the importance which the technical translation has assumed today, it is not surprising that a substantial part of the proceedings has been taken up by the exposition of problems encountered in it.

The value and importance of this book to a professional translator cannot, of course, be over emphasized. But even to the general reader, who is more often than not inclined to think that anybody can produce a translation, this book would come as a revelation, inasmuch as it would give him an insight into the formidable task with which a translator is confronted and the arduous training to which a writer has to subject himself before he can enter this profession.

M. S. DANDEKAR

PUBLICATIONS RECEIVED

SOME PROBLEMS OF PLASTIC DEFORMATION OF METALS AT HIGH PRESSURES edited by W. J. McG. Tegart; translated from the Russian by V. M. Newton (Pergamon Press Ltd, Oxford), 1963. Pp. xi+79. Price 35*s*.

THE SCATTERING OF ELECTROMAGNETIC WAVES FROM ROUGH SURFACES by Petr. Beckman & André Spizzichino (Pergamon Press Ltd, Oxford), 1963. Pp. viii+503. Price £ 5 5*s*.

ELECTROMAGNETIC SCATTERING edited by Milton Kerker (Pergamon Press Ltd, Oxford), 1963. Pp. xii+592. Price £ 7

ADVANCES IN FLUORINE RESEARCH AND DENTAL CARIES PREVENTION: Vol. 2, edited by J. L. Hardwick, J. P. Dustin & Han R. Held (Pergamon Press Ltd, Oxford), 1964. Pp. viii+218. Price 120*s*.

SCIENCE AND TECHNOLOGY FOR DEVELOPMENT — AGRICULTURE (United Nations, New York), 1963. Pp. viii+309. Price $ 8.00 (cloth)

ADVANCES IN ANALYTICAL CHEMISTRY AND INSTRUMENTATION edited by Charles N. Reilley (Interscience Publishers Inc., New York), 1964. Pp. vii+523. Price $ 15.00

ECONOMIC SURVEY OF ASIA AND FAR EAST 1963 (United Nations, New York), 1964. Pp. ix+238. Price $ 3.00

PROCEEDINGS OF THE FIFTH REGIONAL CONFERENCE ON WATER RESOURCES DEVELOPMENT IN ASIA AND FAR EAST (United Nations, New York), 1963. Pp. vii+208. Price $ 2.50

SYMPOSIUM ON PHYTOCHEMISTRY edited by H. R. Arthur (Hong Kong University Press, Hong Kong), 1964. Pp. xiv+256. Price HK $ 50

FUNCTION OF A COMPLEX VARIABLE AND SOME OF THEIR APPLICATIONS: Vol. 1, by B. A. Fuchs & B. V. Shabat (Pergamon Press Ltd, Oxford), 1964. Pp. xvi+431. Price 70*s*.

HISTOPHYSIOLOGY OF SYNAPSES AND NEUROSECRETION by E. de Robertis (Pergamon Press Ltd, Oxford), 1964. Pp. xiii+244. Price 70*s*.

ADVANCES IN MACHINE TOOL DESIGN AND RESEARCH edited by S. A. Tobias & F. Koenigsberger (Pergamon Press Ltd, Oxford), 1964. Pp. vi+500. Price £ 8

MICROPOWER ELECTRONICS edited by Edward Keonjian (Pergamon Press Ltd, Oxford), 1964. Pp. vii+216. Price 84*s*.

MAGNETIC AND ELECTRIC SUSPENSIONS by P. J. Geary (British Scientific Instrument Research Association, Chislehurst, Kent), 1964. Pp. 170. Price 50*s*.

MECHANISMS FOR THE GENERATION OF PLANE CURVES by I. I. Artobolevskii; translated from the Russian by R. D. Wells (Pergamon Press Ltd, Oxford), 1964. Pp. xv+278. Price 84*s*.

THE MECHANICS OF AEROSOLS by N. A. Fuchs; translated from the Russian by R. E. Daisley & Marina Fuchs (Pergamon Press Ltd, Oxford), 1964. Pp. xiv+408. Price £ 6

STRUCTURE ANALYSIS BY ELECTRON DIFFRACTION by B. K. Vainshtein; translated from the Russian by E. Feigl & J. A. Spink (Pergamon Press Ltd, Oxford), 1964. Pp. ix+420. Price £ 5

ADVANCES IN WATER POLLUTION RESEARCH: Vol. 1 edited by A. Southgate; Vol. 2 edited by W. W. Eckenfelder; and Vol. 3 edited by E. A. Pearson (Pergamon Press Ltd, Oxford), 1964. Pp. Vol. 1, xiii+341; Vol. 2, vi+578; Vol. 3, vi+437. Price £ 15 each

MANUAL OF EXPERIMENTAL ELECTROPHYSIOLOGY by I. C. Whitfield (Pergamon Press Ltd, Oxford), 1964. Pp. vii+137. Price 40*s*.

MECHANICS OF AUTOMOBILES by H. E. Barnacle (Pergamon Press Ltd, Oxford), 1964. Pp. x+250. Price 35*s*.

ATMOSPHERIC POLLUTION by A. R. Meethan, D. W. Bottom & S. Clayton (Pergamon Press Ltd, Oxford), 1964. Pp. xii+301. Price 70*s*.

NOTES & NEWS

Raman maser action with acoustic waves

Stimulated Brillouin scattering of an intense maser beam, involving coherent amplification of a hypersonic lattice vibration and a scattered light wave, has been detected in quartz and sapphire [*Phys. Rev. Lett.*, **12** (1964), 592]. The process is analogous to Raman maser action, but with molecular vibration replaced by an acoustic wave of frequency *c.* 3×10^{10} c/s. (due to lattice vibrations) and with both the acoustic and scattered light waves emitted in specific directions.

In this phenomenon either compressional or shear waves can be excited, but for a compressional wave the coupling between acoustic and optical waves is simplest and describable as electrostriction. Electrostrictive pressure is given by $p=(E^2/8\pi)\rho(d\epsilon/d\rho)=(E^2B/8)d\epsilon/d\rho$, where E is the electric field, ρ the density of material, ϵ the dielectric constant and B the bulk modulus. These two optical waves whose frequencies differ by ω_s can drive a pressure wave of this frequency, due to quadratic dependence of pressure on E and the consequent generation of a beat frequency. Similarly, a pressure wave of frequency ω_s couples to an electromagnetic wave E through the varying induced dipole moment density $(E/4\pi)(d\epsilon/d\rho)_\rho$. When the radiation is contained in a resonant cavity, analysis of the conditions for the build-up of the acoustic and scattered waves shows that coherent scattering of radiation of frequency $(\omega_o-\omega_s)$ occurs in the direction making an angle θ with the direction of light, given by $\omega_s=2\omega_o(vn/c)\sin\theta/2$, where v is the velocity of the acoustic wave of frequency ω_s, and n the refractive index.

In the experimental set-up for detecting these scattered radiations an intense 6940 A. giant pulse (50 MW in 30 nsec.) ruby maser beam was focused inside the quartz crystal and the backward scattering radiation was studied with the help of two Fabry Perot interferometers using mirrors of reflectivities 1 and 0·1. A comparison of the two interferograms photographed simultaneously with a single maser pulse distinguished clearly between radiation coming from the ruby and that scattered directly backward from the sample. In the light back-scattered from the sample the original ring due to the maser wavelength was accompanied by an inner ring of comparable intensity which was evidently the amplified Brillouin scattering. Measurement of the shift corresponded to an acoustic wave frequency of *c.* 3×10^{10} c/s.

A simple theory for explaining solar winds

A new theory which explains the origin of solar winds as due to the evaporation of the solar corona has been postulated by Dr Hari K. Sen, a research scientist at OAR's Airforce Cambridge Research Laboratories. Intensities and speed of the solar wind at different distances from the sun have been measured by several artificial satellites. Even though the attempts to examine the origin of solar wind have shown that these winds consist of electrons and protons that escape from the solar corona, hitherto no commonly acceptable model of physical processes explaining the measured velocities and densities of the electrons in interplanetary space has been developed. Dr Sen's theory is based on the postulate that electrons and protons boil off from the solar corona (a phenomenon similar to liquid evaporation), and that at a critical altitude in solar corona electrostatic forces balance the solar gravity, resulting in protons that are effectively weightless. The mathematical formulation of Sen's theory incorporates formulae of other workers in related fields, one of these in particular being the Jeans' formula for the escape of gases from planetary atmospheres. The critical altitude for escape of the protons has been evaluated to be about 4 solar radii. Values of electron densities and velocity of the solar wind evaluated on the basis of the theory have been found to agree in the order of magnitude with the data observed in artificial satellite studies [*J. Franklin Inst.*, **277** (1964), 621].

Ni-Fe films: A new type of magnetic domain structure

A new type of domain structure composed of stripe domains running parallel to field previously applied to the films has been found in evaporated Ni-rich polycrystalline films of Ni-Fe, during investigations on anomalous magnetic properties of these films, conducted at Hitachi Central Research Laboratory, Tokyo. The new domain structure observed in Ni-Fe films of Ni composition 75-100 per cent and thickness 500-10,000 A. deposited on cover glass substrates by vacuum deposition is quite different from those earlier reported and is found to be responsible for rotatable anisotropy. This type of domain structure has been analysed to be caused by the anisotropy whose easy axis is normal to the plane of the film, the origin of which is attributed to the magnetostrictive effect due to stains or defects in the film. The width of the domain has been found to increase with the thickness of the film and the formation of the domains takes place at film thicknesses exceeding a critical value which increases with the rise in the substrate temperature and with decrease in the Ni concentration [*J. phys. Soc. Japan*, **19** (1964), 1116].

A new method of producing sawtooth waves

A new method of producing sawtooth waves using a pair of transistors, one n-p-n and the other p-n-p, has been developed at the Institute of Radio Physics & Electronics, University College of Science and Technology, Calcutta. Sawtooth waveforms having a high degree of linearity are required for a variety of purposes in electronic circuit applications and the standard methods for production of such linear waveforms, viz. Miller integrator and the bootstrap

circuit, fail to preserve a good linearity of waveform in the presence of loading or a waveform having a reverse curvature. The new method not only gives a linearity approaching that obtainable with any of the above circuits, but is also able to preserve the linearity even in the presence of resistive loading. An additional feature of this method is that it permits one to obtain a waveform having a reverse curvature that can be adjusted smoothly to any assigned degree. In the new method, a condenser and resistance in parallel, along with the admittance arising out of a transistor, form the section charging the other transistor. A controllable feedback arrangement is provided in the circuit. A theoretical analysis of the circuit shows that by suitable choice of the parameters a sawtooth waveform with a linear sweep can be obtained. Further by controlling the feedback, it is possible to obtain all the three types of waveforms, viz. uncompensated, critical compensated and overcompensated.

Experimentally observed waveforms have been found to correspond closely to the waveforms predicted by theoretical deductions [*Indian J. Phys.*, **38** (1964), 250].

Dew point determination: A new method

A new method of determining dew point, making use of a radioactive α particle source for detection of the formation of dew, has been reported [*Sci. Pap., Inst. phys. chem. Res. Tokyo*, **57** (1963), 169]. The method is based on the principle that the absorption of particles by the deposited dew weakens the ionization current. A disk, on the surface of which the dew is to deposit, is electroplated with a radioactive α particle source and an ionization chamber measures the ionization current. The intensity of the ionization current and the surface temperature of the disk are recorded against time. The temperature at which the current undergoes a rapid decrease as the temperature is lowered from room temperature, and the temperature at which the current becomes minimum as the temperature is increased from a low value, are both nearly equal and correspond to the correct dew point. This method is free from errors that arise from supersaturation of water vapour and incidental rise of disk temperature inherent in the mirror type hygrometer that necessitates illumination. Experimental tests on the performance of the instrument made in an air-conditioned room, the temperature and humidity in which can be regulated, have shown that the new instrument gives precise values of the dew point.

New electric flux pump

A major obstacle to the construction of supermagnets producing fields of 100,000 gauss and above has been overcome by the development of a unique power supply system at the General Electric Co. The new device known as the electric flux pump can convert modest a.c. input into a large d.c. output.

In supermagnets the coils are made of superconducting wire and are powered by a few hundred amperes of d.c. These large values of d.c. being fed into the coil through thick conductors of ordinary wire allow considerable heat leak to the low temperature equipment in which the superconductors operate. This heat leak problem has been solved by the new power supply device, which operates without moving parts in the supercold region (*c.* 4·2°K.). The operation at such a low temperature is a unique feature of the new device since ordinary rectifiers do not function at low temperatures. The heart of the electric flux pump is a transformer wound with superconducting wire and connected through special superconducting switches known as 'reactor cryotrons' which can carry currents of the order of several thousand amperes. As the a.c. is fed into the transformer, the reactor cyclotrons are opened and closed in synchronism with the voltage swings. As a result the d.c. through the coil increases in a series of steps, each of the two reactor cryotrons carrying the current on alternate half cycles. If the voltage into the system is cut off, a permanent current continues to flow through the magnet coil. By proper phase control of the reactor cryotrons energy can also be pumped out.

In experiments with a laboratory model of the new power supply an a.c. input of less than 1 amp. was converted into a d.c. output of 500 amp. Ultimately, it is expected that the new device of the size of a man's fist would be able to generate a d.c. of several thousand amperes, to produce which conventional d.c. sources will be at least of the size of an office desk [*Mech. Engng*, **86** (No. 7) (1964), 66].

Bonding metals with explosives

A remarkable technique of bonding metals using explosives, developed at the E. I. du Pont de Nemours & Co., Wilmington, Delaware, opens up new vistas in the use of explosives as a versatile industrial tool. In this technique, a 2 in. thick sheet of carbon steel is covered with a $\frac{1}{4}$ in. thick sheet of stainless steel and triggered with a high explosive charge. The resulting explosion drives the stainless and carbon steels together into a uniform, permanently clad plate that can easily be fabricated. The metals' individual properties are unchanged by the impact and their bond is as strong as one formed by conventional welding. It is pointed out that the force of the detonating explosive momentarily creates a thin zone of melted metal between the carbon steel base plate and the stainless steel skin resulting in the effective welding of the two metals.

Normally methods of cladding metals require elaborate preparation, the use of intermediate chemicals and materials, electrolytic processes, heat or other conventional procedures and hence are time-consuming and costly. There appears to be no doubt regarding the commercial value of this new explosives metal-bonding process, because of several advantages in addition to the reduction in time consumed. The method has also been extended to the production of steel plates with claddings of several metals and alloys. A most rigorous laboratory testing programme which included inspection of the bonding by ultrasonic, hardness, corrosion tests, etc., has proved the

high quality of the bonded materials. It is claimed that explosive bonded plates can be cut and trimmed by shearing, sawing, flame cutting, abrasive wheel or plasma arc cutting, etc. In addition they can be formed by both hot and cold shop methods, including rolling, pressing and flanging without bond separation [*Nature, Lond.*, **202** (1964), 860].

Conversion of thorium to fissionable uranium

The successful isolation of protactinium-233, an important intermediate isotope in the thorium-uranium fuel chain, by the scientists of Phillips Petroleum Co. at the US National Reactor Testing Station, in sufficiently large quantity (1 g.) to enable measurement of its neutron absorbing properties, is expected to open the way for large-scale use of the abundant but non-fissionable thorium in the preparation of nuclear fuel. The method followed for preparing protactinium consisted in irradiating metallic thorium in the highest available neutron flux, as a result of which 1 per cent of thorium was converted to protactinium; significant quantities of uranium-233 and fission products were also produced and separation of the isotope was performed through a series of complicated chemical separations and purifications. The final product, in oxide form, was a very finely divided snow-white powder, which glowed in the dark. It has been mixed with aluminium powder and compacted into a solid sample for further study [*J. Franklin Inst.*, **277** (1964), 506].

Existence of Ag (III)

Until recently it was believed that AgO was a true oxide of Ag (II). Additional evidence has been gathered which shows that in the solid state AgO contains equimolecular amounts of Ag (I) and Ag (III). When AgO is dissolved in acid it gives Ag (II) ion, but this can be explained by the equilibrium $Ag\ (III)\ O^- + Ag\ (I)^+ + 2H^+ \rightleftharpoons 2Ag\ (II)^{2+} + H_2O$. Silver (III) arising from AgO has also been shown to exist in solution. In a reaction between AgO and KIO_3 in basic solution, the iodate is oxidized to periodate which then forms a complex compound with Ag (III). On adding NaOH a voluminous orange precipitate is formed. This compound is identical to one formed by oxidation of Ag (I) with $K_2S_2O_8$ in the presence of iodate. The overall reaction proposed for Ag (III) complex formation is as follows:

$$6AgO + 2H_2O + 8OH^- + 2IO_3^- \rightarrow 5Ag(OH_6)_2^- + Ag(IO_6)_2^{7-} + 2H^+$$

It is suggested that the first step involves oxidation of iodate to periodate by Ag (III). Additional Ag (III) then combines with the newly formed periodate.

The products obtained from Ag (I) or AgO are found to be triclinic crystals with one molecule per unit cell. Three absorption maxima with large extinction coefficients (indicative of charge transfer bands) occur at 3630 A. ($\epsilon = 13{,}000$), 2550 A. ($\epsilon = 15{,}000$), and 2150 A. ($\epsilon = 21{,}000$). Magnetic susceptibility studies show the compounds to be diamagnetic, which is consistent with the electronic structure of Ag (III), which has 8*d* electrons in its outer shell. The cell dimensions of Ag (III) complex agree closely with those for diperiodatocuprate (III), which has a square planar configuration, with the plane formed by one edge from each of the two periodate octahedra. The periodate acts as a bidendate, contributing to the stabilization of Ag (III) ion [*Chem. Engng News*, **42** (16) (1964), 52].

Direct injunction enthalpimetry (DIE)

A fast convenient method, DIE, for analysing submillimolar samples in very dilute solutions and useful in process control has been developed which involves fast injection of excess reagent followed by recording of the heat of the reaction, which can be either exothermic or endothermic. Unlike the currently used thermochemical analytical methods, which depend solely on equilibrium constants correlated logarithmically with free energies, the DIE solely depends on enthalpy of a reaction, which is an additive function of two stochastic reaction parameters: Enthalpy = $F + T\Delta S$. Since F and $T\Delta S$ are independent of each other, the enthalpimetric method may be workable when free energy methods fail.

The principle behind DIE is that under conditions of invariant heat capacity, the change in temperature in an adiabatic system represents a linear measure of the quantities undergoing reaction in a stoichiometric process. As an example, 300 µl. of a relatively concentrated (1*M*) reagent was injected rapidly into 25 ml. of a dilute (0·001-0·01*M*) unknown sample, and mixed in 0·1 sec. The corresponding temperature change was recorded as the unbalance potential of a thermistor bridge, yielding well-defined enthalpograms on a chart.

A noteworthy feature of DIE is that unstandardized reagents may be used. The reactions which have been used in thermochemical titrations, viz. acid-base, oxidation-reduction, precipitation, and complexation processes, using either aqueous or non-aqueous solvents, can be adapted to DIE [*Chem. Engng News*, **42** (16) (1964), 76].

A new electrode for hydrodynamic voltammetry

Very few electrodes are available for hydrodynamic voltammetry. The best defined methods for the hydrodynamic voltammetric analysis are based on the rotating wire electrode [Kolthoff, I. M. & Jordon, J., *J. Amer. chem. Soc.*, **76** (1954), 3843], conical electrode placed in the flowing stream [Jordon, J., Javik, R. A. & Ranz, W. E., *J. Amer. chem. Soc.*, **80** (1959), 3846], 'bypass' electrode [Muller, O. M., *J. Amer. chem. Soc.*, **69** (1947), 2992] and a 'string' electrode [Jordon, J., *Analyt. Chem.*, **27** (1955), 1708]. Blaedel *et al.* have described a new tubular platinum electrode (TPE) through which the solution flows and is of a very high sensitivity [*Analyt. Chem.*, **35** (1963), 2100].

This new electrode is of a great advantage for hydrodynamic electrochemical measurements. For its preparation, platinum cylinders are cut from seamless platinum tubing of various diameters, the ends being finished squarely and smoothly and sealed into soft glass tubing. This electrode is used in conjunction with a saturated calomel electrode for the study of diffusion plateau of the oxidation-reduction reactions. Constant potentials of the diffusion

plateau are applied to the TPE and the currents are measured with a Sargent Model XXI polarograph.

The diffusion current obtained is directly proportional to the concentration of the substance and the current with this electrode does not show the fluctuations that a dropping mercury electrode or rotating platinum electrode does. The plot of the current versus rate of flow is a straight line up to a flow rate of 10 ml./min. and above it there appears a break in the plot. The logarithmic plot between current and the length of the electrode gave straight line with a slope of 0·61 which is in good agreement with the theoretical value. The diffusion current is independent of the electrode radius.

Diffusion current constant is calculated and its values are quite constant indicating that it is independent of flow rate.

The principal advantage that accrues from the use of the TPE in a flowing solution is high sensitivity. A typical TPE can detect concentrations of electro-active substances below $10^{-8}M$ in streams of moderate velocity. Other advantages are simplicity of construction and reproducibility of measurements, under turbulent as well as laminar flow conditions.— A. L. J. RAO

Device for detection of polar vapours in gas chromatography

A new device to detect polar vapours, installed in gas chromatographic systems, enables discrimination between compounds by differences in polarity. The difference is measured by recording the change in contact potential caused by the physical adsorption and desorption of polar vapour on a nickel surface. The device has been used to investigate a variety of alcohols, ketones and nitro compounds.

The experimental detector cell consists of two circular plates. One is a 0·0005 in. disc of nickel foil that functions as the sensor plate and the other is a 0·002 in. disc of gold foil called the vibrating plate. The plates are separated from each other by a 0·010 in. mica spacer in such a way that vapour can be passed between them. The signal from the two plates goes to an oscilloscope. When polar vapours are adsorbed on the surface of a solid, they exchange the surface potential. This causes the contact potential of the solid to shift with respect to a less sensitive reference surface. The shift can be measured by a capacitor equipped into dissimilar plates. To cause a polar vapour to adsorb and then desorb on the nickel plate, the nickel is alternately heated and cooled. Heating is accomplished by a 6 V. battery, and cooling by precooled nitrogen flowing behind the plate. *n*-Butanol, acetone and nitromethane have been studied and the sensitivity of the detector has been found to be 10^{15} molecules/cc., flow rate 200 cc./min. and response time *c.* 3 sec. [*Chem. Engng News*, **42** (23) (1964), 59].

Reduction of carbonyl group to CH_2

A new method for the conversion of a carbonyl group to a CH_2 group consists in preparing the tosylhydrazone of the aldehyde or ketone followed by treatment of the tosylhydrazone with sodium borohydride. The use of lithium aluminium hydride instead of sodium borohydride also produces traces of unsaturated compounds and is, therefore, not quite satisfactory. The reaction with sodium borohydride is carried out in methanol or dioxane medium. Tosylhydrazones of cyclohexanone, cholestan-3-one, coprostan-3-one, 17β-acetoxy-5α-androstane-3-one, 3β-acetoxy-5α-cholestane-7-one, 3β-acetoxy-5α-androstane-17-one, 3β-acetoxy-5α-pregnane-20-one, α-tetralone, stearinaldehyde and lauraldehyde have been converted into the corresponding derivatives containing CH_2 group usually in yields of more than 70 per cent.

In a typical experiment, sodium borohydride (2 g.) is added to a solution of cholestanone tosylhydrazone (1 g.) in methanol (50 ml.) and the mixture refluxed for 8 hr. The resulting solution is worked up with ether-water mixture, the ethereal layer washed with water, sodium hydrogen carbonate, with water again, dried and evaporated. After crystallization from acetone-methanol, 570 mg. of cholestane are obtained [*Chem. & Ind.*, (1964), 153].

Aromatization of two rings in steroids

Steroids with aromatic A and B rings have been synthesized from non-aromatic steroid intermediates via an ionic method which eliminates the C-19 methyl group. Ionic methods have so far been used to aromatize a single ring in steroid compounds. The present method is simple, involves relatively mild conditions and provides a potentially easy way to prepare equilenin type steroids with a variety of ring and C-17 substituents. The aromatization reaction has been applied to a number of compounds, e.g. 21-acetoxy-9α, 11β-dichloro-17α-hydroxypregna-1,4-diene-3,20-dione with dimethylformamide or pyridine gives two major products, 21-acetoxy-17α-hydroxypregna-1,4,8(14),9(11)-tetraene-13,20-dione and 21-acetoxy-3,17α-dihydroxy-19-norpregna-1,3,5(10),6,8-pentaen-20-one, each in *c.* 25 per cent yield. Equilenin has been synthesized by refluxing 9α, 11β-dichloroandrosta-1,4-diene-3,17-dione in dimethylformamide.

The mechanism of the aromatization reaction involves attack by a halide ion. When a compound of the type 9α, 11β-dichloro-$\Delta^{1,4}$-3-one is refluxed in dimethylformamide or pyridine, the halide ion generated (eliminated from the 9α-position) probably attacks the C-19 methyl group; the attack is made easier by protonation of the C-3 oxygen. An allylic shift, elimination of halogen or an R group, and isomerization provide the double bonds necessary for the aromatization of ring B [*Chem. Engng News*, **42** (24) (1964), 42].

Photoisomerization of olefins

Contrary to the general rule that photoisomerization of olefins favours the less stable *cis* isomer, photolysis of difurylethylene and dithienylethylene at high concentration gives the more stable *trans* isomer. However, a concentration dependence of photostationary states is observed for the two systems studied, at concentrations ranging from $1M$ to $10^{-3}M$. A test case was provided by running an experiment in degassed benzene solution of *cis* and *trans* isomers of difuryl- and dithienylethylene at 30°C., using 275 W. sun lamp.

Composition at equilibrium was determined by capillary gas chromatography with a 150 ft silicon column. The percentage of *trans* isomer relative to *cis* increases markedly at high concentrations. Two competing mechanisms have been put forward to account for the dependence of photostationary states on concentration. The isomerization path for the *cis* to *trans* conversion involves vibrationally excited ground state molecules arising from the first excited singlet state via internal conversion. Competing with this mechanism is a series of reactions for the *trans* to *cis* conversion involving an electronically excited triplet intermediate. At high concentrations of olefin, quenching reactions interfere with the mechanism involving the electronically excited triplet state. Thus the singlet reaction predominates, reducing the *trans* to *cis* interconversion at these concentrations favouring *trans* isomer [*Chem. Engng News*, **42** (16) (1964), 43].

Photochemical behaviour of cross-conjugated cyclohexadienones

Cross-conjugated cyclohexadienones related to santonin display varied photochemical behaviour which might have numerous synthetic applications. Using substituent effects and variation in solvents and light sources, it is possible to direct the major course of light-initiated rearrangements of these compounds. For example, 2-methyldienone can be transformed under the appropriate choice of irradiation conditions to either a spiro-fused hydroxy ketone, a cyclopropyl ketone, or a linear conjugated dienone in a single operation and in good yield (50-70 per cent). On irradiation in acidic media the dienones are converted to hydroxy ketones. This type of reaction suggests that a number of different adducts can be formed by the attack of carbon, oxygen, or nitrogen nucleophiles on the dienones.

If there are no substituents on the A ring (other than oxygen) cleavage of the intermediate proceeds in two ways to give, stereospecifically, a spiro hydroxy ketone and a perhydroazulenone (5/7 fused hydroxy ketone) in approximately equal yields. However, methyl substituents at C-2 or C-4 exert an electronic influence which directs how the cyclopropyl intermediate is cleaved. Thus a 2-methyldienone gives almost exclusively the spiro product while a 4-methyldienone gives a perhydroazulenone product. The directive influence of the methyl substituent on cleavage of the intermediate's cyclopropyl ring (from 5-10 to the 1-10 bond) can be attributed either to an inductive effect (which would cause localization of the positive charge at the substituted position) or to hyperconjugative stabilization by the methyl group of the double bond during cleavage. The predominant product in each case is the one in which the methyl substituent is located on the newly formed double bond [*Chem. Engng News*, **42** (16) (1964), 50].

Progress Reports

Institute of Radio Physics & Electronics, University of Calcutta

The fourteenth annual report of the Institute of Radio Physics & Electronics has collected and presented in one volume the research papers published in various scientific journals during the period under review (1961-62). The research activities of the Institute have been confined to four areas, viz. ionospheric investigations, electronic circuitry, switching circuits, and servomechanisms. Experimental results of the variation of the total amount of ionization below the night-time F layer have been re-examined and it has been shown that it is not possible to discriminate between the two models proposed, viz. Titheridge's constant α-model and Mitra's time dependent α-model. However, it has been concluded that while Titheridge's model will possibly hold in the upper part of the region studied, Mitra's model will be valid near the bottom regions. A method of generation of diverse pulse-shaped functions by means of four-terminal networks which have equivalence to delay lines has been developed. The method can be applied for production of pulses of the form $\sin^n t$ and is free from the restrictions to be applied in the usual method of production of pulses using delay lines. A new method for the measurement of transfer function of both linear and non-linear physical systems has been devised. This method requires only components readily available and permits measurement of transfer gains and angles over a wide range of values. From a study of the non-disjunctive type decomposition of switching functions, two theorems on the decomposition of switching functions have been enunciated. These theorems will have applications in the design of multistage switching circuits. A systematic method of minimization of Boolean functions has been developed; this method yields all the minimal forms with comparatively few trials and also can be easily extended to obtain the minimal products sums. A grouping chart has been designed to aid in evaluating all the minimal forms of a Boolean function. By visual inspection of the chart, the terms of the original function which are related by one change of variable are readily determined and the chart can also be easily mechanized.

A systematic procedure applicable to all types of functions for finding out the group invariance or total symmetry of a switching function has been developed. As a result of studies made on the stabilization of feedback systems affected by hysteresis non-linearities, several non-linear compensation schemes have been suggested for improving the small-signal stability of such systems. Experimental studies on the applicability of these suggested schemes have shown that when the systems are stabilized according to these schemes, the response characteristic also shows some improvement.

The British Coal Utilization Research Association

The research activities reported in the annual report for the year 1963 of the British Coal Utilization Research Association (BCURA) have been well planned to conform to the main task of the association, viz. to improve and effect economy in the ways of burning coal and thus maintain the competitive value of coal as compared to other fuels. An extensive survey has been made of the behaviour of a wide range of coal types with

fusion characteristics of the ash, in an attempt to relate type of coal and ash composition with the formation of clinker and slag. It has been found that the slag formation is not related in any regular manner to the type of coal, ash fusion temperature or the ash composition. A vibrating grate has been tested to establish the best amplitude and frequency of vibration and how best to reduce grit emission and to obtain high burning rates. The results have been used to design a grate for installation in one of the economic boilers. Preliminary trials to measure the fundamental response characteristics of the shell boiler with varying heat impact have indicated the factors that influence the dynamic response in the boiler. These studies may eventually lead to the development of a model that would be helpful in boiler design studies generally. In the field of domestic heating the research programme was directed along four lines, viz. (i) to improve the amenities and performance of the conventional central heating boiler fixed with smokeless fuel, (ii) to devise a means of burning bituminous coal smokelessly in a central heating boiler, (iii) to design a reliable and cheap heat meter, and (iv) to obtain reliable information on the amount of smoke emitted from domestic appliances for a range of fuels. Studies directed to assess the corrosion due to deposits in water tube boilers have indicated that corrosion diminishes at metal temperatures above 700°C. and that there is a marked reduction in corrosion of the two alloy steels used, when the oxygen in the flux gases was reduced from 3·5 to 1·5 per cent.. Studies made on slagging gasification were directed to filling in the gaps in the knowledge of slag formation and behaviour and other aspects of the operation of the slagging in fixed-bed process. Laboratory tests have shown that when refractory mineral matter is dissolved in a slag, the apparent viscosity may attain a value several times that of the viscosity of the homogeneous slag that is finally formed. A programme of research on gasification has also been formulated by the three nationalized fuel industries. During the course of a research scheme on ' slagging properties of ashes of British coals ', the interrelation between the chemical composition of slags and their viscosities in the wholly liquid state has been studied. Two equations have been derived that give a good estimate of the viscosity from the composition based on the fire components of the slag, viz. SiO_2, Al_2O_3, CaO, MgO and Fe_2O_3. A programme in the field of basic studies of combustion and gasification was directed towards exploring the phenomena of preignition heating and devolatilization of pulverized fuel particles in the laminar flow furnaces. From these studies it is expected that it will be possible to formulate a reliable model of the various combustion processes and from this to predict the optimum combustion systems. The study of stress distribution in thin particles loaded in a model of a ring ball mill using photoelastic techniques showed that primary failure occurs along lines of maximum tensile strengths. With a view to elucidating the physical and chemical structure of coals and graphite, a research contract was placed with the association by the UK Atomic Energy Authority and the investigations so far made have complemented the research undertaken by the Atomic Energy Authority on corrosion of graphites in oxidizing gases at elevated temperatures.

Nobel Prize Awards, 1964

The Swedish Academy of Science has announced the award of Nobel Prizes for 1964 to the following scientists:

Physics — The prize for physics has been divided between two Russian scientists, Prof. Nikolai Basov and Prof. Alaxander Prochorov of the Lebedev Institute for Physics, Moscow, and an American scientist, Prof. Charles H. Townes of the Massachusetts Institute of Technology. They have been awarded the prize for their work in developing the intricate oscillators and amplifiers used in masers and lasers.

Chemistry — The prize for chemistry has been awarded to Prof. (Mrs) Crowfoot Hodgkin, Wolfson Research Professor of the Royal Society, London, and a Fellow of Sommerville College, for her determinations by X-ray techniques of the structures of important biochemical substances. Among the complex molecules whose structures were determined by her are vitamin B_{12} and penicillin.

Medicine — The prize for medicine has been jointly awarded to Prof. Konrad Emil Bloch of the Harvard University and Prof. Feodor Lynen, Head of Biochemistry, University of Munich and Director, Max-Planck-Institut fur Zellchemie, for their discoveries concerning the mechanism and regulation of cholesterol and fatty acid metabolism.

Announcement

▪ *The Indian Academy of Forensic Sciences* will award a cash prize of Rs 250 to the author of the best article published in any scientific journal in India on ' Forensic Science ' or ' Forensic Medicine '. Intending competitors should send three copies of their articles, mentioning the name of the journals in which they have been published, to Dr N. K. Iyengar, Secretary, Indian Academy of Forensic Sciences, 30 Gorachand Road, Calcutta 14, by 8 February 1965.

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The Regional Research Laboratory, Hyderabad, organized a symposium on low temperature carbonization of coal during 20-22 November 1961 in order to take stock of the results of the pilot plants and plan the future programme of investigations. A wide cross-section of research scientists, coal technologists and industrialists and representatives from several leading coal processing firms in UK, West Germany, and Japan took part in the deliberations.

The papers contributed to the symposium covering the two main heads, Briquetting of non-caking coal fines and Low temperature carbonization of non-caking coals and lignites, along with the discussions held during the symposium have been brought together in the present volume.

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The second volume of the symposium on low temperature carbonization of non-caking coals (l.t.c.) has been published. This volume contains papers and discussions on two sections: Utilization of products of low temperature carbonization, and Survey, economics and statistics of l.t.c. products. Of the total of 38 papers included, 32 relate to the utilization of products of l.t.c. and the rest to survey, economics and statistics of l.t.c. products.

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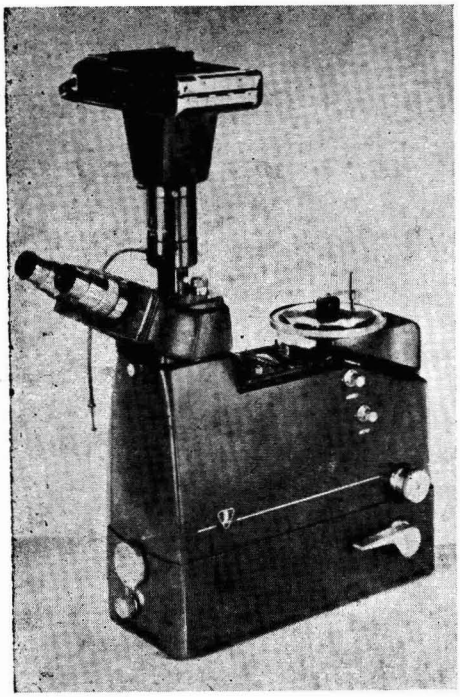

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