

Ithas", by Sri S. N. Sen, which was subsidized by the Government of Bengal, "Nuclear Induction", by Dr. A. K. Saha and Sri T. P. Das, and a monograph, "Non-aqueous Titration", by Dr. S. R. Palit, Dr. M. N. Das and Sri G. R. Somayajulu. Of the lectures given during the year, Prof. G. I. Finch, who was awarded the Association's Jay Kissen Mookerjee Gold Medal for 1950, delivered a course of three lectures on electron optics and study of surfaces, crystal growth in electro-deposition and in surface reactions, and polish, mechanical wear and lubrication; and another course of three lectures was given by Dr. J. N. Ray, as Coochbehar professor for 1949, on carbohydrate metabolism and the role of some plant nucleotides in the phosphorylation of glucose, curariform drugs and their action and anaesthetics. The Ripon professorship lecture for 1950 was delivered by Prof. T. R. Seshadri, who spoke on a line of investigation in the field of plant drugs and insecticides, and Dr. S. K. Banerjee, Dr. M. S. Krishnan and Dr. D. S. Kothari, the Ripon professors of the Association for the years 1948, 1949 and 1950, delivered lectures on, respectively, Himalayan earthquakes; ancient Indian iron ore and its manufacture, the iron ore deposits in India, and the modern iron industry in India and its future prospects; and recent advances in statistical thermodynamics. Dr. Dilip Kumar Banerjee was awarded the Sri John Wood Burn Medal for 1950 and gave a lecture on steroid synthesis. Dr. J. C. Ghosh, the retiring president of the Association, delivered the Memorial Lecture, speaking on the petroleum industry with special reference to India, this being the occasion of the fiftieth anniversary of the death of the late Dr. Mahendra Lal Sircar, the founder of the Association. A symposium on high polymers, including rubber, resins and plastics and fibre, was organized during the year by the Department of Physical Chemistry of the Association, and was followed by a very successful three-day summer course on the subject.

In his report, Prof. Ray gave a brief review of the work carried out in the six research departments of the Association during 1953-54. In the Department of General Physics, X-rays and Magnetism, studies were made on transport properties of matter, thermodynamics of irreversible processes, low-temperature physics, X-ray crystallography, study of low-angle scattering, X-ray study of coal, X-ray study of glass, crystal magnetism, cryogenics, and semiconductors. Investigations carried out in the Department of Optics have related to ultra-violet absorption spectra of organic substances in the solid state at low temperatures, Raman spectra of some organic compounds in the solid state at low temperatures, Raman spectra of organic compounds in the vapour state, Raman spectra of liquids and solutions, relaxation time of polar molecules in the liquid state, absorption of ultra-high-frequency radio waves by organic liquids, absorption of microwaves by organic liquids, and cosmic rays. In the Department of Theoretical Physics, investigations were carried out in meson field theories and nuclear scattering, Born approximation and its connexion with covariant perturbation theory, capture of electrons by ions passing through gases, cosmology, and nuclear shell structure model. The Physical Chemistry Department has conducted its research activities under two broad headings: high-polymer chemistry, and general physical chemistry. Under high-polymer chemistry some of the problems investigated relate

to chain transfer in vinyl polymerization, copolymerization, kinetics and chain transfer studies in polymerization initiated by hydrogen peroxide, vinyl polymerization with metallic soaps, kinetics and chain transfer studies with substituted peroxide and azonitriles, synthesis of hydro peroxides and their use in polymerization, polymerization in the aqueous phase, physico-chemical studies on cellulose compounds, polyelectrolytes, studies on reaction kinetics, fractionation and distribution of polymers. Kinetics of the decomposition of peroxides, studies in cosolvency, non-aqueous titration, alkalimetric determination of mercury, and measurements of dipole moment constituted some of the problems of study under general physical chemistry during the year. In the Department of Organic Chemistry, work was carried out in diterpenoids, dicyclic terpenes, steroids, polynuclear aromatic hydrocarbons and related subjects. The chemistry of co-ordination complexes and analytical chemistry were the two broad subjects for investigation by the research workers of the Department of Inorganic Chemistry.

The complete Council of the Association is as follows: *President*, Hon. Sri C. C. Biswas; *Vice-Presidents*, Prof. S. K. Mitra and Dr. K. S. Krishnan; *Director*, Prof. M. N. Saha; *Members*, Prof. N. R. Sen, Dr. Atmaram, Dr. B. C. Guha, Dr. Triguna Sen, Prof. P. C. Mahanti, Sri Ramani Mohan Roy, Dr. J. C. Ghosh, Dr. Hiralal Roy, Dr. B. B. Dey, Dr. S. R. Bose, Sri J. M. Sen and Dr. D. N. Wadia; *Trustee Member*, Hon. Mr. Justice R. P. Mookerjee; *Nominees of the National Institute of Sciences of India*, Dr. K. N. Bagchi and Prof. D. S. Kothari; *Nominees of the Government of India*, the Secretary of the Ministry of Natural Resources and Scientific Research (or his nominee), the Educational Adviser to the Government of India (or his nominee), Sri C. S. Menon, and the Joint Secretary to the Ministry of Finance, Government of India; *Nominee of the Government of West Bengal*, Dr. D. M. Sen; and *Professor Member*, Prof. B. N. Srivastava.

MELLON INSTITUTE, PITTSBURGH ANNUAL REPORT FOR 1953-54

THE annual report of the president of the Mellon Institute, Dr. E. R. Weidlein, to the Board of Trustees for the year ended February 28, 1954*, refers to growth in the size of fellowships in operation and an increase in comprehensive fundamental projects. Almost a quarter of the Institute's expenditure of 4,375,712 dollars was spent on investigations in pure science in the Institute's six research departments and on eleven fellowships, 131 members of the Institute being engaged in pure science research projects. 383 members were engaged in the sixty-five fellowships in applied science, and, of forty-nine multiple fellowships and twenty-seven individual fellowships listed as in operation during the year, two had been proceeding for forty years, five for thirty-five, one for thirty, ten for twenty years and twenty-five others for more than ten years.

In the Department of Chemical Physics the Raman spectrum of dicyanoacetylene has been redetermined on a larger sample, using a new grating in the Raman

* Scientific Research of Mellon Institute, 1953-1954. (Annual Report Series, No. 41.) Pp. iv + 56. (Pittsburgh: Mellon Institute of Industrial Research, 1954.)

spectrograph. The Raman-active fundamental postulated at 260 cm.^{-1} in earlier work has now been observed at 263 cm.^{-1} , and the vibrational spectrum of hexafluoro- Δ^2 -butyne has been interpreted in fairly complete detail. An extensive survey was made of the alkali metal content of calcite marbles by emission spectrographic analysis, and an earlier photographic technique for the study of the diffraction structure of carbon black has been replaced by a speedier and more accurate X-ray spectrometric method, in which the monochromatization of the X-ray beam is achieved through the low sensitivity of the argon-filled Geiger tube for the short wave-lengths of the white radiation, and a small residual correction made empirically. An improved quantitative method has been developed for measuring crystallinity in elastomers, and an instrument has been constructed for the precision measurement of linear distances on diffraction films.

In the Physical Chemistry Department the Mellon Institute digital computer was being built for a new Department of Applied Mathematics, and is of the low-speed magnetic drum type with large storage capacity. At the end of the year this Department was combined with the Department of Physical Measurements, which has been responsible for several advances in the application of thermal diffusion to the separation of organic liquids, and has recently modified the gas-adsorption apparatus so as to permit the use of krypton or argon-gas for surface-area measurements of materials with low area. In the Department of Instrumentation a method has been devised for the determination of humidity based on the titration of a concentrated solution of lithium bromide with water until the solution humidity balances the atmospheric humidity, and a preliminary study made of the electrical pulse transmission characteristics of sodium chloride solutions.

A programme of research on drug standards which has been continued for twenty-three years in the Department of Organic Chemistry has now been divided, leaving the Department responsible for aromatic chemicals and surgical supplies. It is hoped now to turn attention to the development of systematic schemes for distinguishing chemically the individual analogues in groups all of which possess therapeutic value, and to the investigation of the use of heteropoly inorganic acids in the determination of organic bases. In the Division of Analytical Chemistry an attempt was being made to develop a scheme of analysis for sulphur compounds in crude oil and petroleum fractions, while the study by the Division of Microbiology and Microscopy of the bacteriology of bituminous coal-mine effluents has given a clearer understanding of the bacterium responsible for increasing the formation of acid from sulphuritic materials associated with bituminous coal.

Among the investigations of the pure science fellowships noted in the report may be mentioned those on techniques for ascertaining the quantitative distribution of pollution from industrial or other sources over large geographical areas, in which, for example, an hourly dust-fall sampler was developed, and the work on simpler and more reliable apparatus and techniques for measuring dust loading in stack gases. Results already obtained in a long-range investigation in the toxicological laboratory have demonstrated that the acute toxic effects of fine synthetic and natural inorganic particles may be of fundamental importance in explaining the action of fine particles on lung tissues. Zinc dust fires and

zinc losses in metallizing operations were under investigation to learn why frequent fires occurred in the dust-collector system, and to see if zinc losses through the dust collector could be reduced. Preliminary studies were made in the pharmacology of eighty newly available chemicals and more advanced investigations on thirteen other compounds likely to be retailed. The plastisol shoe-pillar devised under the multiple fellowship on orthopaedic appliances has relieved some two hundred cases of foot distress, an improved knee lock has been developed for an aluminium tubular brace, and the project on the traction brace has supplied a means of walking for persons with missing or dislocated hip joints.

Fundamental researches in glass science have included the design and assembly of microwave spectrographic equipment for following paramagnetic resonance absorption, the spectrophotometric study of the colour centres of irradiated natural crystalline silica samples, and the study of glass surfaces. Under the multiple fellowship on the properties of synthetic rubber, increased attention has been given to molecular size, chain stiffness and the extent to which the long-chain molecules may deviate from linearity because of branching. A semi-quantitative method has been developed for estimating the degree of branching in diene polymers, and research on the dynamic and flow properties of concentrated solutions of polymers has resulted in a theory of flow of viscoelastic materials which accounts for non-Newtonian viscosity, dynamic behaviour and the 'normal stress' or Weissenberg effect. The fellowship on artists' materials has succeeded in isolating factors involved in the ageing of spirit varnishes and in developing materials superior in each respect. Under the multiple fellowship on computer components two novel devices for storing binary information were developed and tested, and the non-linear voltage-current characteristics of semi-conducting materials were further applied in constructing complete logical switching circuits.

Researches under the applied science fellowships included the development of an improved synthetic lubricant for horological instruments; the improvement of selenium power rectifiers; the development of improved methods for testing the effect of weathering on glazes and coating materials for bricks and tiles, and of a more satisfactory method for determining the refractoriness of materials used in industrial furnaces; and studies of the dynamic properties of glass at temperatures in the transformation region, which point to the possibility of manufacturing glass with a permanently oriented structure. The ceramic chemicals fellowship has concentrated its effort on simplifying enamel formulations so as to determine more precisely the effects of varying amounts of single components and of combinations of two or more components. Under the abrasive grinding wheel programme, investigation of factors which influence residual stresses in ground surfaces of tool steel has been extended to a study of the effect of grinding severity on residual stresses in ball-bearing steel. Another fellowship is exploring the chemical behaviour of silicon carbide with the view of finding new uses for this compound; the chemical storage fellowship has investigated widely the storage of aminoethyl alcohol, lard, tallow, raw sewage sludge, calcium carbonate and acetylene, and much work was done on the cause of cracking in making welded joints and on the properties of the metal in welded joints. Further progress is reported in the

development of the icosasphere, a new type of spherical tank, and research continued on components for supersonic wind tunnels, as well as on the 'Stypol' resins, a series of liquid thermosetting materials devised by the Robertson multiple fellowship on protected metals. Research was started on the chemistry of the nickel sulphides, and the multiple fellowship on coal-waste control has recommended methods of constructing refuse piles that assure a desired degree of resistance to spontaneous, incidental or deliberate ignition and has studied in the field a number of methods of extinguishing refuse fires.

The multiple fellowship on acid recovery has extended its scope to include the investigation of other wastes from the manufacture of steel, besides spent pickle liquor, and a survey of literature on the toxicity to aquatic and animal life of substances in streams and on tastes and odours has induced an investigation to determine whether a balance between phenol-consuming and phenol-producing organisms can result in a phenol equilibrium concentration. The chemical potentialities of pyridine were being studied, as well as the development of methods for the treatment and disposal of industrial wastes, the utilization of the ethylbenzene in aromatic petroleum-naphtha fractions for the manufacture of styrene, and the suitability of plastic pipe in a low-pressure distribution system for natural gas. A study of the kinetics of the oxidation of lubricating oil has been leading to new concepts of the function of additive materials in the process, and work on hydrocarbon synthesis over catalysts of the iron group was being completed. Much effort was being given to the development of analytical techniques for detecting and determining the sulphur compounds of petroleum. Work continued on the composition of petroleum waxes and the relation between their composition and physical and engineering properties, and a theory has been formulated which relates the solubility of a gas in wax to the critical constants of both solvent and gas.

A chemical study of the pyrrole pigments and their relations to the chlorophylls and haemins was resumed, while that of the chemical composition of petroleum waxes and petrolatums led to the devising of special analytical techniques for measuring the physical properties of small fractions. Further detailed research was conducted on the factors affecting absorbent efficiency in cane-sugar refinery operations, and experiments on the variation in composition of gases dissolved in purée fruit and vegetable products over prolonged storage confirmed that a fundamental reaction in discoloration is oxidation. Most of the end-products of the discoloration of fruit and vegetables are small enough to go through a dialysis membrane. Compositions containing piperonyl butoxide have now been shown to be safe and effective additions for protecting grain and other stored products from infestation by insects. Zein emulsions have been obtained which possess low viscosity at high solid content and yield films comparable in clarity, gloss and resistance to water to coatings obtainable from alcoholic solutions. Investigations of industrial fabrics have centred on the improvement of dimensional stability and resistance to heat, water and chemicals, and those on alkyd resins indicate the value of 1:3-dimethyl-2-hexenolide as component. Work on the utilization of non-ionic surface-active agents has progressed, and much was done on test methods for evaluating soil conditioners and on the utilization of vinyl resins and silicones.

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1953

IN the annual report for 1953 of the Rothamsted Experimental Station*, it is apparent to the most casual reader that the research staff of the Station have been by no means idle during the year covered by the report. The rapid expansion in the scope of Rothamsted's activities since the Second World War—there are at present approximately three hundred and seventy people actively engaged in research and administration—has necessitated an active building programme, and several new buildings are being provided to meet the more pressing needs for accommodation.

In the Chemistry Department the assessment by laboratory and field tests of the agricultural value of water-insoluble phosphates is receiving attention in view of the attempts made by manufacturers to economize in the use of sulphuric acid for phosphatic fertilizer production. In general, the outstanding merits of water-soluble phosphates on most classes of land have again been evident, particularly when used as a starter dose placed close to the seed; but on some soils and with certain crops, various forms of insoluble phosphates have yielded results comparable to superphosphate. On all classes of soil, with potatoes and swedes, dicalcic phosphate in finely divided form gave results only slightly inferior to superphosphate; silicophosphate gave good results with potatoes on very acid soils, but was markedly less effective on moderately acid and neutral soils. On the other hand, 'Gafsa' phosphate was ineffective for potatoes on even very acid soils. All three forms gave good results with swedes. Experiments with nitro-phosphates indicate that the phosphate in these compounds has a value akin to that in high-soluble basic slags.

Work on fertilizer placement with potatoes indicates that with moderate dressings better results follow when the fertilizers are placed than when broadcast; the reverse is the case when heavy dressings are applied. With horticultural crops—lettuce, cabbage, beetroot, broad beans and runner beans—better results are obtained by placement of fertilizer.

In the Physics Department, work on the crumb structure of soils continues, and a technique for measuring the resistance of crumbs to dispersion developed. Using this technique on grass and lucerne plots sited on a field that had been under arable cultivation for many years, it has been established that two to four years under grass has materially improved the cohesion of the surface crumbs. By using a deep-rooted crop to dry out the subsoil during the summer, the permeability of heavy clay soils during the winter months may be improved, a point of practical importance to those concerned with drainage of heavy clay soils.

A simple method for measuring the deficit of divalent ions in soils flooded by sea water has been devised and will be used for estimating the dressings of gypsum needed on such land to prevent breakdown of crumb structure during the next few years.

The production of antibiotics in the soil by certain Actinomycetes and their influence on combating

* Report of the Rothamsted Experimental Station for 1953. Pp. 228. (Harpenden: Rothamsted Experimental Station, 1954.) 7s. 6d.