in the Association's laboratories were exhibited. Performance trials under controlled conditions also prove valuable. Studies of the mechanical properties of collagen and leather fibres were also displayed. The properties of leather depend on those of its constituent fibres and on their mode of interweaving. An electrobalance for weighing very small fibres and an extensometer for determining their stress/strain relation in different controlled atmospheres have been constructed at Milton Park for this work.

The Biology Department, under Dr. Mary Dempsey, is pre-eminent in the study of the fibre structure of skin; one of the items on show was the album of photomicrographs ("Hides, Skins and Leather under the Microscope"), published by the Association, which has had a wide circulation among investigators in other fields concerned with the structure of animal skins. Other exhibits showed the influence of abnormal skin conditions such as mycotic dermatitis, hyperpigmentation and melanoma, on the resulting leather.

In the Chemistry Department, under Dr. D. E. Hathway, exhibits summarized the work done during the past five years, which has contributed substantially to the understanding of biogenesis and structure of the condensed and the hydrolysable groups of natural organic tannins; the aromatization of glucose yields gallic acid and other phenolics (including ellagic acid formed by oxidation of gallic); these by esterification with glucose form the hydrolysable tannins, which are converted to condensed tannins by oxidation in the plant. A variety of non-tannin extractives from trees were also shown, for example, taxifolin and dihydropiceatannol from barks of native conifers (supplied by the Forestry Commission) and hydroxystilbenes from the heartwood of *Eucalyptus redunca*. The Chemistry Department is also responsible for work on leather dyeing, and has developed the application to leather of the 'Procion' range of dyestuffs introduced a few years ago by Imperial Chemical Industries, Ltd. These dyes combine with the substrate by a covalent link giving improved fastness in comparison with other types of dye, which in general become attached by less-specific links. The use of a resist, of the same chemical type, to modify the fixation of 'Procion' dyes on leather, was

also shown. This material, now manufactured by Imperial Chemical Industries, Ltd., under the designation 'Lissatan PR', was first prepared in the Association's laboratories.

Enzyme treatments have been used by the leather industry for many years for softening skins before tanning, and proteolytic enzymes have been used to a very limited extent for loosening hair in the pre-tanning treatments. Mr. K. G. E. Wyatt demonstrated current work by the Association on the proteolytic treatment which, if it can be made practicable for full-scale operation, will have several operational advantages over the customary treatment with milk of lime and sodium sulphide, for hair-loosening. In the Chemical Engineering Department, under Dr. F. E. Humphreys, investigations on drying leather were displayed. The best drying conditions (air temperature, humidity and flow-rate) for combining fuel-economy and satisfactory leather characteristics have been worked out for the more important types of leather, and a simple drying tunnel with air re-circulation, suitable for most kinds of leather, has been devised. In many of the processes of leather manufacture, accurate control of simple physico-chemical factors such as pH value, electrolyte concentration and temperature is desirable and the Department is studying methods for making the necessary measurements inside revolving drums; continuous determination of pH value of the liquid in a drum was demonstrated.

Following Procter's application of the Gibbs-Donnan theory of membrane equilibrium to the gelatin/acid system, much work has been done by the Association and in other laboratories on the swelling of collagen in water mostly by acid or alkali, but the addition of any electrolyte, one ion of which can be fixed or adsorbed in the collagen phase, will set up a membrane equilibrium or modify an existing one. An application of this was shown by Mr. E. F. Nattrass in the use of a polymeric phosphate, the anion of which combines with collagen, to control the swelling in acid pre-tanning treatment, so that the maximum practicable leather thickness is obtained; but the swelling is kept below the level at which practical difficulties, such as retarded absorption of tanning agent, would occur.

K. W. PEPPER

REACTOR FUEL ELEMENT TECHNOLOGY

A COURSE of ten lectures in reactor fuel element technology was given in the Department of Chemical Engineering at the Imperial College of Science and Technology, London, during February and March. The lecture series, which formed part of the postgraduate diploma course in nuclear technology (chemical), was designed to lay emphasis on the industrial problems of reactor fuel element technology and to appeal to scientists and technologists interested in the metallurgical aspects of nuclear power development. All the lecturers, who were from the United Kingdom Atomic Energy Authority, were specialists in their subjects and spoke from personal experience about the problems inherent in fuel element manufacture.

The course was arranged by the reader in nuclear technology (Mr. G. R. Hall) in collaboration with Mr. L. Grainger, chief metallurgist at the Atomic Energy Research Establishment, Harwell.

Mr. Grainger gave the introductory and concluding lectures. He described various types of reactor fuel element, the qualitative requirements of a satisfactory fuel element, and future developments in fuel element design and fabrication. In Mr. Grainger's opinion, progress in fuel element performance was now the most vital factor in the economic utilization of nuclear power; experimental irradiations would determine the rate of advance for some years to come.

Dr. J. F. M. Bishop, deputy head of laboratories at Springfields, discussed the theoretical evaluation of a fuel element. He outlined the general methods of procedure, illustrated by examples, and described the effects of irradiation and other factors which require consideration. The first stage in the evaluation of a fuel element is to see if it will endure for the proposed charge life under the conditions of stress and temperature imposed. If so, the effects of

changes induced by irradiation are then considered in detail. During his second lecture, special attention was paid to ratcheting and irradiation creep.

Mr. J. Harper, head of laboratories, Springfield, described the Springfield manufacturing process from ore to machined bars for Calder and Central Electricity Generating Board fuel elements. The emphasis was placed on the metallurgical stages in the process. He pointed out that the efficiency of slag/metal separation in uranium billet production is a major factor in the quality of a fuel rod. Each fuel rod has its case-history recorded on a punched card.

Mr. D. O. Pickman, deputy head of laboratories, Springfield, described the design and manufacture of Calder-type fuel elements, assembly and testing procedure, and out-of-pile proving tests. In the course of his second lecture he reviewed performance experience in Calder and irradiation proving of Central Electricity Generating Board fuel elements. Out of the 90,000 fuel elements loaded up to mid-July 1959, only twenty-seven failures have been observed.

Mr. L. M. Wyatt, late deputy head of laboratories, Culcheth, and now with the Central Electricity Generating Board, described fuel elements for the advanced gas-cooled reactor and fast reactors. He considered the design and expected performance of these uranium dioxide fuels with stainless steel, beryllium and other cladding materials. The design of similar fuels for light water and/or heavy water-cooled and moderated reactors was also briefly

referred to. In his second lecture, Mr. Wyatt described fast reactor fuels and cans and expected operating conditions. He concluded by briefly comparing British, American and Russian fuel elements. Design drawings of the advanced gas-cooled reactor fuel elements aroused great interest.

Mr. H. Lloyd, leader of the Fuel Element Fabrication Group at Harwell, discussed the fabrication of *Dido*-type fuel elements including the Mark III version, and considered their application to power reactors. Possible variations and improvements in fuel materials and design were mentioned and comparison was made with similar American fuels. Although various power reactors employing plate-type fuel elements have been built in the United States, only design studies have so far been made in Great Britain. Mr. Lloyd displayed samples illustrating various stages in the fabrication of the *Dido* fuel element, and these aroused much interest.

The course was well attended and it was particularly pleasing to see about forty representatives from industry. Each of the lectures provoked a stimulating discussion. Although the lecturers would have liked to answer the questions put to them fully, they were occasionally prevented from doing so by commercial security regulations. This applied mainly to questions concerning throughput and costs.

In view of the interest the lectures aroused, it is hoped to hold a similar series early in 1961.

S. HARTLAND

THE LEVERHULME TRUST

REPORT FOR 1956-58

THE third report of the Leverhulme Trust*, which covers the period 1956-58, in which commitments of £593,000 were undertaken, is the first of a series of triennial reports. Of this sum, 33 per cent was devoted to universities and centres of higher education, 8 per cent to learned societies, 30 per cent to medical research and 12.5 per cent to grants to individual scholars. Of those to British universities, the largest grant, £30,000, was to Liverpool for fellowships in general research, mathematics, physics and town planning. The University of Manchester received £14,900 for research fellowships and studentships at Jodrell Bank Experimental Station, Nuffield College, Oxford, £14,100 for a study of industrial relations with particular reference to the history and problems of the trade union movement, collective bargaining, the appointment and responsibilities of shop stewards and so forth, and St. Antony's College, Oxford, £12,500 for the study directed by Lord Ismay's committee on the changes in the international status of the United Kingdom since the Second World War and of its position as a Colonial power. £6,000 went to Birkbeck College, London, for research by Dr. N. Pevsner on the buildings of England, and £16,950 to the London School of Economics for miscellaneous scholarships and research awards. The University of Leeds received £7,500 for a research fellowship, scholarship and lectureship in the history

and philosophy of science; the Institute of Commonwealth Studies, London, £6,000 for research fellowships in economic development in the Colonies; and the University College of Rhodesia and Nyasaland £28,000 to finance inter-collegiate conferences.

Of the grants to learned societies, research institutions, etc., those of £4,500 to the British Association for the Advancement of Science for an inquiry, under Sir Patrick Linstead's direction, into the broadening of the education of those intending to become scientists and technologists, and of £8,400 to Political and Economic Planning for a study of the effects of economic planning on governments and administration may be mentioned; in medical research, the Royal College of Surgeons received £42,000 for research fellowships and scholarships in dental surgery; the Middlesex Hospital Medical School, £35,000 for scholarships at the Institute of Clinical Research; the London School of Hygiene and Tropical Medicine, £14,000 for research in industrial medicine over four years; the London College of Osteopathy, £12,500 for scholarships; the Institute of Laryngology and Otology, £9,100 for research fellowships; King's College Hospital Medical School, University of Durham, £8,700 for a research fellowship and the Department of Education of the Deaf, University of Manchester, £2,000 for research in connexion with the design of hearing aids. St. Mary's Hospital Medical School received £9,500 for biochemical research.

* The Leverhulme Trust. The Third Report of the Leverhulme Trustees. Pp. 55. (London: The Leverhulme Trust, 1959.)