breeding, moderate levels of protein feeding are indicated, since birds on moderate planes of nutrition attain similar weights at 33 weeks of age to those reared on high planes of nutrition. For egg production, maintenance of layers at a low plane of nutrition, whether induced by the use of inferior feeding-stuffs, restriction of food consumption, or by the use of bulky or fibrous foods, results in a diminution or cessation of egg production and is consequently uneconomic and wasteful of food.

On the problem of making the most efficient use of available resources, Prof. M. M. Cooper expressed the view that there is considerable room for improvement in the use of grassland, particularly the so-called rough grazings, and estimated that no less than nine million acres of land are capable of improvement. The difficulty of dealing with the hill country, particularly some areas in Scotland, was emphasized during the discussion, in which it transpired that on some hill farms the annual lamb production is 60-70 per cent, and it takes two years for a cow to produce a calf.

With regard to sheep, Mr. Pomeroy suggested that the future of the sheep industry appears to lie in concentrating on the production of fat lamb from cheap grass in the spring and summer, and reserving the more expensive winter feeding-stuffs, hay and roots, for carrying the breeding flock through the winter. In the case of pigs, assuming that the era of cheap imported feeding-stuffs is unlikely to return in the near future, it would be better to spread the breeding-sow population thinly over as many farms as possible, the basic idea behind this policy of 'two sows on every farm' being that, with the provision of the requisite minimum of concentrated food in the form, say, of fish meal, the average farm should be able to supply sufficient food in the form of grass, chat potatoes, tail corn, crop surpluses and the like to support two sows and their progeny.

With regard to milk production, Dr. S. Bartlett suggested that the most hopeful method of increased production in existing circumstances is in the direction of increasing the average yield per cow rather than in attempting to increase the number of cows. A better use of roots in the ration gives some hope of achieving this; in an experiment the daily starch equivalent intake of a cow on a diet of hay and roots was raised from 14.5 lb. to 18.4 lb. starch equivalent by increasing the roots fed from 33 to 99 lb. The kind of roots fed is important, and Dr. Bartlett said that he had been impressed with the dependence placed by the Danes in their dairy production on the use of 'fodder beet', a root crop which in addition to being palatable has a high dry-matter content (approximately 21 per cent). By this increased use of suitable root crops, coupled with the practice of 'steaming up' prior to calving, there is no reason why increased yields of milk should not be obtained on home-grown foods and with present resources.

On poultry meat and egg production in Britain, the future appears to rest, in Mr. Halnan's opinion, on the provision of adequate supplies of cereal grains and cereal by-products. War-time experience on the use of substitutes has shown the very limited capacity of poultry to deal with bulky or fibrous foods, except geese, which considerably increased in number throughout the War. The only feeding-stuff capable of acting as a cereal substitute is potatoes, and these are capable of replacing one-half of the daily food requirements. The use of potatoes is, however,

wasteful of fuel and labour, and the suggestion was made that from the national point of view it would be more economical to make available for poultry feeding the 700,000 tons of wheat offal that would arise from a reduction of milling extraction-rate from its present 82 per cent to 70 per cent, rather than to ask poultry producers to increase egg production by using the calculated 2,800,000 tons of potatoes required as a substitute. E. T. HALNAN

2116

FLUORINE AND ITS COMPOUNDS

A SHORT symposium on "Fluorine: the Element and Some of its New Compounds" was held by Section B (Chemistry) of the British Association at the recent Newcastle meeting. Sir Alfred Egerton presided, and made a few opening remarks commented on the rapid progress made in recent years in the chemistry of fluorine compounds.

The first speaker, Mr. H. R. Leech (Imperial Chemical Industries, Ltd., Runcorn), gave a lucid account of the production and techniques of handling elementary fluorine. After dealing briefly with Moissan's original isolation of the element in 1886, he gave an account of the development of different types of cells in Germany, Great Britain and the United States during the past few years. These all involve the electrolysis of a potassium and hydrogen fluoride mixture at high, medium or low temperatures. In most cases, the cells have steel cathodes and either nickel or carbon anodes. In Germany during the War, a fluorine installation built for chlorine trifluoride production had a potential output of 700 tons of fluorine per annum, and the cells running at 250° C. used silver for the electrode material. A good deal of attention was necessary for the successful running of such cells. Fluorine was produced in America in very large amounts for the Manhattan atomic energy project. Modern British and American cells use medium temperatures (up to 90°), and in the British cells polarization troubles have been largely overcome by use of a special form of carbon for the anodes. Mr. Leech outlined the work done in his laboratories on fluorine bubble growth and formation during electrolysis of the molten potassium hydrogen fluoride (KF.2HF), and a striking illustration was given of the 'non-wetting' effect of the electrolyte at the carbon anode. Reference was made to the importance of electrode-electrolyte contact angles. Although it has taken sixty years to achieve, it is quite clear that there are now no important technical problems to be solved in the production and handling of fluorine on the largest scale.

Prof. H. J. Emeléus (Cambridge) dealt with some recent advances in the chemistry of certain inorganic fluorides. He outlined the reactions of fluorine with the other halogens, making special mention of chlorine and bromine trifluorides and of iodine pentafluoride, and dealt briefly with some of their chemical properties.

Chlorine trifluoride is a gas, boiling at 11.3° C., which can readily be prepared by burning chlorine and fluorine together under appropriate conditions. It is already available in cylinders from Mr. Leech's laboratories. It behaves as a powerful fluorinating agent and is probably the best means of storing and transporting fluorine. Chlorine trifluoride in the pure state is a non-conductor, though both bromine trifluoride and iodine pentafluoride do conduct. In bromine trifluoride the existence of the ions, BrF_2^+

and BrF_4^- , has been demonstrated clearly by conductimetric methods. Bromine trifluoride can function as an ionizing solvent. Thus, those substances such as $\text{BrF}_2^+\text{SbF}_6^-$, which contain the BrF_2^+ ion, can act as acids, while those such as K^+BrF_4^- , which contain the BrF_4^- ion, can act as bases.

Prof. Emeléus then dealt with a new field of chemistry which he and his colleagues have recently opened up and which clearly demonstrates the overlap between organic and inorganic chemistry. It concerns the use of the halogen fluorides as fluorinating agents for organic substances, and of metallic derivatives of fluorocarbons. Iodine pentafluoride can be used to prepare $\text{Hg}(\text{CF}_3)_2$, HgCF_3I and $\text{Hg}(\text{C}_2\text{F}_5)_2$. Furthermore, the reaction between iodo-fluoromethane or iodo-fluoroethane and olefinic hydrocarbons and fluorocarbons has led to a new range of fluorocarbons of high potential importance.

The final paper was given by Prof. M. Stacey (Birmingham), who considered organic fluorine compounds. He dealt initially with methods available for the introduction of fluorine into organic compounds, discussing first those reactions which do not require the use of elementary fluorine. They involve chiefly the replacement of chlorine, bromine or iodine in an organic halide by agents such as the fluorides of hydrogen, silver, mercury, antimony, etc.; and the merits and special applications of these were demonstrated. The influence and stability of fluorine atoms in different positions and in different groups in certain molecules were outlined, and the point made that, in general, elementary fluorine is necessary for complete replacement reactions to give 'p' or per-fluoro compounds. The methods for using elementary fluorine as a fluorinating agent need either fluorine-inert liquid diluting agents or a metallic catalyst such as gold-plated copper. Other fluorinating methods utilize inorganic fluorides such as cobalt trifluoride or silver perfluoride, which at suitable temperatures readily give the lower fluorides of the metal and atomic fluorine. These methods need further study in order to control them for partial fluorinations. Prof. Stacey also dealt with the polymerization of fluoro- and fluorochloro-ethylenes and -butadienes as initial material for fluorocarbon production. The

stability of the —C—F bond may endow fluorocarbons

with remarkable chemical and thermal stabilities.

Attention was directed also to many of the unusual properties of fluorocarbons, some of which, for example, the 'Freon' refrigerants and the polytetra-fluoroethylene plastics, are already in use in industry. Other uses suggested were for non-inflammable lubricants, hydraulic fluids and plastics; heat-transfer agents, fire extinguishers, and so on. The striking properties of trifluoroacetic acid and its derivatives were described, and the highly toxic nature of substances containing the $\text{CH}_2\text{F—CO}$ groups, as shown by Dr. B. C. Saunders *et al.* in Cambridge, was used to illustrate how important the organic fluorine compounds may become in biology. It appears that a vast new field of organic chemistry and technology is ahead.

During the discussion which followed, numerous questions were asked of the speakers, and the audience gave a great welcome to Dr. N. V. Sidgwick, who mentioned some anomalous properties of certain fluorine metal bonds.

In connexion with the symposium an exhibition of fluorine cells and fluorine compounds was arranged.

M. STACEY

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1947-48*

34.

THE thirty-third report of the Department of Scientific and Industrial Research covers the year 1947-48, and is almost exactly half the length of the twenty-third report, the last published report of the Department. That report covered the year 1937-38, and it now appears from a note to the present report that the intervening reports, though prepared and formally submitted to Parliament as required by Order in Council, will not be published.

The present report departs considerably in arrangement and content from the pre-war reports. It includes, like them, indeed, the report of the Committee of the Privy Council for Scientific and Industrial Research, signed by the Lord President, Mr. Herbert Morrison, and the report of the Advisory Council over the signature of its chairman, Sir Geoffrey Heyworth. There are the customary lists of assessors and of members of research boards and committees of the Department, of establishments and research associations, statistics of maintenance allowances, research awards and grants, and the expenditure over the whole period is summarized in the usual form. The lists of departmental publications and of publications by individuals in receipt of grants are not, however, appended, either for the year or for the whole period.

The omission is the more noteworthy in that there is nowhere a clear account of the work of the Department during the particular year under review. Much of the Advisory Council's report consists of a review of the years 1938-48, including sections on the post-war development of existing establishments, on the research associations and on other general or broad topics. Scientific workers and industrialists alike will conclude that if the substance of the intervening reports is, indeed, incorporated in the present report, a miracle of compression has been performed.

The largest section of the report of the Committee of the Privy Council is that dealing with the post-war period. Reference is made to the creation of various new organisations, such as the Pest Infestation Research Organisation, in 1940, the Joint Fire Research Organisation of the Department and the Fire Offices' Committee, in 1946, of a separate Radio Research Organisation to absorb and develop the work of the Radio Division of the National Physical Laboratory, and the creation of a new Mathematics Division of the National Physical Laboratory. As a result of reviews of their fields by each of the existing research boards, proposals have been formulated and generally approved for extending the scope of the Department's other research organisations. Between 1937 and 1947 the number of research associations increased from twenty-two to thirty-five, and their total income from a little more than £400,000 to nearly £2.5 million. The expenditure of the whole Department increased from £682,180 in the year ending March 31, 1939, to £1,239,570 in 1945-46, £1,961,293 in 1946-47, and £2,694,061 in 1947-48. In that year net expenditure on the National Physical Laboratory was £381,327, on building research £203,663, on chemical research £51,073, food investigation £116,571, forest products research £71,477, fuel research £149,815, radio research £85,023, road

* Department of Scientific and Industrial Research. Report for the year 1947-8, with a Review of the Years 1938-48. (Cmd. 7761.) Pp. iv+103. (London: H.M. Stationery Office, 1949.) 2s. net.