

Harker obtained very wide publicity in the daily papers. In contrast to this, the discussion on "Valency and Polarity in Organic Compounds," to which Prof. R. Robinson and Dr. J. Kenner made weighty contributions, was somewhat too abstruse for many of those present; but no criticism of this kind could apply to the very lucid expositions on the "Hydrogenation of Fats" given by Dr. E. F. Armstrong and Mr. E. R. Bolton. Reports were presented by the Committees on Colloids, Fuel Economy, and Absorption Spectra, but none of these was discussed.

Hull is a very favoured locality from the point of view of chemical industry, and the excursions to works, organised by Mr. A. R. Tankard, local secretary to the Section, proved very popular. The special thanks of the Section are due to the directors of the following companies for their generous hospitality: The British Oil and Cake Mills, Ltd. (seed-crushing and solvent extraction, soap, margarine); G. & T. Earle, Ltd. and the Humber Portland Cement Co.; Reckitt & Sons, Ltd. (ultra-marine, starch, metal polishes, etc.), and the Frodingham Iron and Steel Co., Scunthorpe.

We give below further abstracts of papers presented, together with a *résumé* of a paper on the resistance to fire of concrete, read before Section G (Engineering) by Prof. F. C. Lea and Dr. R. E. Stradling of Birmingham University, and some remarks from the joint discussion on Vitamins held by Sections I and M (Physiology and Agriculture).

### The Composition of Esparto Cellulose

By E. L. Hirst

Esparto grass, after removal of waxes, lignins, etc. in the ordinary course of paper-making, gives a material which is homogeneous and similar in appearance to cotton cellulose, but differs markedly from it in giving on distillation with 12 per cent. aqueous hydrochloric acid an amount of furfural corresponding to the presence of 18–20 per cent. of a pentosan.

Esparto cellulose is not acetylated so readily as cotton cellulose, but by slightly modifying Barnett's method, in which sulphuryl chloride is used as catalyst, almost quantitative yields of acetates have been obtained without appreciable loss of the pentose-content as shown by furfural estimations. This acetate mixture has been subjected to the action of acid methyl alcohol in sealed tubes at 130° C., when it is found that after prolonged digestion practically the whole of the material dissolves and the solution then contains methylglucoside together with a proportion of a methyl pentoside. That the pentose is identical with xylose has been confirmed by isolating from esparto cellulose a pentosan which on hydrolysis is converted into a reducing sugar identical with ordinary xylose. In the course of quantitative experiments esparto cellulose has thus been converted into methylglucoside and methylxyloside in such a manner that 90 per cent. of the whole material can be accounted for. The analytical results indicate that the over-all yield of methyl-

glucoside is 95 per cent. and that of methylxyloside 68.5 per cent. of the theoretical amount, calculated on the assumption that only glucose and xylose residues are present. The loss in yield, as indicated by the results of control experiments, is due to the destruction of pentose owing to furfural formation during the digestion in the sealed tubes.

The evidence therefore points to esparto cellulose being, to the extent of 90 per cent. at least, a definite chemical substance composed of glucose residues and xylose residues present together in the proportions of 80 per cent. and 20 per cent. respectively.

### Determination of Compressibilities up to High Pressure and Applications to High-Pressure Chemistry

By E. D. Williamson

A new form of pyknometer has given satisfactory results, particularly in determining compressibilities at the lower end of the pressure range. By means of a movable electrical contact, the instrument allows of continuous readings without removal from the pressure chamber.

In the study of the chemical effects of pressure on systems of more than one component, it is necessary to know the compressibility of each solution in order to compute the volume changes on which these effects depend. The volume changes can be readily calculated from the slopes of the density-composition curves. Even in the case of a simple system, such as a salt and water, it is necessary to make a number of other measurements in addition to those of compressibility. For instance, good density-composition data must be obtained at atmospheric pressure. Also, some form of equilibrium determinations, such as those of vapour pressure or EMF, must be made in order to calculate the initial differences in "free energy" (used in the same sense as by G. N. Lewis) between the solid salt and salt in solution. For the case of  $\text{H}_2\text{O}-\text{NaCl}$  almost all the necessary data for the complete elucidation of the system under pressure have been obtained, and a beginning has been made with some others.

### Hydrogenation of Fats

This discussion was opened with an address by Dr. E. F. Armstrong, who said that fat-hardening presented problems which brought in almost every aspect of the chemist's work and nearly every trick of his art. Fat-hardening was discovered in theory by Sabatier and in practice by Dr. Normann whose small-scale experiments paved the way for the elaboration of the process on an industrial scale in England. The enormous number of patents, very few of which were of any value, which had resulted was typical of chemical industry, and he regarded this as one of the drags upon the wheels of progress which ought to be removed. Fat-hardening had been much delayed by the difficulties experienced in manufacturing hydrogen, but many of these had now been overcome. Inventors of processes for making hydrogen seldom took into consideration all three factors involved, viz., the capital cost of the plant, operating costs, and the cost of maintenance and repairs. In localities where cheap power was available, there was no difficulty in making cheap hydrogen by the electrolytic method, and he under-

stood that it was being produced on the continent with the aid of cheap water power at 2s. 6d. per 1000 cb. ft. The process adopted by the Badische company was preferable when hydrogen was required in very large quantities, but the ordinary catalytic process was best for small plants. Dr. Armstrong then described the preparation of the nickel catalyst used in hydrogenation and emphasised the points that the efficiency of the catalyst depended upon the existence of maximum surface, and that the oil to be hydrogenated must be clean. The remainder of the address was devoted to an explanation of the manner in which the catalyst brings about the hydrogenation, viz., by the intermediate formation of an unstable additive compound of the nickel and the fat. (Cf. J., 1920, 249 R; 1922, 67 R, 304 R.)

### Aerosols, or Solid Disperse Systems in Air

By R. Whytlaw-Gray and J. B. Speakman

Dilute smokes analogous to the solid-liquid systems of colloidal solutions can be formed, (a) by heating substances of high boiling-point in a rapid air stream (paraffin wax, acetanilide, *ortho*-phthalic acid, and diphenylamine disperse readily); (b) by the arc discharge from metallic electrodes in an air current, forming with most metals an oxide dispersoid, and with silver, gold, and platinum a metallic one; (c) by chemical interaction between highly diluted vapours or gases, i.e., zinc ethyl and air or ammonia and hydrogen chloride. An ultra-microscopic method has been developed of counting the number of particles in a given volume of these smokes and by working with a large volume of dispersoid (1 cb. m.) the changes that take place have been followed and shown to be due to aggregation. Different substances form aggregates or complexes of various structures, those of zinc and cadmium oxides giving irregular flexible threads in which the particles appear as beads on a string and exhibit remarkable Brownian motion.

The curves obtained by plotting the number of particles per c.c. against time showed in all cases a steep initial drop corresponding with the period of most rapid aggregation.

The weight of the particles in a given volume was found by filtration through asbestos and weighing the small filter on a micro-balance sensitive to 0.0002 mg. and the resulting weight-time curves showed that the weight falls off much more slowly than the number of particles. By combining the two sets of curves it was possible to calculate the sizes of the particles: these were found to increase with time and then become constant.

Liquid and solid disperse systems are produced in a large number of chemical operations, such as the passage of gases through liquids and the decomposition of solids by heat, and this possible source of error in measurements of high accuracy does not seem to have been considered.

### The Study of Soap Solutions

By Prof. J. W. McBain

In view of the large number of current theories which are irreconcilable with the conclusions to which the study of soap solutions has led it is necessary very carefully to prove the evidence for the existence of the ionic micelle.

1. The following methods agree in showing that hydroxyl ion is only a minor constituent of soap

solutions (about 0.001N):—Electromotive force with hydrogen electrode; catalysis; conductivity; ultra-filtration with direct analysis of the filtrate.

2. The osmotic activity is about half that of a salt. Trustworthy measurements have been obtained by the following methods:—Freezing-point; dew-point; minimum pressure required for ultra-filtration; vapour pressure.

3. The conductivity is that of a salt; this is indicated by hundreds of concordant measurements with many kinds of soap.

4. Half the conductivity must be ascribed to a constituent of very high equivalent conductivity but of negligible osmotic pressure, the ionic micelle. Its conductivity is several-fold that of all the fatty ions contained in it.

5. By ultra-filtration the ionic micelle is found to be colloidal, and, in addition, the undissociated neutral colloid, consisting of still larger particles, may be separated from the ionic micelle. Sodium and potassium electrodes confirm the concentrations of sodium and potassium ions assumed. Migration determinations are also in agreement. Hydrolysis is impossible in the case of cetyl sulphonic acid, whose behaviour is closely similar.

6. An important result is the theory of gel structure. The only differences between a transparent jelly and a sol are mechanical—elasticity and rigidity. The colloidal particles in both are identical in nature and amount, but in the gel they are arranged in ultra-microscopic filaments or aggregates. The equilibria and the resistance to the passage of the electric current are unaltered on gelatinisation.

7. "Electrical endosmosis" and "cataphoresis" in a transparent soap jelly are quantitatively identical with electrolytic migration in the corresponding soap sol.

8. The theoretical conclusions are of general applicability to very large groups of organic and inorganic solutions in aqueous and non-aqueous solution.

### Raw Materials for Synthetic Ammonia: The Manufacture of Hydrogen and Nitrogen

By J. H. West

There are two main sources of commercial hydrogen—coal and water. Electrolytic hydrogen is very pure, but owing to the high capital cost of the plant and the great consumption of electric energy, the cost of production is prohibitive unless cheap water-power is available. Many coals contain about 5 per cent. by weight of hydrogen, equivalent to about 21,000 cb. ft. per ton of coal, but only about one-quarter of this amount is set free on distillation of the coal in retorts or coke ovens. Coke-oven gas, where available, is an excellent source of hydrogen, when the latter is separated from the other gases by Claude's liquefaction process. The interaction of steam and hot coke gives water gas containing about 50 per cent. of hydrogen and 42 per cent. of carbon monoxide, the yield being about 55,000 cb. ft. of gas per ton of coke. The carbon monoxide in water gas may be caused to react with steam, giving carbon dioxide and hydrogen.

The process devised by Dr. A. Jaques and the author combines the distillation of coal in a retort, the formation of water gas from the resulting coke,