Another point of interest is to be found in the prevalence at these intermediate depths of species that possess a red or purple coloration; this is particularly striking in the Crustacea and in certain species of fish. Above this level, planktonic animals tend to be colourless, while below it many species of fish are brown or black. In the words of Sverdrup, Johnson and Fleming, "the further examination of the distribution of such organisms and their adaptation to the extreme condition represents one of the fascinating biological problems".

Another problem that requires investigation is whether this minimum-oxygen layer forms an obstacle to the admixture of surface-living forms with those of greater depths. In this connexion Dahl[19] has pointed out that a large number of species of Copepoda are to be found in the upper stratum, while below this lies a second, extending down from about 300 to 1,000 m., in which there are only a few Copepods that are common to the upper layer; and the few species that are common to both strata are mostly rare in one while being numerous in the other, in which they are really at home. It is interesting to note that Grace Pickford[20] in a study of *Vampyroteuthis infernalis*, captured by the *Dana*, shows that the vertical distribution of this Cephalopod appears to be limited in all the oceans by the zone of minimum oxygen. According to Torsten Gislen[21], the minimum-oxygen zone will equally play a part in the distribution of the benthonic species; basing his conclusion on the catches of Echinoderms made by the *Albatross* off Panama and the California coast, he believes that not only is there a remarkable paucity of the fauna at a depth of 500–600 m., but also he shows that the species above and below this level are entirely distinct.

It is thus abundantly clear that a detailed study of this zone and of the fauna that inhabits it, as well as a comparison of the faunas above and below it, present a number of problems that are of considerable interest, not only to the taxonomist but also to the physiologist and biochemist; and it seems worth while, now that oceanographic investigations are once again being contemplated or actually carried out, to direct the attention of investigators to this zone.

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USE OF LIQUID FUELS

CONFERENCE AT BIRMINGHAM

IN scientific research, and in the application to industry of the results of research, the problems encountered are of increasing complexity. Scientific workers engaged in this work feel the necessity for consultation or collaboration with specialists in fields other than their own. Indeed, it has become a commonplace that most industrial research problems require teams of experts from many branches of science and engineering. The interdependence of the various branches of science and technology has long been recognized; but collaboration between the corresponding societies has been practised to a noticeable extent only in comparatively recent years. Joint conferences, such as that held at the University of Birmingham during September 21–23, are therefore welcome not only for their immediate value, but also as tokens of the growing integration of science.

The Birmingham Conference on "Modern Applications of Liquid Fuels" was organised by the Institute of Petroleum and the Institute of Fuel, in recognition, as Mr. J. A. Oriel, the president of the Conference, put it, of their joint responsibility for ensuring that all kinds of fuel available in Great Britain are used with maximum efficiency. The scope of the Conference was wide, and while the use of oil fuels for prime movers, as in petrol and Diesel engines, was in general excluded, the seven sessions, into which the Conference was divided, furnished opportunities for the exchange of information, experience and opinion about the design, operation and performance of burners and furnaces, agricultural driers, Diesel rail traction-engines, the use of oil in the gas industry, and the principles of combustion-chamber design for the gas turbine.

One evening was devoted to a lecture on the uses of liquid fuel in domestic heating, largely based on the work of the Liquid Fuel Installations Committee of the Institute of Petroleum. This Committee is preparing a report on the use of liquid fuels for domestic heating at the request of the Minister of Fuel and Power, similar to the Post-War Building Studies arranged by the Ministry of Works in reference to electricity, gas, and solid fuels. The oil fuels chiefly used, for both space- and water-heating, are liquefied butane and other gases, kerosine, and Diesel oil. The development of modern domestic appliances burning kerosine was described, and attention was directed to their high thermal efficiencies; such appliances have many advantages in rural areas.

The Conference was concerned in the main, however, with the industrial application of oil fuels for purposes for which coal and petroleum may be used alternatively, and the chief scientific interest of the Conference, therefore, was the opportunity which it provided for making a comparison of the two fuels. In Great Britain, coal always has the advantage of lower cost, and the opinion is widely held that but for this advantage, oil would always be used in preference to coal. Oil has a higher calorific value, and is certainly easier to handle and store than is coal; and it is cleaner in use—qualities which account, for example, for the replacement of coal by oil for use at sea. Petroleum, moreover, has a very small content of mineral matter; this becomes concentrated in residual fuels by distillation, and the use of distillate fuels is accordingly entirely free from the troubles due to ash-formation which are associated with the use of coal. The same is, however, not true of residual fuel oils; although ash-formation is much less than with coal, it may give rise to serious problems, as, for example, in the gas turbine, where ash-deposition is a major obstacle in the development of this prime mover to use heavy fuel oils. Fuel oils, of course, still have a great advantage over coal in this connexion; but it is important to realize that the use of oil is by no means entirely free from the problems which attend the use of coal. Thus both fuels contain sulphur, and the fuel oils available for use in Great Britain often have high sulphur contents (two per cent or more) which may cause deterioration of product quality in the steel and metal industries. In this respect, therefore, the advantage frequently lies with coal or the fuels derived from it, namely, producer-gas and coal tar.

The oil flame has a higher radiation efficiency than the gas flame—a property which has contributed to the improved results which have been obtained in the manufacture of steel in the open hearth furnace by conversion to oil firing. Several other factors are, however, also involved, and there was considerable divergence of opinion at the Conference as to the relative merits of oil and coal in this and similar applications. In some instances, conversion to oil firing has shown little advantage; but the bulk of the evidence supports the conclusion that it leads to greater steel production. It is, in fact, probable that the use of oil has made an important contribution to the record steel output in Britain now being obtained. It cannot, however, be immediately concluded that conversion from coal to oil firing is necessarily advantageous to the steel industry.

In the first place, consideration must be given to the cost of any technical advantage, and the differential price of coal and oil in any particular locality is clearly a most important factor. This is illustrated very clearly by the American experience which was recorded in one of the papers contributed to the Conference. The steel industry in the United States was originally based on coal; but oil firing was adopted, at a time when fuel oil was relatively very cheap, with a consequent increase in thermal efficiency and steel production. At present, however, the supply position and the changing price differential have started a reverse trend from oil to coal firing. The combined use of oil and coke-oven gas has given good results, and it is suggested that other combinations, including such fuels as coke breeze and powdered coal, might be used with advantage.

A second factor in the achievement of improved results with oil firing is the greater ease of control which attends the use of oil. Partly in consequence of this, the application of oil firing has usually been made with greater instrumentation and scientific control, and it seems likely that improved results could also be obtained with producer-gas if similar methods were employed. This consideration suggests that the comparison between oil firing and conventional practice with producer-gas has not always been fair to the latter. It is certainly also true that the comparison has sometimes been unfair to oil firing because of unsuitable furnace design. Thus it has been shown that the jet action due to the greater velocity of the oil flame may result in a serious air inleakage which could be avoided in a furnace designed specifically for the utilization of oil.

The use of fuel oil in glass furnaces also gives the advantages of greater ease of control and increased rate of glass melting, but the intense radiation from the oil flame results in increased wear on refractories; and although increased efficiency could be obtained by greater preheat of the combustion air, it is concluded that oil firing is not at present economic in comparison with an efficient producer-gas system. It is evident that the assessment of the relative values of coal and oil firing involves many technical and economic factors.

It is not possible, in this short article, to do justice to the vast amount of technical information which has been provided by the many papers contributed to the Conference. Readers interested, for example, in the application of the Diesel engine to rail traction, in modern developments in agricultural drying processes, or in any of the other modern applications of liquid fuels in the field already indicated, will be well advised to consult the Conference records; when published, these will constitute a valuable work of reference which will perhaps be the major achievement of the Conference.

F. H. GARNER

OBITUARIES

Dr. S. E. Sheppard

SAMUEL EDWARD SHEPPARD died in Rochester, N.Y., on September 29, aged sixty-six. Dr. Sheppard was born in Catford, and was educated at St. Dunstan's College, Catford, and University College, London. There he obtained the degree of B.Sc. by research in 1903, his thesis dealing with the theory of the photographic process and involving a repetition and extension of the earlier work of Hurter and Driffield. This work was greatly extended in his research for the D.Sc. degree, which was granted in 1906 for a thesis which was published in 1907 jointly with that of C. E. K. Mees under the title of "Investigations on the Theory of the Photographic Process". Much of the work had been published in a series of papers in the *Photographic Journal*, the *Transactions of the Chemical Society*, and in the *Proceedings of the Royal Society*.

In 1906 Sheppard was awarded an 1851 Exhibition for two years and went to Marburg, where he worked with Karl Schaum, professor of photo-chemistry and the editor of the *Zeitschrift für Wissenschaftliche Photographie*. Sheppard's work was on the molecular structure of sensitizing dyes and particularly of pinacyanol, the red sensitizer discovered only a short time before by Homolka, of the Hoechst dye-works. The study of the structure and behaviour of dyes like pinacyanol continued to attract Sheppard's attention throughout his entire life. After a year in Germany, Sheppard went to Paris, where he worked with Victor Henri at the Sorbonne on colloid chemistry.

In 1913 Sheppard accepted an invitation to take charge of the sections of physical and colloid chemistry in the Kodak Research Laboratory, which had just been organised under the direction of C. E. K. Mees at Rochester, N.Y.

His early work there dealt principally with the physico-chemical properties of gelatin, and a number of papers were published dealing with the measurement of the viscosity of gelatin solutions, the measurement of the jelly strength and the elastic properties of gelatin jellies, the setting and melting points of gelatins, the drying and swelling of gelatin, and the structure of gelatin in solution, in the jelly,