manufacture of fine chemicals in India. He observed that there is no dearth of well-trained chemists in the country, but what is lacking is business experience which is of great importance in running a manufacturing concern. He cited an instance of a properly trained chemist earning Rs. 150 per month by purifying (by recrystallisation) ordinary bazaar chemicals and selling them to the schools and colleges in the United Provinces. Dr. R. B. Forster (Bombay) observed that before the preparation of chemicals could be undertaken, it was essential to have the necessary supply of starting materials and solvents. There is no reason why the distillation of tar should not be undertaken and the importation of raw materials rendered unnecessary. Dr. N. N. Godbole (Benares) opined that fine chemicals can and should be manufactured in India. While pointing out the difficulties in packing and selling, the latter requiring business experience, he suggested the desirability of the Science Congress constituting a body that will analyse and certify the standard preparations. Dr. J. N. Ray (Lahore) was in full sympathy with the views expressed by the President and Dr. Wheeler. He realised that such ventures may not be financially very profitable in the beginning but if the Indian Chemical Society takes the lead, there is no reason why the desired goal should not be achieved. While expressing his disagreement with the view expressed by Dr. Forster, *viz.*, that it is essential to manufacture starting materials and solvents, pointed out the possibilities of exploring new solvents, *e.g.*, furfurol, furyl alcohol, etc., there is no reason why alkaloids, *e.g.*, ephedrine, emetine, etc., as also other useful chemicals from indigenous plants could not be economically manufactured in this country. Dr. J. N. Mukherjee (Calcutta) expressed the view that as a first step, it is desirable to restrict the scope to the preparation of such chemicals as would meet the requirements of research workers in India. By mutual agreement a list might be prepared and the work may be distributed over the different laboratories. Regarding the broader issue of preparations on a commercial scale, he suggested that the first step should consist in collecting information on the possibilities and to have them critically examined by a committee with a view to arriving at definite proposals.

The following resolution proposed by Dr. N. R. Dhar and seconded by Dr. J. N. Ray was unanimously passed at the meeting :—

"That the Council of the Indian Chemical Society be requested to carefully consider this important question and explore means as to how and on what lines the preparation of fine chemicals can be undertaken in this country."*

* The following resolution was passed at the annual general meeting of the Indian Chemical Society held on Monday, 6th January, at Indore :

" Resolved that a committee consisting of the following members with powers to co-opt be appointed to consider possibilities of preparing fine chemicals for laboratory use and to collect informations regarding the possibility of new chemical industries in India :

Dr. H. K. Sen (Calcutta) ; Dr. J. N. Mukherjee (Calcutta) : Dr. S. K. Ray (Dhanbad) ; Dr. P. K. Ghosh (Calcutta) ; Dr. N. N. Godbole (Benares) ; Dr. J. K. Chowdhary (Dacca) ; Dr. N. R. Dhar (Allahabad) ; Dr. P. C. Guha (Bangalore) ; Dr. P. C. Mitter (Convener); Dr. T. S. Wheeler (Bombay) ; Dr. S. G. Sastry (Mysore); Dr. B. Sanjiva Rao (Bangalore); Dr. K. L. Moudgill (Trivandrum); Dr. S. S. Bhatnagar (Lahore); Dr. M. S. Patel (Bombay) ; Dr. K. H. Hassan (Hyderabad, Deccan); Dr. B. S. Srikantan (Waltair); Dr. N. G. Chatterjee (Cawnpore)."

Progress of Fuel Research.*

THE Department of Scientific and Industrial Research issued the Report of the Fuel Research Board together with the Report by the *Director of Fuel Research for the year ended* 31st March 1935. The Report is made the occasion for a review of the progress achieved in the Fuel Industry during the twenty-five years of His Majesty's reign. Consideration is given to the relation between the Board's researches and the remarkable changes which are taking place in the utilization of coal.

Despite increasing industrial prosperity and rising population the consumption of coal in Great Britain has fallen from 180 million tons a year in 1910 to 165 million tons in 1934. It is sometimes suggested that this fall is due to the replacement of coal by oil but the report shows that this is largely erroneous and the decrease is due mainly to the increased efficiency of practically every process for which coal is used.

In 1910 *about 4½ million tons of coal were* required to produce 2,500 million units of electricity, while for the 16,100 million units generated by authorised undertakings in 1934 only 11.4 million tons were necessary. If the efficiency of production of electrical power had remained the same, 29 million tons of coal would have been used in 1934.

An overall thermal efficiency exceeding 27 per cent. has now been obtained in large installations and further major advances in this direction cannot be expected. Incidentally it may be stated that the capacity of individual boilers has been raised from 20,000 or 30,000 to 300,000 pounds of steam per hour, and an efficiency exceeding 90 per cent. has been attained in this section of the plant.

The gas industry has also made great advances, and in the period under review the gas supplied by all authorised gas undertakings in Great Britain increased from 178,000 million cubic feet in 1910

* Department of Scientific and Industrial Research; Report of the Fuel Research Board for the year ended 31st March 1935, with report of the Director of Fuel Research. His Majesty's Stationery Office, London, xi + 188 pp. Price 3 *sh.* 6*d.* net.

to 295,300 million in 1934, while in the same period the coal used only increased from 15.1 to 17.1 million tons a year. If the efficiency of the process of gas manufacture had remained stationary throughout the period an additional 7.9 million tons of coal would have been needed by the industry in 1934. Coke ovens now supply 18,000 million cubic feet per annum to the gas industry. This closer co-operation between the two sections of the carbonising industry emphasises the need for an examination of the types of coal-blends suitable for coke and gas manufacture, a question that is being investigated at the Fuel Research Station.

The coke-oven industry is closely associated with the iron and steel industries, whose coal requirements have fallen by some 15 million tons a year. A considerable proportion of this is due to reduction in the amount of pig iron produced, but it is claimed by the British Iron and Steel Federation that since 1923, largely from the application of the results of research, £ 4,500,000 per annum has been saved in the cost of fuel. This figure indicates broadly that about 6 million tons less coal were necessary in 1934 than would otherwise have been the case.

The economies in the use of coal in furnaces have been secured largely by burning it in a form that enables it to be fed at a controlled rate into the combustion space. The greatly increased use of mechanical stokers and of pulverised fuel has given to coal and coke a large measure of the flexibility possessed by fluids such as oil and gas. Quite substantial advances are taking place at present in applying mechanical stokers to comparatively small coal—or coke-burning units such as are installed for central heating.

The use of pulverised fuel has increased in the last five years from 2¾ million tons per annum to over 4½ million tons. The Pulverised Fuel report states :—

> "Pulverised fuel is used for many purposes and there has lately been a marked expansion in its application to metallurgical purposes, which include heating and reheating billets, smelting and melting, annealing and copper refining. It is of interest to record that at the end of 1933 the first plant for supplying coal ready-pulverised was installed by a colliery in Yorkshire, and that pulverised coal of a standardised calorific value is now being offered from a plant in the London area for delivery in tank wagons to small consumers.
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> "Though these economies have the immediate result that less coal is mined, the total energy derived from coal and usefully applied was appreciably greater in 1934 than in 1910. The gain in efficiency has an important bearing on the cost of living and the cost of production of manufactured articles."

In the last eight years the amount of coal cleaned has risen from 51.4 million tons or 20 per cent. of the total coal raised to 87.5 million tons a year or 40 per cent. of the total.

The notable advances that have been made in cleaning coal, both by wet and by dry processes, have resulted in a reduction in the amount of inert material that is transported from the collieries and handled, as clinker and ash, after the coal has been burnt ; at the same time they have increased the difficulties of disposing of the dirt at the collieries.

Future improvements leading to increased economy in the use of fuel, the Report states, will depend more and more on the selection of the most suitable coal for the particular purpose required, and pre-treatment of the coal before its final combustion will become of increasing importance. The pre-treatment starts at the collieries, where the coal is graded and cleaned as required. The grading may consist of sizing alone, or may include blending the coal from different seams or the separation of the coal from one seam into different portions such as "hards" and "brights". Further pre-treatment consists in converting coal into gas, coke and tar, or its energy may be converted into electricity. The tar, or the coal itself, may be converted into motor spirit or oils.

The programme of research carried out by the Board is related to a greater or lesser extent to all these developments. Good progress is reported in the National Coal Survey which must form the foundation of future development in the use of coal. This work is being carried out in nine laboratories situated in the principal coal fields, and large-scale investigations are carried out at the Fuel Research Station. The object of the Survey is the examination of the coal seams as they occur in the ground and the various grades of coal as they are prepared and marketed by the different collieries.

> "There is an ever increasing movement," Dr. F. S. Sinnatt, the Director of Fuel Research, writes, "to regard coal as raised from the mine as a raw material which must be processed before it is offered for sale. In some respects coal is being viewed in the same manner as raw cotton. Treatment in washing and cleaning plants, screening into suitable sizes, together with the selection of parts of seams or the mixing of two or more seams, are the normal practice of the coal industry. This technique is, however, being rapidly refined, and accurate grading and precise mixing and blending to produce coals of uniform qualities are assuming increased importance. In some cases it would be an advantage if the inorganic matter present in the coal could be reduced to the lowest possible percentage ; an extreme case would be the use of pulverised coal in internal combustion engines, should this develop, and there are signs that a demand may arise for "ultra clean" coal. Coal containing less than 2 per cent. of ash may be considered as ultra clean, but lower percentages are possible, and greater demands for coal of this type may be made in the future.'

In this connection, it is pointed out, that the results of the Survey are showing that in practically all the British coal-fields there are seams containing less than 2 per cent. of ash. In many cases a still higher degree of cleanness can be attained. In Durham, for example, the ash content of "brights" from the Plessey seam varies from 0.8 to 2.0. In South Yorkshire, Haigh Moor coal supplied for household purposes contained only 0.8 to 1.2 ash. In South Yorkshire some crushed samples indicated a yield of between 90 and 70 per cent. of coal containing between 0.5 and 0.8 per cent. ash, and in South Wales two commercial samples were found to contain 0.7 to 0.8 per cent. ash respectively.

In other directions the work of the Survey is assisting in the often difficult problem of identifying coal seams, in districts where, for example, the seam is known by different names or different seams are known by the same name, or where correlation is difficult because of geological "faults". This problem, the Report states, is of importance because a wrong correlation of a seam may, after working through a disturbed area, result in unexpected troubles and danger from water and gas as well as in a waste of effort in searching for seams at a wrong level.

In North Staffordshire survey samples have been taken in a number of cases from seams which are not at present worked. In one case the results proved the seam to be of so good a quality as to justify the immediate re-opening of the mine. In South Wales and in the case of the Busty seam of Northumberland and Durham maps have been drawn showing where coal of various volatile contents occurs, thus enabling any variation in the coal to be predicted as the mines are developed.

Another interesting example of the work of the Survey comes from the Forest of Dean. Here it has been shown that a band of "black dirt" of variable thickness overlying the Coleford High Delf increases not only the amount of ash but also the sulphur in commercial grades, besides having a very deleterious effect on the coal from a carbonisation point of view. This material is similar in appearance and density to the coal itself and therefore does not lend itself to separation by any of the normal methods. It is concluded, therefore, that at present the only satisfactory method of dealing with this problem is to remove the "black dirt" from over the seam before actually getting the coal.

In connection with the preparation of coal for the market, good progress has been made at the Fuel Research Station with the development of methods of cleaning of fine coal and the clarification of washery water, leading to economy in the use of water and the prevention of river pollution. A new dry cleaning process is also being developed in which the unwanted dirt is separated from the coal by jets of air. Problems in connection with the mechanical breaking down of large coal to graded sizes suitable for particular purposes are being investigated.

In connection with the production of motor spirit and lubricating oil from home sources, researches have been continued into the principles underlying the hydrogenation of coal and the hydrogenation-cracking of tars and tar oils, the development of these processes is being studied in technical scale plant in order to obtain sufficient of the motor spirit and oils to test them under practical conditions. The motor spirit is being examined under service conditions. The most important item in this field has been the design and erection of a plant capable of treating about 300 gallons of tar per day, together with the distillation and refining plant required to deal with the spirit produced. Diagrams and descriptions of the plant are given, as well as an account of preliminary experiments to test the various parts and to gain experience in the control of the plant. The results of these experiments, it is stated, have fully justified the erection of the plant; only very minor alterations have been necessary, and little difficulty is anticipated in settling down to normal working at full capacity. It has been found that the technique of hydrogenation does not necessarily require high pressures and thanks to increasing knowledge of catalysts (*i.e.*, substances which hasten the chemical reactions although themselves remaining unchanged at the end of the process) a process has been worked out on a semi-commercial scale at the Fuel Research Station for treating, at atmospheric pressure, acids present in coal-tar from gas works and coke ovens to obtain motor spirits such as benzine.

Considerable progress has been made in the improvement of burners for pulverised fuel furnaces towards overcoming the difficulties of burning low volatile coal, such as some South Wales coal in furnaces, with restricted combustion spaces. Two of these new burners are being manufactured by commercial firms under licence and with one of them—the "Grid" burner—good results have been obtained in a Lancashire burner with a coal containing as little as 15 per cent. of volatile matter. A satisfactory solution has also been obtained to another practical problem presented in the burning of pulverised fuel. In pulverised fuel firing the distribution of the coal particles moving along a pipe or conduit in a stream of air is not uniform as regards the concentration or the size of the particles, so that dividing the stream into equal parts to supply two or more burners from a common stream is extremely difficult. Moreover, fluctuations occur—for reasons that are not fully understood—in the distribution, necessitating frequent adjustment of the burners to a varying supply of coal and air. A study has been made of the problems involved, and the difficulties have been overcome by a device that is at once simple and efficient. It appears, also, that the device can be adapted to other purposes; with slight modification it can be used for sampling, where a small proportion of material must accurately represent the bulk; or, on the other hand, the flow of material can be reversed, and the device will then intimately mix the material fed to it from separate streams. In some commercial installations, where they have been tried, these distributors have led to a reduction in the number of boilers necessary to supply the required load and to considerable saving in labour and fuel through the better reductions in fuel and labour costs through the better control made possible by their use.

The carbonisation of coal is being studied on a works scale in three types of retort—*viz.*, in a setting of horizontal retorts, in narrow vertical brick retorts, and in chamber ovens. Considerable interest attaches to a modified method of operating horizontal retorts, which has been developed at the Fuel Research Station. It has long been the practice to introduce steam into vertical retorts during carbonisation, but certain practical difficulties prevented this being done in horizontal retorts. The Report states that a successful method has now been evolved at the Station and the results show that the output of gas can be increased 8 to 10 therms per ton of coal carbonised, *i.e.*, the thermal yield of gas produced can be increased by about 10 per cent. at very slight extra cost. As nearly

7,000,000 tons of coal a year, *i.e.*, half the coal used in gas works in this country, is carbonised in horizontal retorts the potential value of this work to the gas industry is very great. Several large gas companies have been quick to realise this and have adopted the modification in their works.

"The intermittent vertical ovens," the Report states, "are in use for investigating the effects of blending strongly and weakly coking coals, with and without the addition of coke breeze. The best coking coals have been worked for many years, and in some districts are becoming scarce; it is therefore necessary to know as accurately as possible how good coke can be obtained from coals, or blends, not previously considered as possessing the best coking qualities."

Referring to domestic heating the Report states :—

> "The open domestic fire is still a national institution, but is responsible for much direct and indirect waste of fuel, as well as for most of the costly smoke nuisance. Small inefficient industrial boilers also give rise to smoke and waste. The increasing use of gas, coke and electricity is steadily improving the position, and further developments in production of easily-combustible coke and of suitably-designed open grates will accelerate the improvement. The output of free-burning smokeless fuel, produced by carbonising coal at temperatures lower than those of coke-oven or gas-works practice, is gradually increasing. The amount of smoke, especially from small industrial furnaces, can also be reduced by using mechanical stokers and suitable blends of coal, which are now being prepared commercially."
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> "The optical method devised for the comparison of the densities of smoke emitted by different coals has been utilised to study the effect of coal blending on smoke reduction. The method consists in comparing the density of a column of the smoke passing through an inclined tube situated at the top of the chimney with smoke screens of known density. Preliminary experiments in well and bar grates have shown that the amount of smoke per lb. of bituminous coal can be reduced by 10–25 per cent. by mixing with a low volatile coal."

There are 36 figures which appear in appropriate places and render the explanations very easy to follow.

This is one of the very few technical publications we have seen, which, in our opinion, could be read even by the non-technical man with pleasure and considerable profit.

Recent Developments in the Chemistry of Bicyclic Terpenes.*

THE introductory portion of the address deals in a short but comprehensive way with the homocyclic "bicyclic ring-systems, in general". By means of a chart, an idea is given of the various bicyclic ring-systems which can be constructed with or without bridge members, starting from three, four, five and six membered monocyclic rings, and this is followed by a systematic discussion on the chemistry of the more important members of those of the individual bicyclic rings known to the day, thus bringing into prominence the gaps that remain yet to be filled. The theoretical speculations of Sachse and Mohr on the multiplanar character of *cyclo*hexane and higher carbon rings that led the way to the brilliant investigations of Huckel and his followers to a study of the stereochemistry of bicyclic rings like decalin and hydrindane are briefly referred to. In passing, the interesting case of *cyclo*hexane itself is examined. After shifting the evidence for and against a multiplanar configuration for *cyclo*hexane, the con clusion is drawn that any claim advocating the existence of multiplanar *cyclo*hexane rings has to be accepted with reserve.

The bicyclic terpenes themselves which come in for attention next are conveniently divided into (*a*) Camphane-Fenchane, (*b*) Santane, (*c*) Pinane, (*d*) Thujane, and (*e*) Carane series. The various sections are again divided into subsections, evidently for the purpose of lucid presentation. The outstanding and recent contributions are described and the work done by the President and his students is incorporated at appropriate places.

In the camphane-fenchane series, reference is at first made to the recent syntheses of parent compounds, like *norbornylane* (Komppa and Beckmann, 1934), endocamphene (Lipp and others, 1927), *d* and *l*-epi-camphor (Bredt, Asahina, 1929, 1933), homocamphor (Lapworth and Royle, 1920), and β-homocamphor (Salmon Legagneur, 1931). The very useful "diene" reaction of Diels-Alder as applied to the synthesis of important substances in this series (1929 1931) including camphene and camphor is dealt with. The syntheses of degradation products like camphenic (Lipp, 1914), homo*apo*fenchocamphoric (Bardhan and others, 1935), *apo*fenchocamphoric (Short, 1927) and Balbiano's acids (Bardhan, 1928) are briefly described and those awaiting synthesis are pointed out. The tricyclic compounds derived from members of this

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*In order to draw the attention of the scientific world to some of the important and interesting features of Dr. P. C. Guha's presidential address to the Chemistry Section of the Indian Science Congress (Indore, 1936) not fully covered by the abstract published in a previous issue of the *Journal* (Vol. 4, No. 7, p. 505) we are publishing above another summary. Chemists in India will feel indebted to Dr. P. C. Guha for his admirable and learned address bearing on an important branch of research in Organic Chemistry.—ED.