difficulties which will require much patience, great courage, untiring effort, and a fine spirit of sacrifice on the part of the community to realise. Yet the reward will be great. There will need to be the closest co-operation among educational authorities to give the requirements of the Act their full effect, and they can only be solved painfully step by step. The supply of suitable teachers is in itself a vast problem, as well as the provision of appropriate buildings. The arrangement of the hours of instruction so as to meet the necessities of the various industries is scarcely less perplexing. In many cases it must be met by taking the whole of a working day or more per week for a limited period, and in rural areas during some weeks of the winter season. Indeed, it will be seen that no greater step was taken during the great war towards peace-time reconstruction, seeing that the Education Act, worked to its logical limit, means reconstruction all round.

THE PRODUCTION OF OIL FROM MINERAL SOURCES.[1]

MANY and very various products can be obtained by the carbonisation of bituminous minerals, the character and quality of the materials produced depending mainly upon the temperature at which the process is conducted. It does not, however, follow that all identical products will be obtained from different bituminous materials when they are subjected to the same temperature conditions, because the chemical composition varies, and consequently when subjected to heat the method of decomposition also varies. The organic body or bodies in shale are called kerogen, and this, on being subjected to moderate heat, yields oil of the olefine and paraffin series, ammonia also being produced. The organic matter in coals and cannels is generally described as volatile matter, and probably differs considerably in chemical character from the kerogen; consequently, on being subjected to moderate heat, different products are obtained, although they also are mainly of the olefine and paraffin series. When coals are subjected to high temperatures a different class of hydrocarbon is produced, mainly the hydrocarbons of the benzene series. It is probable that this would also be the case to a greater or less extent if shale were also subjected to high temperature in retorts similar to those employed for heating coal.

It is extremely difficult to obtain an even distribution of heat in any carbonisation process; consequently it is by no means easy to make certain of always obtaining the same products from a given material in the same proportions, and great care has to be exercised to ensure that the conditions are as nearly constant as possible. The form of the retort has much to do with the quantity and quality of the products obtained. In all cases the first effect of the heat is low-temperature distillation, because the material is introduced cold into the retort, and, however high the temperature of the retort, the heat must first get through the badly conducting mass before the temperatures can approximate to that of the retort, and by that time a considerable part of the volatile matter will have been driven off. Then another question arises, viz. whether the form of the retort is such that the volatile products, as they are formed, come in contact with the surface of the retort before being drawn off, or whether they are removed without being heated after they have been expelled from the material. The quality and character of the final products depend almost entirely upon this. Thus in horizontal gas retorts the volatile matter as it leaves the coal comes in contact with the highly heated arch and sides of the retort before it enters the ascension pipes and is carried to the hydraulic main. This causes radical changes in the volatile products, and hydrocarbons of the benzenoid or aromatic series are largely produced. On the other hand, in a vertical retort the volatile products, as they are released from the coal, ascend upwards through the cold incoming coal, only a portion coming in contact with the hot walls of the retort, and, as a consequence, the resulting products contain a considerable proportion of hydrocarbons of a paraffinoid nature.

Whether high or low temperature should be employed for carbonising bituminous material entirely depends upon what products are required. For gas-works, where a large-volume yield of gas is required, high temperature is essential, but where motor spirit, fuel oil, lubricating oil, and paraffin wax are required, low-temperature carbonisation must be adopted. In low-temperature carbonisation the gas produced is less than half that obtained by high-temperature carbonisation, and contains less hydrogen and more hydrocarbons than the latter; low-temperature carbonisation could, therefore, not be employed for the manufacture of gas for lighting purposes. The main distinctions between high and low temperature are as follows:—

High Temperature.	*Low Temperature.*
(*a*) Large volume of gas, say 12,000 cu. ft. on the average.	Low volume of gas, say 5000 cu. ft. on the average.
(*b*) Yield of sulphate of ammonia, on average, say, 20 lb.	Yield of sulphate of ammonia, on average, say, 10 lb.
(*c*) Yield of tar on average, say, 11 gallons per ton of coal carbonised.	Yield of tar (crude oil) on average, say, 20 gallons per ton of coal carbonised.
(*d*) Tar is largely of aromatic series, and yields benzol, toluol, naphthalene, anthracene, carbolic acid, and cresols. These are the raw products for the manufacture of dyes, explosives, photographic chemicals, drugs, and many other synthetic products.	Tar (crude oil) consists of hydrocarbons of the aliphatic series (paraffins, olefines, and naphthenes). From the tar can be obtained motor spirit, fuel oil, lubricating oil, and paraffin wax. The tar acids are useful for disinfectants, but of no use as raw products for other industrial purposes.

It should be mentioned that when coals high in volatile elements and rich cannels are subjected to low-temperature distillation, much larger yields of crude oil are obtained, as much as 40 and 60 gallons.

Oils obtained by the carbonisation of bituminous material come under the same category as natural oils; they may, therefore, be classed as mineral oils, even although their origin was probably organic, as was that of natural oils, but many organic substances, such, for example, as peat or wood, will give oils of a similar character when carbonised under suitable conditions.

At the outbreak of the war the world's production of natural oil was in the neighbourhood of 50,000,000 tons, and last year more than 60,000,000 tons.

Before the war Great Britain was, with the exception of the oil obtained from the Scottish shale-oil industry (275,000 tons crude oil), entirely dependent upon imported oil for all the various purposes for which oil is required. Our aeroplanes, warships, motor-cars, etc., were dependent upon sea transport for petrol and fuel oil, and our machinery for lubricants. Unfortunately, we are still in the same position. Great Britain, with her vast Navy and her great

[1] Abstract of a paper read before the Institution of Petroleum Technologists on December 17, 1918, by Dr. F. Mollwo Perkin.

fleet of aeroplanes, is dependent for fuel upon sea-borne transport, and this should not be necessary, or, at any rate, only in a partial degree. In the future our merchant ships will probably burn oil fuel. We have at hand mineral resources from which we can produce mineral oils—petrol, fuel oil, lubricating oils, and paraffin wax. Why do we not employ them? There are, of course, many difficulties in founding a new industry, and one of the greatest difficulties has been Government action or inaction. There is now, however, a stirring among the "dry bones"; a great deal of experimental work has been carried out, much of it on semi-commercial plant, and there are now several large schemes under consideration, which would involve the putting up of an extensive plant both for retorting and refining the oil and to obtain power from the residuals or domestic fuel.

The ordinary shale retort is not adapted for dealing with caking bituminous material, or, indeed, for treating cannel and non-caking coals; hence the larger amount of research work which has been carried out in the endeavour to devise a suitable retort for dealing with bituminous materials which contain a large amount of fixed carbon, and will yield, after extraction of the volatile matter, a good fuel for domestic purposes. It might be replied: "But this is already obtained in the gasworks, where, when coal is carbonised to produce gas, a residue of from 68 to 70 per cent. remains in the form of coke, besides which tar and ammonia are produced." True, coke is produced, and this coke contains a very low percentage of volatile matter, and for this reason is not adapted for burning in the ordinary grate. Coke produced by low-temperature carbonisation (350°–550° C.) is softer than that produced at high temperatures (above 900° C.), and usually contains from 7 to 11 per cent. of volatile matter. The presence of this volatile matter causes the coke to burn readily, practically without flame or smoke, and to give out a great heat. It is, consequently, very clean for household purposes, and if it were used instead of coal the cost for the painting and decoration of the house would be considerably reduced. Furthermore, the atmospheres of our large towns and cities would be very much less contaminated by smoke, and the living conditions would be healthier.

In producing this smokeless fuel by low-temperature carbonisation there is produced at the same time oils of the aliphatic series, which on refining yield motor spirit, fuel oil for internal-combustion engines or for direct boiler firing, lubricating oils, and paraffin wax, besides which there is a small quantity of ammonia and sufficient gas to fire the retorts and leave a small surplus.

Now in low-temperature practice there are three possibilities, any of which might be a financial success, or they might be combined:—

(1) The production of oil and smokeless fuel.

(2) The production of oil and the conversion of the fuel residue into power-gas by gasifying it in a producer.

(3) The production of oil, using a portion of the fuel for domestic purposes and gassifying the remainder.

In districts where power is not required for manufacturing purposes, but where coal or cannel could readily be obtained without having to transport it for long distances, then the first proposition would be the one to embark on.

On the other hand, where cheap power in large bulk is required, then (2) would be the process to take up. Probably in all cases a certain proportion of the residue would be sold as smokeless fuel.

Those who do not know the quality of the low-temperature products have said: "We shall then be able to win back the dye industry from Germany." We nearly lost the war to Germany from lack of oil. Lord Curzon recently told us that at one time there was a stock of only 900,000 tons in the country against a minimum of 1,500,000 tons which the Admiralty considered necessary. The Fleet, in fact, had to restrict its exercises in order that, if a battle took place, there should be sufficient oil to go round. When we know more of the internal management of Germany during the war, it will doubtless be found that the Germans produced large quantities of oil by low-temperature carbonisation of bituminous material. They were doing so before the war.

One of the reasons why low-temperature carbonisation has, so to say, hung fire is due to the exaggerated claims made by inventors, backed up by company promoters. In all distillations of bituminous material water is obtained along with the oil, and is at times extremely difficult to separate, as the specific gravity of the crude oil approximates to that of water. In fact, it is not unusual to find 30 to 40 per cent. of water in the crude oil. This has all been lumped in as oil, hence the impossible claims for oil yields which have been made.

The days of exaggeration are, it is to be hoped, past, and careful research has taken the place of romance. If the claims are more moderate, at any rate we are working on a sure foundation, and many of us believe that a home oil industry can be founded on business lines, which, although not rendering us self-supporting, will, at any rate, supply a portion of our needs and tend to prevent exploitation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—A new educational office has been established by the council of St. John's College, with a view to the co-ordination of the college teaching in natural science subjects and the special encouragement and direction of scientific research. Dr. W. H. R. Rivers, fellow of the college, has been appointed to this office, with the title of prælector in natural sciences. Mr. R. Whiddington, fellow of the college, has been appointed to the office of director of studies in physics.

The compulsory Greek in the Previous Examination was abolished by vote of the Senate on January 17. By a very large majority (161 to 15) the Senate approved a report of the Previous Examination Syndicate containing the recommendation that Greek should be made an optional subject. Although the final plans for the reconstitution of the examination are not complete, since the details of parts ii. and iii., which it is proposed shall consist of papers in mathematics, science, and English subjects, are still under consideration, the question of compulsory Greek was regarded as being so urgent that the proposals for part i. were submitted to the Senate without further delay. In consequence of the approval of this report, a candidate, after January 1, 1919, is allowed to take as an alternative to the old classical part i. of the Previous Examination a new part i., in which Latin is compulsory, but Greek is made alternative to French, German, Italian, or Spanish. The "additional subjects," which hitherto have had to be taken by candidates for an honours degree, are abolished.

Men who have been engaged on military service are now coming up to the University in large numbers, and lecture-rooms and laboratories have begun to resume something of their pre-war aspect. Four terms