Modern Methods of Using Coal

By F. W. Gray

COAL is of world-wide occurrence. It is found in rocks of every geological era since the Carboniferous Era, and is being formed today. The classification of coal into its numberless varieties has occupied many minds over many years and is the subject of lively interest and continuous research at this time. The methods of coal utilization are therefore as numerous as the locations of its occurrences, of its chemical and physical variations, and of the economic needs and achievements of the populations living where coal is mined. The processes and methods of coal utilization should always be viewed in relation to the varying conditions named and other conditions that cannot be covered in any brief manner. This complex of considerations precludes hard-and-fast or dogmatic approach to any given local development of the mining and use of coal. While even in our divided world civilisation the gain in technical knowledge of the constitution and uses of coal is shared more or less in common, it should not be assumed that processes called forth by local needs, say in Europe, are adaptable to or likely to be commercially successful in North America. Much capital has been unprofitably invested because this fundamental condition has not been recognised and admitted.

In Western Europe and the British Isles the native sources of petroleum are meagre or non-existent, and petroleum must be imported at relatively high cost. This economic problem has increased in importance as the use of petroleum and its derivatives has increased in industry, transportation and defence.

Much attention has consequently been given in Europe to the manufacture of motor fuels from coal, primarily from the viewpoint of national defence. It has to be conceded that to date it has not been found possible to manufacture motor fuels from coal or coal derivatives as cheaply as petroleum can be imported, but coal-derived motor-fuels are being manufactured on a large scale with the assistance of protective tariffs and subsidies to manufacturers.

There is no incentive to the use of coal, or oil-shales, for production of motor-fuels in North America so long as ample supplies of cheap petroleum persist.

Central heating of buildings and houses is general in North America, and the use of the open grate, burning bituminous coal is not as universal a practice as it is for example in Britain. The ample supplies of anthracite, natural gas, petroleum, supplemented by high-temperature coke, and their use in central heating-furnaces avoid the public demand which exists in Britain for a fuel that will provide a cheerful open-grate fire while avoiding smoke pollution of the air of great cities in a foggy country. To meet this hotly-debated situation there have been developed many "low-temperature" coal-carbonisation processes, designed primarily to produce a relatively smokeless fuel but with sufficient volatile combustibles left in the fuel to ignite easily and give a cheerful glow in use. The other main object of low-temperature processes has been to produce light oils suitable for motor fuel.

While valuable additions to the technical knowledge of coal carbonisation have resulted from experimental plants using some modification of low-temperature carbonisation, commercially there has been much more loss than profit in such ventures, and at this date by far the greater yield of carbonisation products of coal comes from high-temperature carbonisation processes, while hydrogenation methods and synthetic processes, such as the Fischer process, are making notable progress in so far as manufacture

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of light oils and motor fuels are in question.

The Report of the Secretary for Mines in Great Britain for 1937 gives the production of refined motor spirit, including motor benzole, from coal, coal-tar and coal-tar oils for that year in the United Kingdom as follows:—

High-temperature Carbonisation:	
At Coke-ovens	34.5
At Gas-works	10.0
Low-temperature Carbonisation	1.0
Tar and Tar-oil distilleries and refineries	11.8
Hydrogenation	35.0
From Shale	7.7
	100.0

The important position attained by hydrogenation is clear from these figures. This method is used at the Billingham Plant of Imperial Chemical Industries. It was planned to produce up to 45 million gallons of petrol per annum from coal, creosote and low-temperature tar, and it was anticipated some 600,000 tons of coal would be required each year. In 1937, 35 million gallons of petrol were produced compared with 33½ million gallons in 1936. The total quantity of coal consumed in this plant for all purposes in 1937 was 440,000 tons, of which only 110,000 tons was directly hydrogenated. The greater part of the motor spirit produced was obtained by hydrogenation of creosote (a derivative of coal-tar), low-temperature tar, high-temperature tar, anthracene oil and neutral oils. The investment required for a plant of this character is said to be from six to eight million pounds.

An interesting and unforeseen consequence of the operations of the Billingham Plant—still in its experimental stages—has been the use of coal-tars of various composition provided by low-temperature plants, by-product coke-ovens and gas works.

Indeed it now appears as if the future of low-temperature carbonisation lies in the possibility that the tars and tar-oils from such plants can be disposed of to central hydrogenation plants in sufficient volume to permit of commercial production of the smokeless fuel for open-grate fires. The Falmouth Report in England dismissed low-temperature carbonisation as a possible major source of indigenous oil supplies because the production of oil was small relatively to the tonnage of processed coal requiring to be marketed.

The synthetic processes of making oil from coal is best exemplified by the Fischer-Tropsch method which has been developed in Germany as an aid to the self-sufficiency plans of the Reich. This method, in its bare outlines, takes water-gas or "blue gas" produced by passing steam over red-hot coke. The gas produced—a mixture of carbon-monoxide and hydrogen—is recombined in the presence of a catalyst to produce an oily compound that upon fractionisation will produce motor-spirit, heavy oils suitable for Diesel motors and waxes.

The interest of European nations in production of oils from coal is that of national defence. In Britain the whole question was considered by a sub-committee of the Committee of Imperial Defence, who recommended the guaranteed preference of fourpence per gallon on motor spirit should be raised to eightpence and made operative for 12 years from 1938.

Coal carbonisation in Canada, which is chiefly associated with steel plants and gas works, has to date been—with some exceptions interesting because of their technical nature—entirely high-temperature, with a tendency for the by-product coke-oven to replace the retort method at town gas-works. The reasons for this are that the Canadian demand is for a hard, dense coke primarily for metallurgical processes, and in so far as domestic coke is concerned an anthracite substitute is required. Also the demand in Canada is for high-temperature tars and not for low-temperature tars because these are unsuited to the products of the tar distilleries, in especial road tars.

Further, and this is probably the most important factor in coal carbonisation as it has developed in Canada, the modern by-product coke-oven is adapted to and designed for economical mass-production; enabling a uniform product to be made on a large scale with minimum interruptions and at a minimum cost.

Much progress is being made in all countries in the use of coal for steam generation in pulverised form and in this regard Canadian practice is at least keeping pace. In Great Britain pulverised fuel installations have risen from 74 in 1929 to 216 in 1937 and the use of coal in this form has increased from 2,755,000 tons in 1929 to 6,101,000 tons in 1937.

A recent example of good practice in modern steam-boiler installation is the installation about two years ago of two large boilers at the Sydney Steel Plant. These are designed to be fired by blast-furnace gas or pulverised coal, either fuel alone or in combination, and can be converted from one fuel to the other in about 20 minutes. These boilers have a steaming capacity of 185,000 lbs. each per hour when delivering steam at 475 lbs. pressure and 750° F. total temperature.

Ideally complete utilization of the heat energy in coal should theoretically be secured by supplying each particle of combustible matter present with sufficient oxygen to effect complete combustion. An intimate and correct admixture of the fuel particles with air is therefore to be sought.

The use of coal in small particles intimately mixed with air is in effect a specification of coal in pulverised or dust form. Similarly greater efficiency in combustion is possible when the combustible values of raw coal are used in the form of oil and with still greater efficiency in the form of gas, because of the possibility of intimate and exactly measured combination with the combustion air, that is pre-heated air.

For Canadian industrial conditions and the full use of Canadian coals, pulverised-coal promises to give best results. In a contribution to the Mining Society of Nova Scotia in 1924 the writer dealt with the suitability of pulverised-coal plants for Canadian conditions, and as the statement then made is applicable to present-day conditions the following quotation seems permissible:—

"The completeness and efficiency of combustion in a properly designed dust-fired furnace permits the use of locally available coals of inferior quality, and enables them to be used commercially instead of imported coals of better quality.

That is to say, some grades of coal of low calorific value, that are not economically usable in lump form on grates, are usable in pulverised form, because of the more complete combustion thereby obtained, and the consequent more efficient results.

In the case of coals that are unsuitable for steam-raising in grate-fired furnaces, because of clinker troubles, (arising usually from a combination of high sulphur content and low-temperature fusibility of the ash content) use in pulverised form has obvious advantages, and in addition gives the benefit of any heat units that are contributed by free sulphur in the coal.

By the use of water-screens it has been found possible to precipitate the ash and cause it to fall to the bottom of the furnace in granular form, thus avoiding the deposit of the ash on the boiler-tubes and in the flues.

It is not, of course, claimed by the advocates of pulverized coal that a poor coal will be made equal to a good coal by this method, because where a good coal is available it will always give better results than a poor coal, if the same method of firing is used in each case.

There has as yet been no worth-while attempt, on a commercial scale, to utilize the poorer coals of Canada, with the exception, possibly, of some form of concentration or benefication, such as was attempted by the Lignite Utilization Board. This is a statement generally true of all North America, where, up to this time, so great a variety of excellent coals have been available that only the best of them have been used. Canadian industrial concerns have followed the general practice of purchasing coals of first-class quality, too often for use in out-of-date equipment. That is to say, the deficiencies of equipment have been sought to be compensated by excellence of fuel quality. It may not be inopportune to suggest that thought should be expended on obtaining the best results from local fuels of less excellence through adoption of equipment designed to use these fuels to advantage.

Pulverized-coal firing will, it may be forecasted, attain much importance in districts containing lignites, such as Saskatchewan and Alberta, and in enabling wider general use of such coals from the Maritime Provinces as combine high calorific value with the presence of fusible ash, and have a tendency to clinker where forced draft is used under grates of small area.

Any method of coal firing that enables general use of local fuels of varying quality without greatly impairing the load that can be carried by a boiler-plant, is of especial interest to Canada, if more extended and permanent use of home-mined coals is considered to be desirable. From this angle all developments of pulverised-coal firing should be closely followed by those interested in Canadian coal mining."

In the meantime the very successful powdered-coal installation has been made at the Seaboard Power Plant at Glace Bay, where two 7,500 K.W. turbines operating on steam at 750 degrees and 420 lbs. pressure, are fed from boilers using only refuse coal from the colliery picking belts, averaging over 20 per cent in ash content.

It may be conservatively stated that combustion practice in the East of Canada is modern in outlook and is developing along lines indicated by the character of the coals available. It may also be conceded after consideration of the facts reviewed in this summary of a very large set of questions, that there is no place as yet in our Canadian economy for plants to produce "oil from coal". We actually possess in our large high-temperature coking and gas plants the equipment best suited to our conditions and capable of being quickly adapted to production of motor fuels, i.e., benzols—in the unlikely contingency of a shortage of petroleum products in North America.

The chief problem of the Canadian coal-producer and especially of the coal producer in Nova Scotia is to get coal to market at a cost competitive with imported coal. That is our real problem. Not the uses of coal, but how to get coal cheap enough to be able to get people to use it, is the line of research which is likely to be most profitable to all interested in Nova Scotia coal-mining, operators and workmen alike.

Economic Planning for Nova Scotia

By George V. Haythorne

NOT many years ago anyone speaking on the subject of economic planning would have had to explain at some length his reasons for so doing. Unless he restricted the use of the term, as is rarely done, to apply only to planning done by individuals he would have had to answer the queries of those who would claim that any thought of planning in the field of economics constituted a serious interference with the existing organization of business, which it was thought, worked best when left completely alone. These questionings and doubts, today, are breaking down and more and more people are recognizing the importance of viewing economic problems on a wider scale, of taking stock of their economy as a whole to see what effect certain policies or lack of policies are having on the various groups in the country.

There have been several factors giving rise to this change of attitude on the part of people from a pre-occupation with those matters relating to how they make their own living to a wider interest in economic questions which confront the whole state.

An earlier interest in social problems affecting communities provided something of a basis for an interest in broader economic questions. Work in the fields of public hygiene, family welfare and education served as a background for this wider interest.

The recognition that the frontiers of settlement have been reached and that steps must be taken to conserve natural resources so that they will be of value for present and future generations has played an important part in bringing about the new emphasis. Until recently many young people left Nova Scotia annually to help open up sections in other parts of Canada. Today this is

EDITOR'S NOTE: The article is the shortened version of an address given before the Rural and Industrial Conference in Antigonish last August. Mr. Haythorne is Secretary of the Nova Scotia Economic Council.