

effort to bring before the engineers of this country in a public way the apparent wastes going on, and the possibilities of future development, if worked on the existing English practices.

The author would like to express his indebtedness to the coking and gas engineers of the United Kingdom, especially Mr. Jos. Harrison, Middlesborough; Messrs. Chas. Hunt and P. N. Hambly, London; Messrs. S. Hunter, E. Lloyd, and A. Naylor, Manchester, through them in enabling him to gather sufficient data and experience on the subject matter of this paper.

Members of the Australian Forces have found the Engineering profession of England quite eager at all times to go to any extreme in order to comply with a request; the Australian uniform was alone sufficient guarantee, and with that one could obtain without question all data he required, and permission to visit any works.

DISCUSSION.

MR. POOLE: I have much pleasure in moving a hearty vote of thanks to Mr. McAuliffe for his highly interesting and valuable paper. Mr. McAuliffe is to be congratulated on the thorough and able manner in which he has dealt with this subject, which is of increasing importance to this country.

The Association was to be congratulated in that a new class of subject had been added to the already wide scope of Engineering subjects which from time to time have been presented to members. It was also a pleasure to note that one of the younger members, while serving his country with the Expeditionary Forces, had taken advantage of his furlough for visiting modern coking and recovery plants in Great Britain to ascertain the most

recent developments in practice. It is to be hoped that the Author will complete and present to us his contemplated paper on Coal Washing.

The recovery of by-products from coking is a most important one for every coke-producing country. Coal, like other mineral resources, is a wasting national asset in that once a ton of it has been mined and used (or misused) it cannot be replaced. There is a definite, even if distant, limit to the coal asset of the State. It is, therefore, a national duty that steps be taken to prevent the reckless and wanton misuse in the mining and utilisation of coal. The conservation and proper utilisation of natural resources, but especially of coal, is one that has been receiving close attention in many countries. Germany, with its national organised foresight, has done more in this important matter than any other State, e.g., it is necessary for coking plants to be provided with by-product plants. Public opinion and practice in Great Britain and U.S.A. are moving in the same direction. The time is now ripe for similar serious consideration in New South Wales.

The coals that are being mined in New South Wales belong to the Permo-Carboniferous Age, and are divided into the Lower, Middle and Upper Coal Measures. The Lower Measures are only worked in the Northern District, e.g., the Maitland-Greta Field. The Middle Measures are only in the Northern District, and very little worked. The Upper Measures are worked in the Northern, Western and Southern Districts. There are also Coals of Mesozoic Age in other Districts, but these as yet are not being worked.

In Table 1 the Author gives average analyses of Coals from New South Wales. That quoted for the Northern District is for the Lower Measures. The average analysis of the coal of the Upper Measures is as follows:—

..... Volatile Matter	36.0%
..... Water	2.0%
..... Fixed Carbon.....	53.3%
..... Ash	8.7%
..... Sulphur	0.5%

The coals of the Northern District, more especially those of the Lower Measures, are good gas-making coals, but produce a "tender" coke.

Metallurgical Cokes are made from coals of the Upper Measures, viz., Bulli Seam in the Southern District, part of the Lithgow Seam in the Western District, and the Borehole Seam in the Northern District. Of these, the Bulli Coal Seam produces the best coke, and most of the Metallurgical Coke used in Australasia comes from this source. The best coals for making metallurgical coke contain about 25 per cent. of volatile hydrocarbons; if the percentage is higher the coke is light and friable, and with a decreasing percentage the coal has a decreasing capacity to coke or fuse together. Good coke may be made by blending various types of coal to make a coke superior to that from any constituent coal.

The percentage of oxygen in coal greatly influences the coking capacity of a coal, as pointed out by the Author. Slack from a good coking coal which has been exposed to oxidation in heaps may entirely lose the capacity for coking.

Good metallurgical coke should have the following qualities:—(a) Hardness, (b) Open cell structure, (c) High rate of combustibility, (d) Lowness of Ash. New South Wales Cokes have usually to be sent a long distance. Hardness or its capacity to withstand rough handling is, therefore, a very essential quality.

Coking in New South Wales is undertaken in Beehive ovens of various types, semi-retort ovens and retort ovens.

Of these only one plant is working, with a plant for the recovery of by-products.

It is urged in favour of the continuance of erecting Beehive oven plants that they are—(a) Easily constructed, (b) The capital cost is moderate, (c) They are easily worked, and that no great technical knowledge is required, (d) They are easily put in or out of commission to suit fluctuations in trade demands, (e) The coke produced in the Southern District is excellent in quality, and there is a strong demand for that type of coke.

At first sight there would appear to be a wanton waste of valuable resources, but it should be clearly remembered that in the past there has not been a payable market for by-products. The economical conditions controlling the establishment of by-product plants have been materially improved in recent years. The only working by-product plant is at the Broken Hill Proprietary Company's Steel Works at Newcastle, where there is ready use for surplus gas and tar as fuel within the works.

There is, however, one ignorant waste at non-by-product plants, for which there appears to be very little excuse, viz., that of the non-utilisation of waste heat from the ovens. All coke works require power for finely grinding the coal, and for mechanical handling of the coal and coke. Beehive plants may be readily constructed at a small extra cost, so that the waste heat from the ovens may be utilised for raising steam in boilers. Nevertheless, there are only two plants in New South Wales at which this is done.

The amount of surplus heat from coke oven plant depends on the method of working the plant, as will be seen from the following table:—

Method of Work.	Temp. of waste gases.
Regenerative By-Product Ovens. . .	1000 to 1100 deg. F.
Waste Heat do.	1400 to 1500 deg. F.
Beehive Ovens	1600 to 1900 deg. F.

Mr. Blake Walker, in a recent paper before the Institution of Civil Engineers, stated that on the average the following power was obtainable from waste heat by-product plants, viz., 1 to 1.25 tons of steam at 100 to 120 lbs. per sq. inch for each 1 ton of coal that is coked, also power equal to about $\frac{1}{4}$ to $\frac{1}{3}$ of the above obtainable by utilising surplus coke oven gas in gas engines.

The waste heat from Beehive plants is greater than that from other types, but the method of working these ovens gives a much greater variation in the temperature of the waste gases. Unfortunately, the minimum temperature occurs during the period of maximum demand for power. Investigations carried out by Mr. Poole show that with intelligent management 1 ton of 100 to 120 lbs. pressure steam can be obtained during maximum demand per ton of coal carbonised.

By-product ovens may be heated with producer gas made from waste small coke, thus saving the high quality coke oven gas for other purposes. There has been a great extension of installation of by-product plants in Great Britain and also in U.S.A. British plants use charges of 10 to 12 tons, and in U.S.A. charges up to 20 tons are used. In the latter country greater use is made of silica brick in the construction of the ovens, thus admitting of higher temperatures and faster work, but at the expense of a lower recovery of by-products which have lower values than in Britain.

By-product coke is driving Beehive coke off the market in Britain, not because it is a better coke, but because Beehive plants are not remunerative enough to compete with by-product plants. Coke is becoming the by-product instead of the main product. The by-products of coking have been the source of enormous national wealth in Germany.

Coke oven gas is largely and increasingly being used for public supply for domestic and town lighting and power in Britain, U.S.A. and Germany.

It is supplied from—(a) Ordinary coke work, (b) Plants built as an adjunct to ordinary gas plants, or even their sole source of supply of gas. Their use under the latter heading is urged for the following reasons:—(1) Decreased labour costs; (2) Charging may be confined to day shift; (3) Coke, breeze or low grade fuel may be used for heating the ovens, thus conserving the whole of the richer gas for sale purposes; (4) A good metallurgical coke and a superior tar may be obtained.

There is in this State one serious obstacle that stands in the way of utilising coke oven gas for public supply, viz., the candle power standard of illuminosity demanded under the Gas Act. This standard has been abolished in Great Britain and most other countries, and a calorific standard substituted for it. This alteration in standards should also be made in New South Wales.

If no illuminosity standard is required, a very large increase of benzol may be obtained by stripping the gas. "Stripping" considerably lowers the illuminosity of the gas, but only slightly lowers its calorific value.

Increasing use is being made of tar as a fuel, as it has a higher calorific value than crude fuel oil. Tar has, in Australia, a greater monetary value for use as fuel than for other purposes. It is being increasingly used for this purpose in Metallurgical Works.

MR. WM. CORIN said: I have read Mr. McAuliffe's paper with much interest, and am very glad that he has brought this matter prominently before the Association.

When I visited England and the Continent of Europe in 1913/4, I made particular inquiries with regard to coke ovens and the use of surplus gas and waste heat for

power supply, and visited a number of coke ovens, including in Great Britain:—

Powell Duffryn Co.'s Power Station at Bargoed,
Harrington Coke Works, Workington,
Grassmoor Colliery,
Nunnery Colliery,
Priestman Collieries, Blaydon,
Birmingham Corporation Gas Works,

and in Germany:—

Eschweiler Colliery Co.'s Anna Pit,
Gelsenkirchen Co.'s Bonifacius Mine,
Deutsch-Luxemburg Co.'s Prinz Regent Mine.

I made certain recommendations in an official report which I presented upon my return, which was not, however, published.

More lately I have referred to the question in papers read before the Electrical Association and the Institution of Civil Engineers.

I have estimated the value of the wasted by-products from all the coke ovens of the State at pre-war prices as £350,000 per annum, which agrees close enough for an estimate with the £400,000 per annum mentioned by Mr. McAuliffe.

When the question is mooted in New South Wales, one is met by the argument that the South Coast coal is low in volatile hydro-carbons, and that there is only one successful installation of by-products coke ovens elsewhere; and, further, that the amount of ammonia and benzol is not worth recovering.

I found, however, that the Germans were quite content to recover a fraction of 1 per cent. of benzol and less than 1 per cent. of ammonium sulphate, and that they made this pay. Then, again, one is informed that some of the mining interests have looked into the question, and

have turned it down from a financial point of view. In the meantime, they continue to discharge into the air hundreds of thousands of pounds' worth of valuable tar, ammonia and benzol, thus wasting part of the valuable assets of the State which should be employed for the improvement of roads, for the fertilisation of the soil, and other uses mentioned by Mr. McAuliffe, as well as heat which should be turned into mechanical power.

What struck one about the German Coke Ovens was the great number grouped together, and evidently by careful and well-organised working they reduce their operating costs to a minimum.

I am of opinion that rather than for all the Beehive ovens on the South Coast to be replaced by by-product ovens where they are situated, it would be better for a number of collieries to combine and form one large coking establishment where the by-products might be treated systematically, with a view to saving every ounce of useful material commercially feasible, and furnish a supply of waste heat or surplus gas, or both, to a modern power station, which should be tied in with the general system of power mains supplying Sydney, the South Coast District, and the surrounding area.

In Great Britain the Government has risen to the occasion, and the Committee of the Privy Council for Scientific and Industrial Research has appointed a Fuel Research Board, consisting of—

Sir George Beilby, F.R.S. (Director)

The Hon. Sir Charles A. Parsons, K.C.B., F.R.S.,

Sir Richard Redmayne, K.C.B.,

Sir Richard Threlfall, K.B.E., F.R.S.,

Professor W. A. Bone, F.R.S., Consultant to the Board, who have reported on a scheme of research and on the establishment of a fuel research station, with a view to

definitely experimenting on what best can be done with British coals in order to avoid the deplorable waste that has hitherto taken place, and make use of all the products to the best advantage.

The Board has described in a Report dated 10th September last their scheme involving a fuel research station which has been planned in the vicinity of East Greenwich Gas Works, of the South Metropolitan Gas Company, who are cordially co-operating with the Board, having provided a site 250ft. wide x 750ft. long on the main South-Eastern Railway Siding, and who have undertaken to give every facility for transport of coal and other supplies to the station, and to take over at market prices the surplus products, gas, tar, liquor, and coke, resulting from the operations of the station. There is, therefore, every indication that this question of the most economical use of fuel will be definitely solved on a large scale in Great Britain at an early date.

I submit that what is needed is for New South Wales similarly to enter upon a well-considered scheme for ascertaining the best that can be done with her coal, so as to put an end to the lamentable waste which is now taking place, and if this Association can move in the direction of initiating such a scheme it will be performing a service to the State of the greatest value.

MR. A. WILSON said he was much impressed by the paper, and it was one of extreme interest to him, as he had been for many years intimately connected with gas-making. There certainly seemed to be waste from the use of beehive ovens, but upon close investigation it was not so apparent. Until recently there was not a very great market for the by-products of the gas oven, but it is very evident that to-day and in the near future this market will be rapidly developed. He greatly deprecated the

Gas Act of 1912, whereby an Act was passed that was already obsolete in the United Kingdom. He hoped that in the near future the 15 c.p. standard would be abolished, and the "heating" standard adopted. He coincided with the author when he hoped that research would be carried out to assist the community in establishing the industry handling the by-products of coal.

MR. TUCKWORTH (visitor) said he was much impressed with the author's paper, and as he was much interested in coal working plants, he felt it incumbent upon him to offer his assistance to the author in any way possible that would assist in the preparation of a paper on this subject. He offered a hearty invitation to the author to visit his plant on the South Coast.

MR. LANGSTON (visitor) said he was very pleased to state that he had been acquainted with the author since his apprenticeship, and he felt sure they had all appreciated the efforts to broach this important subject. He had recently inspected a plant in Pittsburg, U.S.A., handling 25,000 tons of coke per day. The difficulty was in disposing of the by-products, and a company had started at Islington, near Newcastle, N.S.W., to treat the same, but for some reason or other the project had been dropped for the present.

MR. TINDALE remarked that the alteration to the "heating" standard would be the means of greatly increasing the available quantity of motor spirit to the consumer. The absence of chemical industries prohibits the manufacture of by-products, and until these are definitely established he was afraid that the by-product industry would remain in abeyance. The value of tar alone as an adjunct to good road construction was in itself a very considerable item. He thanked the author for his efforts that evening.

MR. KNEESHAW, on behalf of the Electrical Association of New South Wales, thanked them for the invitation to be present that evening. He felt sure that any move towards developing the industry would be appreciated by all engineers. He could not say very much on the subject, but was personally much indebted to the author for the valuable information put forward to-night.

THE PRESIDENT, Mr. D. F. J. Harricks, said he felt very gratified that such an excellent paper had been presented by one of their junior members, more particularly as he had gone to such trouble to obtain his information first hand whilst on convalescent leave from active service in Europe. He did not wish to add more to what had already been said during the discussion that evening. He thanked the author for his paper, and conveyed to him the vote of thanks passed by the meeting.

The author, in reply, thanked them for the way they had received his paper. With regard to Mr. Poole's remarks re legislature to cover the waste now occurring, he felt sure that this would come, as it now is in the United Kingdom. He felt sure that the by-product industry had come to stay. Referring to the quantity of inherent ash in Australian coals, he did not see any great difference with that of other countries. He felt sure that we could produce coke here that would compare favourably with that produced elsewhere. Speaking of the operation of the "Beehive" oven, he contended that a man could be taught to use a by-product oven with equal facility to the former, and not take very long about it either. He would like to thank Messrs. Wilson, Tindale, and the other speakers for the suggestions put forward by them on the several matters referred to by them during the discussion. He was very grateful for the vote of thanks accorded him by all present.