DISCUSSION ON "GAS FIRING BOILERS." *

YORKSHIRE LOCAL SECTION, 15 JANUARY, 1918.

Mr. C. N. Hefford: I rather gather that the main object of this paper is to assist engineers who are already connected with coke-oven processes or iron works where they possibly have already got waste gas and are either dealing with it or anxious to use it in some form or other. I do not draw any information from it which would encourage one to go in for steam-raising from gas-fired boilers where one had to consider the obtaining of the gas purely for the purpose of heating the boilers. I am surprised to find that the extra heating surface that would be required to generate steam from gas-fired boilers is comparatively small compared with what we have to provide for in coal-fired boilers. I expected to find a much greater difference. When figures are quoted for gas-fired boilers indicating an evaporation of 5½ lb. per square foot of heating surface, it must be admitted that these compare favourably with results obtained with the usual low-grade fuel consumed in generating stations. I expected to have to consider the provision of considerably more boiler power than that. It is very difficult for electrical engineers to follow and keep as closely in touch with scientific developments as they possibly ought to do. Already in addition to being electrical engineers we have to be mechanical engineers and civil engineers, and apparently we must be gas engineers; and I suppose we shall be chemists also before long. What would be very useful to the station engineer would be a continuation of this paper that would take the form of how an expert like the author would proceed to deal with the problem of generating, say, possibly 2,000 million pounds of steam per annum from gas-fired boilers, his object being primarily to produce steam. That is to say, what investigations would he make with a view to deciding upon a suitable by-product to produce, and what extra capital charges, if any, would be incurred in the provision of the necessary additional plant, taking into consideration the handling of large quantities of coal, with the necessary sidings and handling apparatus, and of course assuming also that such a steam-raising plant could not be accommodated in any large centre of industry, but would have to be remote from the town under consideration and would be situated probably adjacent to a colliery or wherever the process could most suitably be carried out, the energy being ultimately transmitted to the town in the form of electrical energy? There will have to be an enormous saving in the cost of generating electricity to justify the removal of central stations from the districts to be supplied.

Mr. E. Harris: I consider that gas-firing for steam boilers is particularly a question of utilizing the waste gases which are a by-product from blast furnaces and coke ovens, rather than of using the gas from producers especially installed. The bulk of our large steam users are situated in or near the centres of our cities where it would be difficult to find room for large gas-producing and by-product plants. This and other disadvantages largely prohibit the use of gas for such a purpose. Some years ago I was engaged in the manufacture of gas producers and furnaces, and in several cases we had to apply gas-firing to steam boilers. I know of very few of these installations that are at work at the present time. I believe that Messrs. Brunner, Mond & Co. and Messrs. Robert Heath & Sons of Stoke-on-Trent have gas producers for such a purpose and extract the by-products, which no doubt has been a profitable undertaking. A company has been in existence in South Staffordshire for the manufacture and distribution of producer gas, but I have no knowledge of what the gas is used for or the results obtained, and I should therefore be glad if the author could enlighten us on that point. What interests most of the steam users in the West Riding of Yorkshire are actual working results, showing (1) the fuel efficiency in the steam boilers per ton of coal gasified; (2) the evaporation from a large-sized Lancashire boiler of 8 ft. 6 in. or 9 ft. diameter by 30 ft. long; (3) the cost of fuel and labour to evaporate each thousand gallons of water; (4) the market value of the by-products per ton of coal gasified. In the Yorkshire and Lancashire textile trades a large amount of steam is used for dyeing, steaming, and heating purposes, which causes rapid fluctuations in the steam requirements; so that when we take into consideration the heat units contained in these respective types of boilers, it is found that the Lancashire type of boiler is more suitable for most of the textile trades and it is questionable if any ground space could be saved by using water-tube boilers. My experience of gas-firing for Lancashire boilers is the small evaporation and inability to deal with sudden fluctuations as compared with the best method of firing with mechanical stokers. This is one of the chief reasons why gas-firing for steam boilers has been abandoned in many cases. In my opinion if the boiler plant at a large electric light station were fired by gas, it would necessitate at least double the boiler power required for direct coal-firing. I should like to ask the author the following questions: (1) Would he recommend the installation of gas producers to fire large batteries of boilers with gas? (2) With what size of plant would it pay to use gas-firing? (3) What class of fuel does he recommend as the most suitable for gas producers? (4) Is there any installation of boilers fired from producer gas in connection with by-product recovery plant in this part of the country? It is generally admitted that gas-fired water-tube boilers are more satisfactory than gas-fired Lancashire boilers. With regard to using colliery refuse such as coke dust, pond settlings, shale, etc., as is sometimes advocated, I think it will

* Paper by Mr. T. M. Hunter (see pages 57 and 163).

be found that most collieries use all their waste materials at present with modern firing appliances.

Mr. W. Hartnell: I have had considerable experience with boilers. Some years ago on calculating the amount of water evaporated per hour per square foot of heating surface per pound of coal burned per hour, I was surprised to find that such different types of boilers as the locomotive, the vertical, and the Lancashire gave nearly the same results. Thus on drawing a curve the base lines of which represented the number of square feet of heating surface per pound of coal burned per hour in various boilers, and the corresponding verticals the pounds of water evaporated per hour per square foot of heating surface, a curve could be drawn nearly coinciding with the tops of the verticals. By means of such a curve the evaporative value of different gas fuels or coals although tested in different boilers can be practically compared with each other when the total heating surface and fuel burned per hour in each case are known. In the case of a textile machinery works near Rochdale, where Mond gas producers were supplying vertical gas engines, thd Staffordshire coal required was $1\frac{1}{4}$ to $1\frac{3}{4}$ lb. per horse-power per hour. There is an example near Barnsley on a large scale of the economical use of waste coke-oven gases for fuel by the Yorkshire Waste Heat Company. The coke ovens are of the most modern construction and connected to the latest appliances for recovering by-products. At the Farnley Iron Works near Leeds there is a Mond gas producer and ammonia-recovery plant arranged by the late Mr. Mathieson. The gas is used for gas engines driving dynamos which supply all the power and lighting; the gas is also used for heating the ovens in which the glazed bricks, etc., are burned.

Mr. E. Balmford: On page 63 the author refers to the fixing of projecting pieces or rings of angle iron on the boiler as a means of increasing the heating surface. It appears to me, however, that if this method is adopted on water-tube boilers, either the rings must be arranged parallel to the gas flow so as not to interfere unduly with the draught, in which case the effect due to them will be a minimum and probably hardly appreciable; or, if they are placed so as to be more effective as regards the transmission of heat, the draught will be so seriously interfered with that the last stage may be worse than the first. I should be very much obliged if the author would give some instances of where and how this method has been applied and what were the results obtained.

Mr. A. J. Terry: I should like to ask whether in view of the recent proposals of the Coal Conservation Sub-Committee the author would suggest that the installations therein recommended should all be situated close to the coal mines and the coal be first used in by-product ovens, the gases then being used under boilers for the generation of electricity; also whether he holds that this is the most economical way of making use of our supply of coal. Is it the best way apart from using existing coke ovens, and does he hold it to be the best plan to put down more coke ovens and work through them?

Mr. J. Shepherd: The paper describes how gas which would otherwise be wasted may be utilized; but it leaves untouched that great problem which will have to be faced shortly, namely, what is the best way to get power from coal? Should we burn the coal under boilers and make no attempt at ammonia recovery, or should we produce gas, recover the ammonia, possibly benzol, and other products, and then utilize the gas under boilers and the steam from the boilers in turbines? When we are dealing with large amounts of power it seems to me that to gasify the coal is more economical than to burn it. I know it is the opinion of recognized authorities that with a large installation utilizing all ammonia compounds and other by-products at the prices of those compounds before the War there would be a saving of something like 5s. a ton for every ton of coal gasified. Yet in the paper on page 58 the author says that he knows of no case where coal is gasified to obtain the ammonia and other products except in the case of so-called waste gas. I know that to do it on any workable scale means a large installation —certainly much larger than that which is found in any ordinary industrial works—such an installation as one would get in towns of considerable size where electricity is generated for general power purposes. In the boiler house of such an installation the cost of generation for both wages and coal is usually about three-fourths of the works cost, and that of course is the item which one must attempt to reduce. Anything like the gas-firing which I have seen, such as oil-firing, means entirely changing the conditions of the boiler house. At present this is a dirty, dusty, and uncomfortable place to work in. When burning oil (and gas) on a large scale it is quite different. One man will look after 30 boilers without any trouble, and there is no smoke, dust, or ashes to handle. There are one or two questions which I should like to ask the author. He gave a figure of 5 per cent saving in radiation when boilers are enclosed in a boiler house. I should like to know if this is an ascertained figure, or only estimated. Again, elsewhere in the paper the author gives the maximum superheat as 85 degrees C. I should like to know why 85 degrees is said to be the highest which is economical. That gives a total temperature of only 500° F. with ordinary pressures. As anyone who has used turbines knows, it is necessary to get something over 600° F. if one wants to get the greatest economy with even ordinary commercial plant.

Mr. T. M Hunter (*in reply*): This paper was written to assist engineers who are actually working gas-fired boiler plants at present, and for the benefit of engineers who have to specify such plants, to give them an idea of what they ought to specify and what it is reasonable they should get. Mr. Hefford and one or two other speakers have sketched out another very interesting paper which I might have written, on the "Production of Gas." I found that it was quite a wide enough subject to deal with the combustion of gas, keeping quite away from the question of the production of gas. There is one point I should like to make in regard to what Mr. Hefford has said about transmission losses. Transmission of electricity is very expensive, but transmission of gas is in comparison cheap. The losses on transmission of gas are very

small. I believe the figure given in America for favourable cases is something like 0·5 per cent, and for cases that are not so good up to about 2 per cent loss in transmission. In America they sometimes transmit gases for 100 miles or so, and under high pressure. If gas were generated outside the towns and transmitted in pipes to the existing power stations, these stations could be used economically, without much additional capital expenditure, in comparison with the expenditure which would have to be incurred if new stations had to be erected near collieries.

Mr. Harris has said that I have been speaking only about the use of waste gas, especially blast-furnace gas. A blast-furnace owner will say that his gas at the present moment is not a waste product, but is a very valuable commodity. If we take the price of coke at 30s. a ton, and consider a plant where one ton of coke is used per ton of iron made, half of the calorific value of the coke comes out of the furnace in the gas, so that the gas coming out is worth 15s. per ton of iron made. The distribution of the gas is as follows: 1s. 6d. for all losses, heating the blast about 4s. 6d., and gas available for boiler-firing purposes about 9s. These figures give an idea of the amount of gas available and the value put upon it by the owner at a blast furnace. In South Staffordshire the Mond plant distributes gas over a large district. At Wolverhampton I believe the present price is 5d. per 1,000 cubic feet. It is mostly used for heating in furnaces, in small works where they make chains and other small articles by hand. It would not pay to fire a boiler with gas at 5d. per 1,000 cubic feet if the gas were of 145 therms per cubic foot. The price would have to be 1½d. or 1¼d. per thousand cubic feet to allow it to compete with coal at 18s. per ton.

We cannot expect a gas producer plant to take peak loads at a power station. It can only give a steady output. It is not possible to press a producer plant. We must have some other method for taking the peak loads. If we had sufficient producers to take the peak loads, the capital charges would swamp the whole scheme.

The provision of superheated air is very important with regard to gas-firing, as it is with coal-firing. In this country we have done little in this direction. In Belgium and on the Continent generally they are very far ahead of us. I heard the other day from a British manufacturer that he had supplied to the Ougrée Works in Belgium, preheaters for heating the air to burn cleaned blast-furnace gas with Terbeck burners in water-tube boilers. At the outbreak of War he was on the point of delivering a large repeat order, while engineers in this country have hardly begun to think about the subject at all.

I was very interested in Mr. Hartnell's reference to the waste-heat installation of the Yorkshire Waste Heat Company. I had to do with the gas burners fitted to the boilers there, which burn coke-oven gas. It is quite a show installation and has been very successful. The average working efficiency is 82½ per cent for the Stirling boilers and superheaters. No economizers are fitted.

Mr. Balmford spoke about the use of metal projections in boiler tubes. Interesting experiments were made some years ago by putting metal studs into the flue of a boiler, projecting a considerable distance into the gas, and just screwed through the plate of the boiler. These added considerably to the heat transmitted per hour by the boiler flue. I do not think that these studs have been used commercially, but I believe that the method is right.

One of the largest installations of by-product producer plants in the country is at Runcorn. The Castner Kellner installation runs mostly with gas engines. Up to about some seven years ago it was run with gas-fired boilers. Gradually they used gas engines more and more. I hear that now they are adding steam-turbine plant and are again going to use much of their gas in boilers in addition to what they are using in gas engines.