

ON THE HEATING POWER OF COAL GAS OF DIFFERENT QUALITIES.

By DR. W. WALLACE.Read at the Meeting of the Philosophical Society of Glasgow, December 3, 1879.

The extensive employment of coal gas for heating purposes, and especially for cooking, gives an interest to the question whether the heating power varies like the illuminating power, and if so, to what extent in the gas used in different towns? As regards illuminating power, we know that it varies exceedingly. In Aberdeen and Edinburgh it is 30 candles for 5 cubic feet per hour; in Glasgow, Paisley and Greenock, about 26 or 27 candles; in Liverpool, Manchester and Carlisle, about 20; in London and Dublin, 16; in Birmingham and many other English towns, 14; and in some as low as 12 candles. But as regards heating power we have no definite information, although there is a general belief that a rich gas has a greater calorific effect than one of poorer photogenic quality.

My attention having been directed to the subject by a correspondent, I caused a small apparatus to be made, in order, when opportunity offered, to test the matter practically. It is of very simple construction, consisting of a cylindrical tin-plate vessel, 8 inches in diameter and 6 inches high, with a cylindrical opening in the centre, $1\frac{1}{2}$ inches in diameter, through which the whole of the products of combustion pass. It contains exactly one gallon of water. Below is a brass tube bent into a circle 5 inches in diameter, and pierced with 34 small holes, from which the gas burns with flames about $\frac{3}{4}$ of an inch high. This tube is placed 1 inch from the bottom of the vessel, and is surrounded by an outer case having a sufficient number of small holes for the admission of air. On the top of the vessel there are two openings, in one of which a delicate thermometer is placed, while the other is provided with an open glass tube.

The opportunity of using the apparatus occurred recently, when I had occasion to test, on the same day, three samples of coal, which gave gas of 33, 26 and 15 candle-power respectively. Each experiment occupied, as nearly as possible, thirty minutes, and consisted in raising one gallon of water from 60° to 160°F. , and measuring the quantity

of gas consumed in the operation. The system is by no means a perfect one, but the results are strictly comparative. These are arranged in the following table:

Illuminating Power of Gas in Standard Candles.	Durability of 1 C. Foot by flame 5 inches high.		Specific Gravity Air=1000.	Comparative Value for Lighting.	Gas consumed in Heating Experiment. Cub. Ft.	Heat Units Fabr. for 1 C. Foot.	Comparative Value for Heating.
	Mins.	Secs.					
33·07	64	45	574	4s 10d	1·916	522	4s 5d
26·24	54	40	525	3s 10d	2·200	455	3s 10d
14·75	39	35	442	2s 2d	2·888	347	2s 11½d

The heat units represent the number of pounds of water heated 1° F. by the combustion of one cubic foot of gas. I have taken Glasgow gas of 26 candles at 3s. 10d. per 1000 cubic feet as the standard of value, and it will be seen at a glance that, while the heating value rises and falls with the lighting value, the amount of difference is by no means so great in the former as in the latter.

Having made these simple but instructive experiments, I naturally wished to compare the results with the theoretical heating values obtained by calculation from the composition of the gases. Unfortunately, I had no apparatus at the gas-works where the experiments were made for analyzing the gases, and the best I have been able to do is to make the calculations from two analyses by the late Dr. Letheby, one of 12 candle gas, and the other of London Cannel gas, the illuminating power of which is not stated, but which may be assumed to be somewhere between 22 and 23 candles. The analyses are given only, as is usual with gaseous mixtures, by volume, but I have, for convenience, calculated the composition by weight.

	Common Gas, 12 Candles.		Cannel Gas, 22 Candles.	
	Vol.	Wt.	Vol.	Wt.
Olefiant gas, etc., C_2H_4 ,	3·8	9·5	13·0	24·9
Marsh gas, CH_4 ,	39·5	56·5	50·0	54·8
Hydrogen,	46·0	8·2	27·7	3·8
Carbonic oxide,	7·5	18·7	6·8	13·0
Carbonic anhydride,	0·6	2·4	0·1	0·3
Nitrogen,	0·6	1·5	0·4	0·8
Aqueous vapor,	2·0	3·2	2·0	2·4
	100·0	100·0	100·0	100·0

Specific gravity (calculated),	387	506
Weight of a cubic foot in pounds,	0.0296	0.0387
Calorific power, C.,	11,790	11,754
“ “ F., pounds of water heated 1° by		
the combustion of 1 pound of gas,	21,222	21,157
Heat units for 1 cubic foot, C.,	345	455
“ “ “ “ “ F.,	621	819
Pounds of boiling water evaporated by 1000		
cubic feet of gas,	639	842

We see from this tabular statement that, while the heating power of the two gases is almost identical, weight for weight, the practical result when we take the same measure of gas is very different, the Cannel being much heavier than the common gas. I calculate that in my practical comparative test I have realised about 55 per cent. of the theoretical heating power, which is pretty nearly the proportion of effective heat obtained by the combustion of coal in a fairly well-constructed steam boiler.

The question naturally suggests itself, What is the comparative cost of heating by gas and coal? The calculation is a simple one. The theoretical heating power of ordinary soft coal may be taken at 13, that is, the number of pounds of boiling water evaporated by 1 lb., equal to 29,120 lbs. for a ton of coal, value, say, 11s. 6d., being the price of 3000 cubic feet of Cannel gas, the heating power of which is, say 2500. The gas, therefore, costs $11\frac{1}{2}$ times as much as the equivalent quantity of coal, or, in round numbers, a penny-worth of coal gives as much heat as a shilling's-worth of gas. When, however, we consider the handiness, the cleanliness and the convenience of gas, it is not surprising that it is extensively employed as a source of heat, as an illustration of which I may state that in my own laboratory from 250,000 to 300,000 cubic feet are consumed annually, almost the whole of which is burned for the production of heat.

English Industrial Laborers.—The iron workers of England include 140,000 laborers in furnaces and forges, 169,000 in the manufacture of machinery, 5500 in steel works, 48,000 in shipbuilding, and about 200,000 in various branches of iron and steel manufacture, making about 570,000 in all. The mining population is about 530,000 and the laborers in cotton mills about 600,000.—*Chron. Indust.*