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# SOME EXPERIMENTS ON THE FUEL VALUE OF BITUMINOUS COAL ASHES.

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DURING the winter of 1902-3, when the scarcity of coal was so great, it was considered desirable to know the exact amount of unburned coal, which was being thrown away in our ordinary soft coal ashes. From some experiments carried out, under the direction of and reported upon, by the late Col. Waring,[1] the amount of unburned coal seemed to him large enough to warrant the city in recovering this coal, and he also recommended various uses for the ashes. By means of a specially constructed small boiler, built on the order of a Rumford calorimeter, measurements were made of the unburned coal in the ash. The amount of waste coal in ashes examined varied from 20 per cent. to 40 per cent. by weight. If the ashes from the tenement-house district be included, the average would fall to about 20 per cent. It is further estimated, that on this average there would be lost about 125,000 tons of coal for every 1,000,000 cubic yards of ashes. These numbers seemed to show such an appalling loss that it seemed highly desirable to subject the question to further experiment. As the method for determining these values was not strictly accurate, it was decided to repeat some of this work in such a way that the personal element was reduced to a minimum, and to express the results in terms of standard values.

In order to test the fuel value, ashes were obtained from four sources; *viz.*, the Rogers Building heating plant of the Massachusetts Institute of Technology, the Edison Electric Light Co., the Hotel Berkeley, and from a large packing house in which was used a mechanical stoker. These four samples will be referred to as A, B, C and D respectively. Starting with barrel lots, each one was carefully weighed, and was then subjected to a screening process, in order to classify the material into coarse, medium and fine ashes, so that in case there was enough coal in any one of these products to warrant its recovery, a commercial extraction might

[1] Report of the Department of Street Cleaning of the City of New York, 1895-97.

be developed. These separate lots were weighed, and then sampled by coning and quartering. The final sample in each lot was then crushed and powdered, and from this material the calorific value was obtained. In this way the calorific value of samples from the coarse, medium, and fine ashes was obtained, and represented a true average of the whole.

All determinations were made in a Mahler bomb with all the precautions necessary for accurate work, with the exception, that no corrections were made for sulphur compounds, which may have been in the ash, nor in the coal, which it was necessary, in some cases, to add. The values, which are given, therefore, are not, strictly speaking, absolute values. The corrections, which would be necessary, however, would be exceedingly small, and the values given are not far from the actual truth. As all experiments were carried out under the same conditions, the values are strictly relative. Attempts were made at first to burn the ash direct, but this was successful with the richest products only. In the poorer products there was some combustion, but the heat developed was sufficient to soften the slag, which formed a glassy mass, protecting the unburned part from further action of the oxygen. On account of this difficulty, it was found necessary, in each case, to add a weighed quantity of standard coal, and to burn this with the ash. A blank determination of the calorific value of the coal was made before each determination of the ash, and knowing the number of calories contained in the coal, the difference represented the number of calories in the ash.

The following table shows the results obtained in the screen analysis, and the value in calories of the various products. It will be noticed that the percentages given are obtained from comparison with a coal giving 8,500 calories, instead of the actual fuel value of the coal from which the ash was obtained. This was considered desirable, since it was necessary, in some cases, to add some such coal to the ash, in order to make a perfect combustion.

| Sample. | Screen analysis. | Weight in kilos. | Percentage weight. | Total calories. | Calories per gram. | Percentage of unburned coal compared with a coal giving 8500 calories. |
|---|---|---|---|---|---|---|
| | On 1-inch mesh | 16.2 | 49.85 | 1320.3 | 81.5 | 0.96 |
| A | Through 1 on 2 | 9.4 | 28.92 | 2596.3 | 276.2 | 3.25 |
| | " 2 | 6.6 | 20.31 | 1840.1 | 278.8 | 3.28 |
| | Loss | 0.3 | 0.92 | ———. | ..... | ..... |
| | On 2-inch mesh | 20.5 | 44.4 | 45811.5 | 2234.7 | 26.29 |
| B | Through 2 on 4 | 14.1 | 30.5 | 24648.2 | 1748.1 | 20.51 |
| | " 4 | 11.5 | 24.9 | 10574.2 | 919.5 | 10.82 |
| | Loss | 0.1 | 0.2 | ..... | ..... | ..... |
| | On 1-inch mesh | 4.8 | 11.4 | 2674.1 | 557.1 | 6.55 |
| C | Through 1, on 2 | 8.1 | 18.9 | 4770.1 | 588.9 | 6.93 |
| | " 2, on 4 | 8.6 | 20.0 | 4767.8 | 554.4 | 6.52 |
| | " 4 | 20.8 | 48.6 | ..... | ..... | ..... |
| | Loss | 0.5 | 1.1 | ..... | ..... | ..... |
| | On 2-inch mesh | 33.0 | 23.86 | 35805.0 | 1085.0 | 12.76 |
| D | On 4-inch mesh | 39.7 | 28.71 | 83688.0 | 2108.0 | 24.80 |
| | Through 4 | 65.4 | 47.28 | 101370.0 | 1550.0 | 18.24 |
| | Loss | .... | 0.15 | ..... | ..... | ..... |

It will be seen from an inspection of the table, that in two of the samples, the value in coal approaches the results reported upon by Col. Waring, and in those two it is not uniformly distributed in the different sizes. In sample B the highest values are obtained with 26.29 per cent. in the coarse material, which was composed largely of black clinker, holding mechanically enclosed coke and coal. This appearance was also characteristic of the smaller sizes of this sample, indicating a fairly poor coal to start with, and considerable neglect on the part of the fireman. While the amount of unburned coal actually present seems high, judging by the figures which were obtained, it does not seem to be in a form which would make it worth while to save. Instead of existing in the form of separate pieces of coal, most of it was in the form of coke, adhering firmly to, and partially fused into the clinker. A more careful fireman certainly could have decreased this value very considerably. In sample D, the material on the 2-inch mesh also shows a high value. This is, however, to

be traced directly to the character of the slag, which is formed on heating. The clinker melts at a low temperature enclosing coal and coke, and falls through the grate in the form of round pellets of slag. In this material there is apparently no coal, and judging alone from the appearance, it would be pronounced free from it, but on breaking open the shell of a pellet, there is invariably some coal enclosed. This material would not appear to have much value, notwithstanding the high percentage of unburned coal found.

Sample A represents the average run of ash from a good grade of Pocahontas coal. It was taken from the middle of three grates. The ash from the top grate consists only of very coarse clinker, while that from the lower grate contains only very fine ash, both, judging from the appearance only, apparently free from coal.

The material used in this work represents only a very few of the large types of plants, and consequently, it would be unwise to draw from the results any definite conclusions. It is believed, however, that the results represent something near the average. In the cheap tenement districts, there would, undoubtedly, be found very little coal, because of the scrutiny with which the ash is sifted and picked over. On the other hand, from the private residence, and apartment-house district, where the waste is larger, and where there is little or no attempt to work over the ashes, the average would probably be higher than the results reported here.

The average per cent. of unburned coal for each sample is, respectively, 2.49, 19.20, 6.66 and 18.60, and the average for the four only 11.98. This is very considerably lower than the average values reported upon by Col. Waring, and it is believed that the expense of collecting and working the material of this kind would exceed the profit on the recovered product, unless the recovery was done in connection with some scheme for the utilization of the clinker and fine ash.

This conclusion, however, should be accepted only as tentative, as it would be necessary to use a much larger series of samples, not only of bituminous, but also anthracite coals for a final decision of the question.

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