FUSAIN CONTENT OF FINE SIZES OF ILLINOIS COAL*

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During the past ten years some notable changes in coal preparation have taken place, particularly in the smaller sizes. The wide spread use of the domestic stoker and the demand for better fuel for it are largely responsible for these changes. It is now common practice to dedust, w a s h, dry, and dust-proof the stoker sizes. The consumer receives a cleaner, more uniform fuel as a result but its preparation leaves the producer with a serious waste problem as yet unsolved.

In the most common process of dedusting the coal is carried through an air column in which the dust smaller than 10 mesh (1.65 mm) or 48 mesh (.3 mm) is removed. Where the coal is wet washed without dedusting, the coal finer than 48 mesh is carried into the settling pond and is lost.

There is only a limited market for deduster dust in cement and powdered fuel plants, and the market value is below the average cost of producing coal. Other serious difficulties are encountered in the transportation and handling of deduster dust. At one mine 200,000 tons are stacked on the ground (fig. 1), but at mines where storage facilities are lacking the dust must be hauled away, in one instance, at a cost of thirty-five cents per ton.

The authors estimate that 1,000,000 tons of dust are produced each year at Illinois preparation plants at the present time. Assuming the production cost to be $1.76 per ton (the Bituminous Coal Commission's average cost of production for Illinois) the mining cost is over $1,750,000. Storing or hauling on the surface adds to the total cost. At many mines the carbon sizes (minus ⅜ in.), made in normal screening procedure, sell in the market below the cost of production. Between seven and ten million tons of these sizes are produced.

By coking or briquetting, it may be possible to convert this waste or low-priced coal into satisfactory smokeless fuel which will bear a proportionate share in the price structure. As the composition of the raw coal determines the characteristics of the coke or briquettes, a pet-

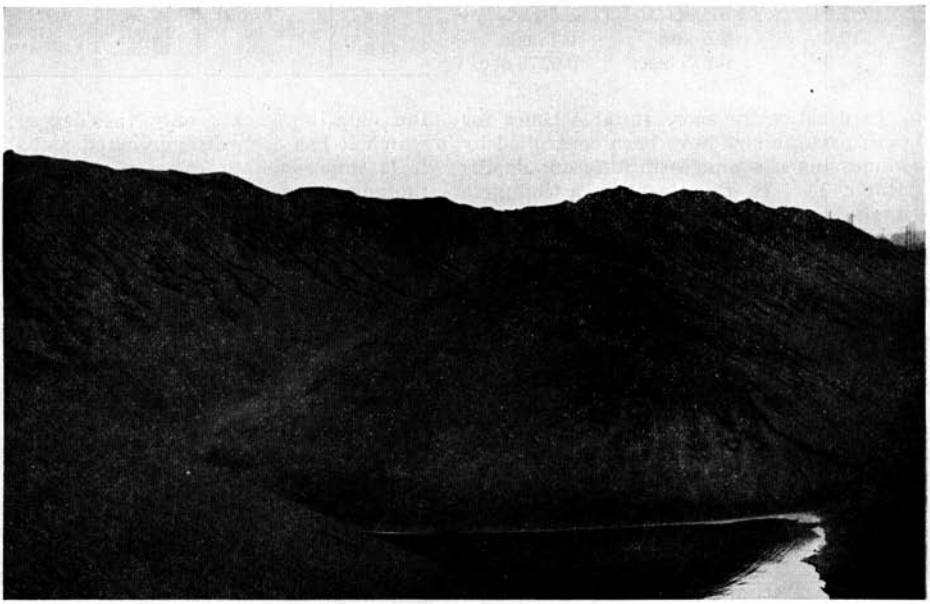

Fig. 1.—Coal dust storage at an Illinois Mine.

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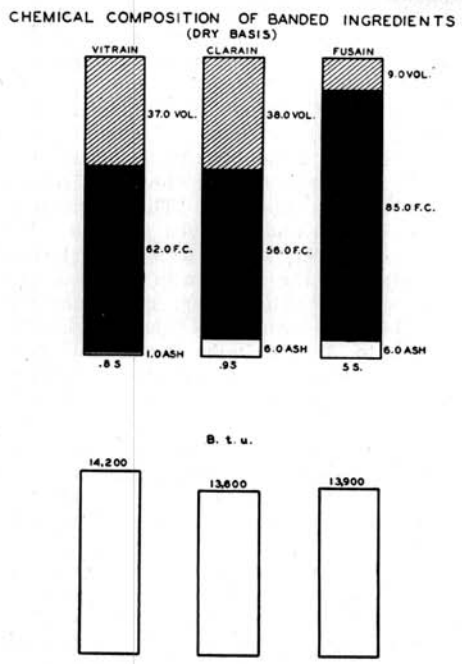


Fig. 2.

MINES SAMPLED IN FUSAIN INVESTIGATION

Fig. 4.

rographic study of the dust and the carbon sizes was undertaken during the past year.

Fig. 2 illustrates the chemical composition of the three most important constituents of Illinois coal. Fusain differs greatly from the other two ingredients in that it has a very high per cent of fixed carbon. While vitrain and clarain readily aglutinate or coke, fusain exhibits no such tendency. Fusain is characteristically acicular or needle like in shape while clarain and vitrain are granular. (Fig. 3.)

In coking or briquetting the presence of some fusain has been found experimentally to be beneficial. The addition of small amounts of fusain[1] tends to give more blocky and less fractured coke. According to Piersol[2] the addition of up to 5 per cent of fusain increases the strength of briquettes made from high vitrain coal and high fusain (up to 20 per cent) coals produce briquettes having reduced smokiness. It is therefore desirable to maintain control of the amount of fusain in the charge to the coke oven or briquetting machine.

It was the purpose of this study to determine the fusain content of the waste or low-priced fine sizes of coal described above, thereby to establish a basis for determining the effect of definite quantities of fusain, first upon the effectiveness of the briquetting process, and second upon the combustion properties of the briquette. Such information would permit the selection of sizes of coal most suitable for briquette production. The present paper describes the methods of study and certain incidental results.

During this investigation samples were secured at 42 mines. A county outline map of Illinois (fig. 4) shows the boundary of the coal measures and the location of 19 mines at which the 27 samples studied to date were obtained. The two mines shown in Saline County are operating in No. 5 coal. All other mines shown on this map are operating in No. 6 coal with the exception of the Vermilion County mine which is in the Grape Creek bed.

The following types of waste and low-priced fine coals were secured at the mines in sample containers holding from 10 to 50 pounds of material: deduster dust from storage piles, wet sludge from

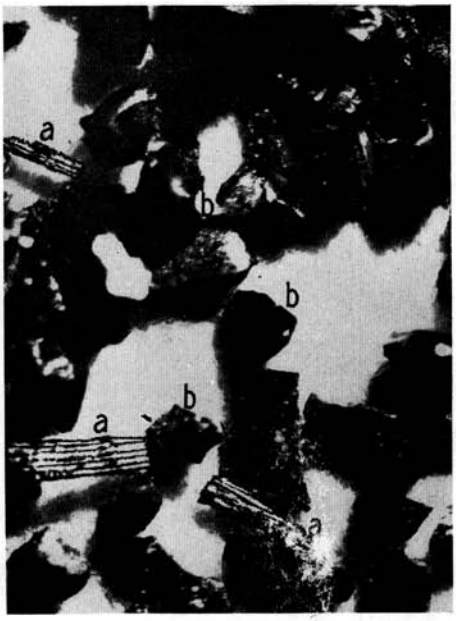


Fig. 3 (above).—Coal particles 35 x 48 mesh; a. fusain; b. vitrain

Fig. 6 (below).—Fusain in thin section.

washeries, dry sludge from settling basins, –⅜ inch screenings of washed coal, and raw carbon from storage piles and loading docks.

Method of Study. In making a petrographic determination of fusain, approximately 500 grams of the fine coal to be studied were cut from the mine sample with a Jones type riffle. The riffle sample was weighed and screened through a battery of Tyler standard screens having openings in the fixed ratio of the square root of two. The battery of screens was divided into two nests from 4 (4.7mm) mesh to 35 (.417mm) mesh and from 48 (.295mm) mesh to 300 (.046mm) mesh. The first set of screens was shaken in a Ro-Tap shaker for ten minutes and the second set containing the finer screens for fifteen minutes. The material retained on each screen was weighed and placed in a marked container.

The essential purpose of screening was to facilitate counting of the coal particles by sorting the material into fractions having a small size range. An ore-dressing type binocular microscope was used in identifying the coal particles. Fusain particles were separated from the non-fusain, and an accurate count of the two classes of material was made during the process of separation.

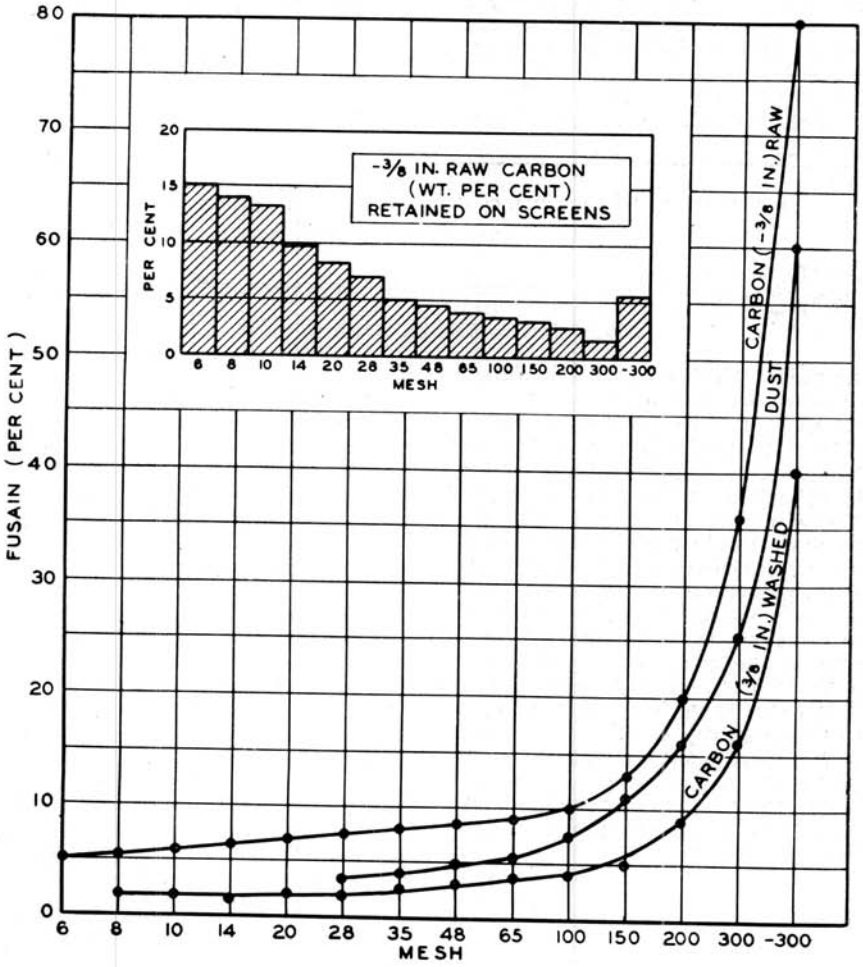
In the calculations it was assumed that the percentage of fusain by microscopic count also represented weight per cent, that is that all coal particles on any one screen are of the same volume and specific gravity. The validity of these assumptions was tested by manually separating the fusain from non-fusain on seventeen screens and determining the actual percentage of each class by weight and by count. The average fusain content of these samples was 2.67 per cent by weight and 2.65 per cent by count.

Coal research workers in Europe and in the United States, particularly at Pennsylvania State College Experiment Station, have developed the Fuchs method[3] of fusain determination which consists of treating the coal sample with nitric acid to oxidize the non-fusain which is then removed by solution with sodium hydroxide. The unoxidized fusain residue is ashed and the fusain percentage is cal-

culated from difference in weight. The chemical method indicates that the material passing the 300-mesh screen is predominately fusain and mineral matter. In fusain containing no visible mineral matter the Fuchs method may indicate as much as 15 per cent inherent mineral matter. Since it is impossible to count fusain in the minus 300-mesh because of the extreme variation in particle size, the Fuchs method was used to determine it in this fraction.

Results. The results obtained from sizing the fractions and calculating the fusain percentage of each size have given important incidental information in regard to the variation in friability of fusain. It is generally recognized that fusain concentrates in the finer sizes of coal. It is also understood that fusain possesses different degrees of hardness. Some workers have used the terms "hard" fusain and "soft" fusain.

The authors have prepared a series of curves (Fig. 5) in which the percentage of fusain in the material on each screen was directly plotted on graph paper and a curve drawn through the points. These curves show graphically the tendency of fusain toward concentration in the finer sizes. The lower part of the curves show a gradual increase in fusain from screen



FUSAIN PER CENT (DIRECT PLOT)

Fig. 5

to screen in the coarser sizes up to 100-mesh. In the sizes finer than 100-mesh the fusain increases very rapidly and the curves consequently take an abrupt rise at this point. The flatness of the curves in their lower portion is indicative of the presence of fusain of a less friable type. This fusain owes its hardness to mineralization of characteristic pore spaces representing the original cell lumens (Fig. 6).

The fusain percentage curves for deduster dust, sludge, washed coal screenings, raw carbon, and whole coal samples are very similar, although there is considerable range in the total fusain content of these various types. The fusain in washed coal screenings was as low as four per cent and as high as 20 per cent in deduster dust. The fusain content of a whole coal sample cut from the face in a Franklin County mine was 4.9 per cent. A sample of raw carbon from the tipple of the same mine contained 12.07 per cent fusain. This relationship indicates that the fusain of the whole coal is concentrated in the minus ⅜-inch which represents about ⅓ of the total production of the mine.

The quantity of fusain in prepared or sized Illinois coal greater than ⅜-inch is probably negligible. In the fine sizes of coal resulting from natural breakage and from preparation there is a relatively low but gradually increasing percentage of fusain in sizes above 100-mesh. In sizes smaller than 100-mesh fusain increases very rapidly reaching a maximum percentage in the minus 300-mesh size.

[1] Ill. Geol. Survey, Bull. 64, 116 and 150, 1937.
[2] Personal communication.
[3] Fuchs, W., et al., Penn. State College Bull. 23, 1938.