ACCELERATED SLACKING TESTS OF SOME ILLINOIS COALS

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Bituminous coals vary considerably in their tendency to slack when exposed to the weather. Some coals weather very easily, as the lower grade coals of the west. Some of these, the black lignites or sub-bituminous coals, slack to such an extent when exposed to the action of rain and sun that they cannot be shipped in open cars but must be transported in box cars. The higher rank coals, such as the anthracites, do not show any slacking tendencies and can be stored for long periods exposed to the weather with very little change in chemical or physical structure. In between these two extremes exists a great number of bituminous coals that show slacking tendencies of considerable variation.

Information relating to this property of slacking should be of great importance to coal users who wish to store coal for several months exposed to the weather. Coals that slack easily have a greater tendency to fire in the storage pile than those that do not slack so easily. Furthermore, dealers handling sized coal suffer considerable loss due to the production of fines from the action of the weather on easily slacking coals. Frequently dealers remark that they won't handle certain coals because they do not store well. Although it is possible by modern storage methods to keep almost any coal in storage without loss from fires, yet it would seem the better policy, if there is any choice between coals, to put in storage only those that withstand to a great degree the ravages of the weather.

The weathering of coal is a topic that has received considerable attention from chemists and engineers for some time. Several bulletins on this subject and the allied subject of storage have been published by the Engineering Experiment Station of the University of Illinois. The work of most scientists until recently has been a study of large samples of coal and of coal in storage piles, with very little work of a nature that would develop a laboratory means of evaluating the property of slacking. The technical staff of the United States Bureau of Mines has developed a laboratory method for the determination of the degree of slacking that a coal will undergo when exposed to the alternate action of drying and wetting. This gives the effect of weathering at a greatly accelerated rate. This method was used in making these tests on Illinois coals.

It has been suggested that data available from slacking tests could be used as a means of classifying coals. However, results so far obtained show such widely varying results, both in individual samples from the same mine and in samples from different mines in the same bed, that it is questionable whether there is any merit to this suggestion.

It has also been suggested that slacking depends upon the amount of bed moisture in the coal. That is, it has been assumed that coals of high bed moisture slack readily while those of low bed moisture do not. As a wide generalization, this is probably true. However, data available show so much variation that it seems there must be other factors that have as much influence as the moisture. Some of the high moisture coals show slacking tendencies comparable to low-moisture coals. It would seem that as a basis for classification, the careful determination of bed moisture might be used since repeated analyses of moisture for a given mine are of great uniformity. It is doubtful whether such a classification could be correlated with slacking data.

An answer to the above variations might be found in a better understanding of the nature of moisture in coal. There is very little definite information pertaining to water in coal. It is generally conceded to be locked up in the pores of the coal. It is possible that certain kinds of coal in a given bed may contain more water than other kinds. That is, fusain is porous and fibrous while vitrain and clarain are not. The fusain in a given bed may contain considerably more water than the other types mentioned.

Some of the water in coal is readily given up upon exposure to the air; some is not. A point of stabilization is reached when the vapor tension of the water in the coal reaches that of the water in the air. As the humidity of the air changes, so will the amount of moisture retained in the coal change.

Furthermore, high-moisture coals are high-oxygen coals. The one goes hand-in-hand with the other. Coals high in oxygen weather easily. Those low in oxygen do not weather so easily. High-oxygen coal oxidizes more than low-oxygen coals, although not necessarily in direct proportion to the oxygen content or to the moisture content. This difference in the rate or degree of oxidizing under given conditions has been used as a means of determining the tendency of a coal to weather.* A study of the data from such tests corroborates previous statements in that only a very broad generalization can be made, that is, that coals weather according to the bed moisture present. Exceptions are noted as in slacking tests which tend to show that other factors than moisture have a powerful influence.

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* Determination of Mineral Matter in Coal and Fractional Studies of Coal, A. I. M. E. reprint of "The Classification of Coal," 1930.

The proposed tentative method of the United States Bureau of Mines for determining the slacking properties of coal is briefed as follows:

1. Not less than three and preferably five samples of fresh coal should be taken from the mine representing different locations.

2. The samples to consist of 30-50 lumps of approximately 1¼-inch cubes. These cubes should be placed in a sample can and the voids around the cubes filled with fine coal to prevent abrasion and oxidation of the cubes in transit to the laboratory.

3. On receipt at the laboratory, screen out the fine coal used for packing by placing the coal on a ¼-inch screen. The fine material simply drops through the screen without the necessity of shaking.

4. Discard any pieces that show evidence of being cracked or crushed. Weigh and determine air drying loss in a standard oven at 30 to 35°C for 24 hours.

5. Remove the sample from the oven, weigh and immerse in water for one hour.

6. The coal is drained and dried again in the oven at 30 to 35°C for 24 hours.

7. Remove the sample from the oven and place the coal on a standard ¼-inch square mesh sieve. The sieve is shaken gently so that fine coal particles will drop through. The sieve should not be shaken vigorously enough to break any of the cubes.

8. Weigh the oversize and undersize and calculate the percentage of undersize.

9. This constitutes the first cycle. Repeat the alternating wetting and drying until 8 cycles have been completed in the case of coals that do not slack readily. The cumulative percentage of the fines produced at each cycle is taken as an index of the slacking characteristics of the coal.

The table of results gives data obtained from some Illinois coals and one sample of sub-bituminous coal from Wyoming. Cycle number 8 gives the cumulative percentage of fines passing through the ¼-inch square mesh sieve at the end of the eighth cycle. The average of the individual samples for each mine is given in the average column.

A study of the data is interesting. The sub-bituminous coal from Wyoming slacked down completely in four cycles, and was practically all slacked down at the end of the second cycle except for a few hard bony particles. This is much faster than any of the Illinois coal samples; also the action was different. The Wyoming coal upon drying checked and cracked, and when immersed in water the cubes completely broke down into fine pieces. The Illinois coals did not check or crack on being dried, and instead of the coal substance disintegrating upon being wetted, it was more of a slow breaking up of the pieces along bedding planes and vertical cleavage planes.

Bony streaks and pieces tend to retard slacking. The hard bony pieces resist the action of alternate wetting and drying and are the last

DATA ON SLACKING TESTS OF ILLINOIS BITUMINOUS COAL

Lab. No.	Mine identification	Sample number	County	Coal bed	Percent loss on air drying 24 hrs.	Weight of air dry sample, gms.	Approximate coal bed moisture	Cumulative percentage through ¼-in. square mesh sieves — Cycle number 1	2	3	4	5	6	7	8	Average
1	EI	1	LaSalle	2	2.5	495	13	1.0	3.0	5.8	9.4	15.5	16.9	18.9	21.9	
2	EII	2	LaSalle	2	5.2	511	13	1.0	3.3	5.6	11.3	16.0	17.40	19.4	23.4	20.3
3	EIII	3	LaSalle	2	4.7	592	13	0.8	2.1	4.3	8.3	12.2	14.7	15.0	15.3	
4	FI	1	Franklin	6	2.3	734	10	0.5	1.6	2.8	6.9	10.2	11.2	12.6	14.8	
5	FII	2	Franklin	6	1.8	750	10	0.4	1.3	2.2	5.8	8.5	8.9	10.0	11.1	11.5
6	FIII	3	Franklin	6	1.9	739	10	0.5	1.2	3.4	6.6	8.4	8.8	9.5	10.3	
7	FIV	4	Franklin	6	3.0	733	10	0.4	1.6	3.5	6.5	8.0	8.7	9.8	10.8	
8	GI	1	Williamson	5	1.5	740	8	0.4	2.0	3.3	3.7	4.9	5.2	5.7	6.1	5.8
9	GII	2	Williamson	5	1.3	708	8	0.4	1.2	2.7	3.3	3.9	4.2	4.5	4.8	
10	GIII	3	Williamson	5	1.3	737	8	0.4	1.5	3.1	4.2	4.7	5.0	5.7	6.5	
11	A-49	1	Will	2	4.7	683	17	1.2	5.2	7.1	13.9	25.3	27.2	30.4	34.5	29.5
12	A-49	2	Will	2	4.7	715	17	1.1	5.3	8.1	11.3	13.0	16.6	20.4	24.6	
13	A-95	1	LaSalle	2	4.7	693	15	2.7	8.5	14.3	18.9	22.5	27.7	30.9	34.9	33.4
14	A-95	2	LaSalle	2	4.2	708	15	2.7	8.2	14.8	19.3	21.6	26.8	28.6	32.0	
15	A-96	1	LaSalle	2	2.3	722	15	0.3	2.3	4.8	5.2	5.6	6.8	8.2	10.0	14.3
16	A-96	2	LaSalle	2	2.8	710	15	2.4	4.9	7.3	9.3	10.7	12.8	15.3	18.7	
18	BI	1	Marshall	7	13.0	48	16	4.5	10.0	14.1	23.3	32.1	39.5	50.0	59.1	
19	BII	2	Marshall	7	13.2	345	16	7.2	14.1	28.9	37.2	48.7	58.7	68.7	82.4	60.1
20	BIII	3	Marshall	7	14.0	490	16	2.6	9.8	12.6	16.6	23.2	26.8	32.7	38.9	
21	CI	1	Peoria	5	12.0	410	16	2.4	4.6	7.5	11.0	17.6	22.9	30.6	42.8	
22	CII	2	Peoria	5	3.2	917	16	3.6	6.7	9.1	11.9	16.4	21.7	28.7	36.2	43.5
23	CIII	3	Peoria	5	12.3	385	16	2.3	8.3	12.6	18.0	26.6	32.0	41.7	51.5	

DATA ON SUB-BITUMINOUS COAL FROM WYOMING

Lab. No.	Mine identification	Sample number	County	Coal bed	Percent loss on air drying 24 hrs.	Weight of air dry sample, gms.	Approximate coal bed moisture	1	2	3	4	5	6	7	8	Average
17	(Wyo.)	1	Sheridan	....	10.0	662	20	57.5	95.0	98.0	100					

to break down. This fact was noticed in all samples in which bony coal was present.

Fusain or mineral charcoal has a marked effect in the manner in which Illinois coals break up in slacking. It is prevalent in all Illinois coals, occurring chiefly along bedding planes. The first evidence of slacking was along these bedding planes. Fusain is porous, and undoubtedly the absorption of water along these bands and streaks caused the cubes to break there. This may be due to the water penetrating into the minute capillaries along these bands.

Shale bands, in many instances, are very much like clay. These bands tend to go into suspension in water, and the cubes break along these clayey bands if they are present.

Calcite, gypsum, and flake pyrite fillings along vertical cleavage planes exert a marked influence in breaking of pieces. The cubes seem to break along these vertical cleavage planes almost as easily as along the fusain bands. The breaking of the cubes in this manner along the fusain bands and vertical cleavage planes causes more or less of the coal substance to spawl off. This action of slacking of the Illinois coals is considerably different from the slacking of the Wyoming coal.

Conclusions

1. Laboratory slacking tests are valuable as a means of evaluating the degree to which a coal will withstand degradation upon exposure to the action of weather.

2. Coals of the sub-bituminous type, as shown by the sample from Wyoming, disintegrate entirely.

3. Illinois coals vary considerably in their slacking characteristics but differ markedly from coals of the Wyoming type tested.

4. Bony particles tend to withstand the slacking action better than the pure coal pieces.

5. Fusain and clay bands, calcite and pyrite fillings in vertical cleavage planes exert a marked influence in causing the coal to break down during the slacking operation.

6. Slacking tests are of questionable value for coal-classification purposes.

7. Mines only a few miles apart working the same bed of coal show quite different slacking characteristics.