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A PRACTICAL TEST FOR COKING COALS.¹

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While engaged recently in studying the physical properties of coal, especially with reference to the color of the streak and powder, the writer observed that some coals adhered much more strongly to the mortar while being pulverized than others, and that the best coking coals were the ones which adhered most, while the non-coking coals adhered very slightly or not at all.

This gave promise of affording a simple and inexpensive method of distinguishing coking from non-coking coals without the necessity of a trial in an improvised rick, or the better but more expensive way of sending the coal to a coking plant for a test in a regulation oven. For a long time geologists, chemists, and practical coal miners generally have been searching for such a test, but up to the present time without success.

In view of these facts the adherence test seemed to be promising, and the writer began experimenting systematically with all coals available in the study collection of the United States Geological Survey. Fortunately this collection comprises a large number of samples of all kinds of coal from lignite to anthracite, and includes some of the best known coking coals of the country.

In all 150 samples of coal were tested, and the results seemed to be of sufficient economic importance to warrant publication. The writer therefore takes this opportunity of presenting in brief

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form a statement of the method of conducting the test and the results obtained on the samples referred to above. He does not regard his conclusions as final, but merely gives the facts for what they are worth, hoping that others will make application of the test and thereby determine its value in a practical way.

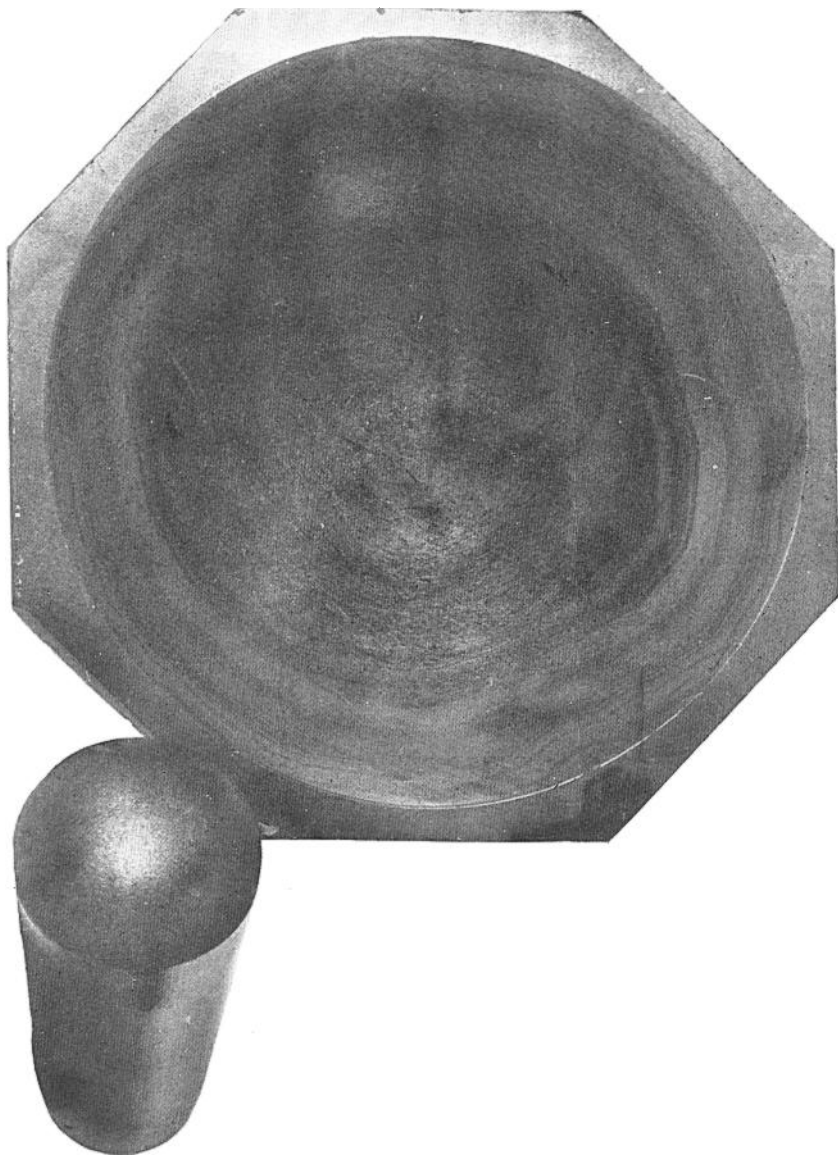
The method of conducting the test is as follows: Pulverize in an agate mortar a small quantity of the coal to be tested until it will pass through a 100-mesh sieve. Pour out the pulverized coal and observe the condition of the mortar and pestle. With some coals the mortar and pestle will be deeply covered with a coating of coal dust which adheres so strongly to the agate surface that it is removed with difficulty; with other coals there will be only a thin film of coal dust adhering to the mortar and pestle; while with still others both mortar and pestle will be nearly as clean after the coal is pulverized as they were before the operation began.

The degree of adhesion seems to coincide with the coking qualities of the coal. If it adheres strongly the coal will probably make excellent coke. If it adheres only slightly the coal possesses the coking qualities to only a slight extent, if at all, and if the mortar shows no coating of dust, the coal is to be regarded as non-coking.

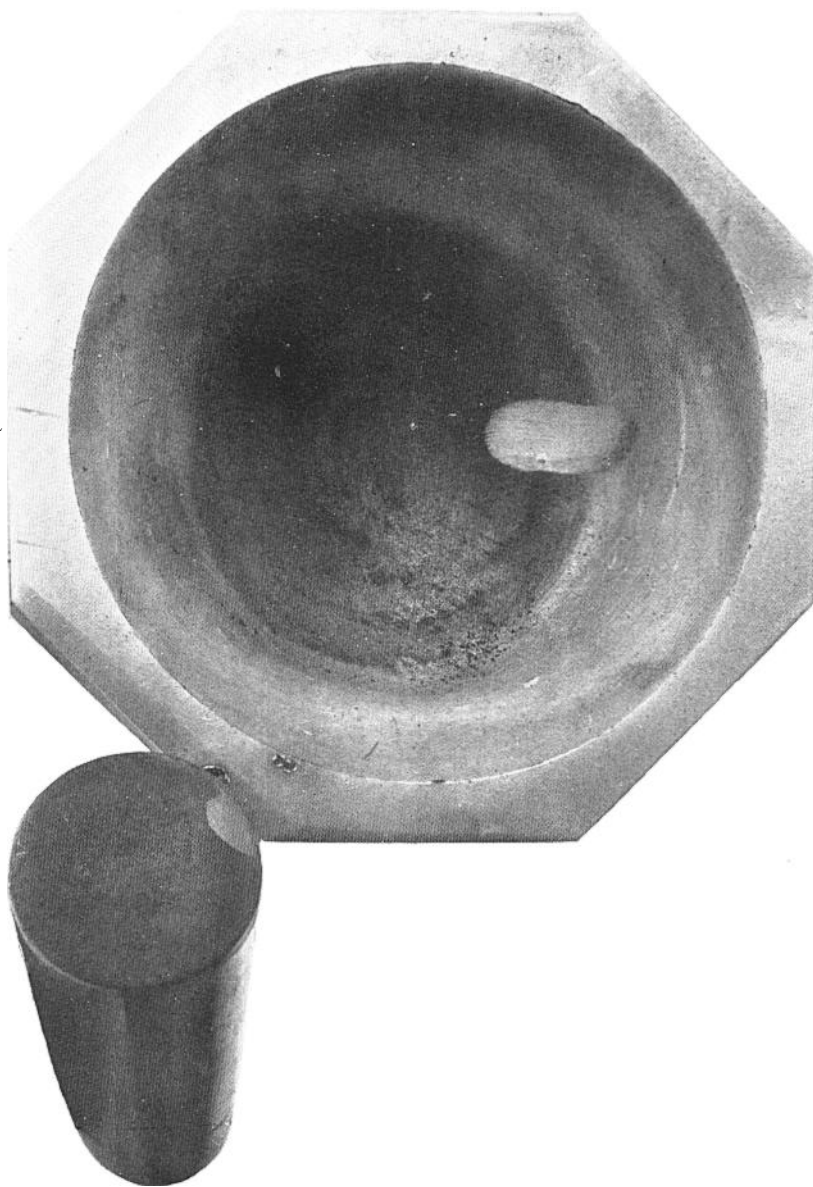
The accompanying plates show how a non-coking, a poorly coking, and a good coking coal behave in the mortar after a charge of each has been ground and removed. Plate V shows the mortar after a coal from Brazil, Ind., had been ground. This is a block coal and is considered to be a good type of non-coking coal. It will be noticed that the amount of adhesion is slight.

Plate VI shows the mortar after a charge of Cambria, Wyoming, coal had been ground. It adheres fairly well. Coke from this coal has been used in smelters in the Black Hills, but it is not first class coke and consequently the product is not in great demand.

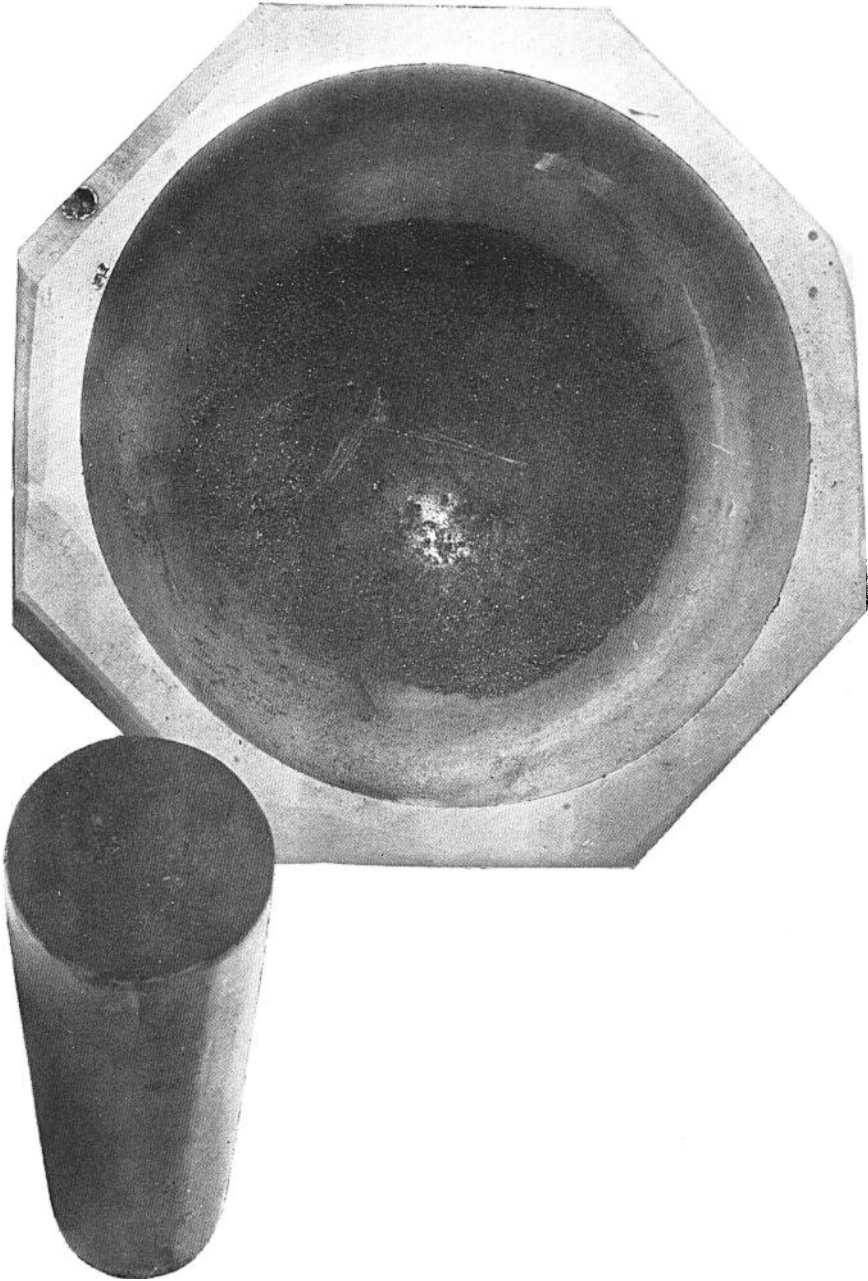
Plate VII shows the mortar after a sample of good coking coal from Straight Creek, Kentucky, had been ground. It adheres strongly and shows a thick film of sooty material covering a



CONDITION OF MORTAR AFTER NON-COKING COAL HAD BEEN PULVERIZED



CONDITION OF MORTAR AFTER A SLIGHTLY COKING COAL HAD BEEN PULVERIZED



CONDITION OF MORTAR AFTER A GOOD COKING COAL HAD BEEN PULVERIZED

circular spot in the center of the mortar where the grinding was done. The intensity of adhesion is noticeable especially when one tries to clean the mortar, for it requires considerable rubbing to entirely remove the coal.

In addition to the adhesion of the fine particles to the mortar, some coals show a tendency to pack together or cohere. Although this phenomenon appears to be limited to coking coal, it is thought to depend more on the moisture content in the coal than on its coking quality, but sufficient work has not been done to determine this point.

The results obtained in testing the miscellaneous samples noted above are given in the following table. The scale of adhesion used in describing the tests is as follows: *none*, *poor*, *medium*, *good*, and *excellent*. It shows that the coking coals range from between medium and good, to and including excellent, and that non-coking coals range from medium to none. Those marked medium are doubtful and may or may not possess coking qualities. If they do produce coke it is probably of such a poor quality as to be worthless for commercial purposes.

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
ALABAMA					
Chicasaw No. 5.....	Carbon Hill.....	Bituminous .....	.....	Medium to good.	
Mine No. 8.....	Horse Creek.....	"	Is coked.....	Good.	
¹ Woodward Iron Co. No. 2.	Dolomite	"	"	Excellent.	
Lookout Fuel Co.....	Lahusage	Semi-bituminous ..	Coked in lab.....	Good	Packs.
ARKANSAS					
² Red Rock	Burnah .....	" .....	.....	Medium to good.	
³ Spadra Anth. Coal Co.....	Spadra	Semi-anthracite ..	.....	" .....
³ S. Anth. Coal Co.....	Russellville .....	" .....	.....	" .....
CALIFORNIA					
Stone Canyon Coal Co.....	Stone Canyon.....	Bituminous .....	.....	Poor.	
COLORADO					
Colo. Anth. Coal Co.....	Deep Creek.....	Anthracite .....	.....	None.	
Sweeney "Tunnel".....	Lay	Bituminous .....	.....	Poor.	
Collom Mine.....	Axial .....	" .....	.....	" .....
Coryell Mine.....	Newcastle .....	" .....	.....	.....
Coal Basin Mine.....	Coal Basin.....	"	Is coked.....	Excellent.	
Book Cliff Coal Co.....	Grand Junction.....	" .....	.....	Poor.	
Rollins Mine.....	Delta	Subbituminous ..	.....	None.	
Fairview Mine.....	Delta .....	" .....	.....	None.	
Watson Mine.....	Cedaredge .....	" .....	.....	None.	
Mosley Prospect.....	Somerset	Bituminous .....	.....	Poor.	
Cooperative Mine.....	Paonia .....	" .....	.....	Medium.	

¹ One piece of nut size taken from a two-quart sample adhered very slightly, whereas another from the same sample adhered strongly, indicating a good coking coal. It seems probable that the bed is made up of different grades of coal, some of which make very much better coke than others.

² This coal is the same as the Hartshorne coal of Oklahoma, which is coked a few miles west of the Arkansas state line.

³ These coals behave alike and in appearance are very much the same. They are brittle and high in fixed carbon. When ground they behave very much like charcoal, soiling the mortar in the same way. Apparently they are on the boundary line between coking and non-coking coals.

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
COLORADO—Continued.					
King Mine.....	Bowie	Bituminous	Is coked.....	Medium to good.	
Phillip Mine.....	Crawford	Anthracite .....	.....	None	
Newman Mine.....	Hotchkiss	Bituminous .....	.....	"
Simpson Mine.....	Lafayette	Subbituminous .....	.....	.....
Calumet Fuel Co.....	Durango	Bituminous	Coked in lab....	Medium to good.	
ILLINOIS					
Clover Leaf Coal Co.....	Coffeen .....	" .....	.....	None.	
Capital Coal Co.....	Springfield .....	" .....	.....	"
Donk Bros. C. & C. Co.....	Donkville .....	" .....	.....	None	High in ash.
Peabody Coal Co.....	Marion .....	" .....	.....	Poor to medium.	
INDIANA					
Parke Co. Coal Co.....	Heckland .....	" .....	.....	.....
Johnson Coal Co.....	Williamsport .....	" .....	.....	Medium to good.	
Crawford Coal Co.....	Brazil .....	" .....	.....	Poor to medium.	
Mutual Mining Co.....	Cannelburg .....	" .....	.....	None	Brazil block coal.
IOWA					
Johnstone Coal Co.....	Clayworks .....	" .....	.....	None	Cannel coal.
Inland Fuel Co.....	Chariton .....	" .....	.....	Poor.	
Centerville Block C. Co.....	Centerville .....	" .....	.....	"
Anchor Coal Co.....	Laddsdale .....	" .....	.....	None.	
KANSAS					
¹ Western C. & M. Co.....	Yale .....	" .....	.....	Excellent.	
¹ M. K. & T. Ry. Co.....	Mineral .....	" .....	.....	Good.	
KENTUCKY					
East Kentucky C. Co.....	Lesley .....	" .....	.....	Poor	Cannel coal.
Prospect	Jackson .....	" .....	.....	Poor	Cannel coal.
Prospect	Big Black Mtn.....	" .....	.....	Good	Splint coal.

¹ According to the tests these coals should coke, and it is reported that coke has been made from this bed in the vicinity of Pittsburg, Kans.

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
KENTUCKY—Continued.					
Straight Cr. C. & C. Co....	Pineville	Bituminous	Is coked.....	Good.	
Central C. & I. Co.....	Central City	"	Coked in lab....	Poor to medium.	Coal bed No. 9.
St. Bernard Min. Co.....	Earlington	"	Is coked	Medium to good....	Coal beds Nos. 9, 11
Wheatcroft Coal Co.....	Wheatcroft	"	Coked in lab....	Medium to good....	
MARYLAND					
Carlos Mine.....	Carlos .....	" .....	.....	Good	Pittsburg bed.
MICHIGAN					
¹ Consolidated C. Co.....	Saginaw .....	" .....	.....	Medium.	
MISSOURI					
Mendota Coal Co.....	Mendota .....	" .....	.....	None.	
MONTANA					
Kendrick Mine.....	Miles City.....	Lignite .....	.....	" .....
Hedges Mine.....	Miles City.....	" .....	.....	" .....
Weaver Mine.....	Miles City.....	" .....	.....	" .....
Dominy Ranch.....	Miles City.....	" .....	.....	" .....
Bear Cr. Coal Co.....	Bear Creek.....	Subbituminous .....	.....	None	Coal bed No. 2.
Bear Cr. Coal Co.....	Bear Creek.....	" .....	.....	None	Coal bed No. 3.
Bear Cr. Coal Co.....	Bear Creek.....	" .....	.....	Poor	Coal bed No. 4.
Washoe Copper Co.....	Bear Creek.....	" .....	.....	None	Coal bed No. 1.
International C. Co.....	Bear Creek.....	" .....	.....	None	Coal bed No. 5.
Northwestern Imp. Co.....	Red Lodge.....	" .....	.....	None	Coal bed No. 1½.
Northwestern Imp. Co.....	Red Lodge.....	" .....	.....	None	Coal bed No. 6.
Cliffe Mine.....	Giltedge	Bituminous .....	.....	Poor.	
Lester Mine.....	Green .....	" .....	.....	None.	
Spring Creek Mine.....	Lewistown .....	" .....	.....	" .....
Cooper Mine.....	Moore .....	" .....	.....	" .....
Havre Coal Min. Co.....	Havre	Subbituminous .....	.....	None	Resembles cannel c.

¹ The Michigan coals are generally regarded as non-coking, but from the results obtained in the mortar they would probably make a poor coke.

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
<i>MONTANA—Continued.</i>					
Montana Coal & Coke Co.	Electric	Bituminous	Is coked.	Medium to good.	
Montana Coal & Coke Co.	Aldridge	"	"	"	
Western Coal & Coke Co.	Lombard	"	"	"	Badly crushed.
Badger Mine.	Como	Lignite	"	"	
<i>NEW MEXICO</i>					
Burns Briggs Mine.	Lumbarton	Bituminous	"	Good	Coal bed No. 1.
St. L. R. M. & P. Co.	Van Houten.	"	Is coked.	Excellent.	
St. L. R. M. & P. Co.	Brilliant	"	"	Good.	
Madrid Mine.	Madrid	Anthracite	"	None.	
American Fuel Co.	Gallup	Subbituminous	"	None.	Coal beds Nos. 1, 2.
Hilton Mine.	Carthage	Bituminous	Is coked.	Good.	
<i>NORTH DAKOTA</i>					
Black Diamond Mine.	Williston	Lignite	"	None.	
Washburn Lig. Coal Co.	Wilton	"	"	"	
Consolidated Coal Co.	Lehigh	"	"	"	
<i>OHIO</i>					
Gallia Mining Co.	Clarion	Bituminous	"	Poor	Coal bed No. 4.
Gosline & Barbour Mine.	Shawnee	"	"	None	M. Kittanning.
Pitts.-Belmont Coal Co.	Nefs	"	Coked in lab.	Good	Coal bed No. 8.
Superior Coal Co.	Wellston	"	"	Poor.	
<i>PENNSYLVANIA</i>					
N. Anth. Coal Co.	Lopez	Semi-anthracite	"	"	
Phoenix Pk. Coll. Co.	Minersville.	Anthracite	"	"	
P. B. C. & E. C. Co.	Ehrenfeld	Bituminous	Coked in lab.	Good.	
P. B. C. & E. C. Co.	Wehrum	"	Is coked.	Excellent.	
Nineveh Coal Co.	Seward	"	"	Good.	
Old Colony No. 2.	Ligonier	"	Coked in lab.	Excellent	Pittsburg bed.
Jamison No. 2.	Hannastown	"	Is coked.	Medium to good.	Pittsburg bed.
Mine No. 2.	Ellsworth	"	"	Excellent	Pittsburg bed.

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
RHODE ISLAND					
Stripping	Cranston	Graphitic-anthracite	.....	None.	
TENNESSEE					
Fork Ridge Coal & Coke Co.	Fork Ridge	Bituminous	Coked in lab.	Good.	
Southern Coal & Coke Co.	Gatlin	"	"	"	
State Mine	Petros	"	"	Excellent.	
Willow Mine No. 5	Oliver Spr	"	Is coked	Good.	
TEXAS					
Chaffin Mine	Waldrip .....	" .....	.....	Poor.	Packs.
Am. Lig. Briq. Co.	Rockdale	Lignite .....	.....	Poor	
UTAH					
North Star Mine	Vernal	Bituminous .....	.....	None.	
Utah Fuel Co.	Sunnyside	"	Is coked	Good.	
Utah Fuel Co.	Castlegate	"	Has been coked	Medium to good.	
¹ Pleasant Valley C. Co.	Clear Creek .....	" .....	.....	Medium.	
¹ Pleasant Valley C. Co.	Winterquarters .....	" .....	.....	Medium to good.	
Kraft's Mine	Mt. Carmel	Subbituminous .....	.....	None	Packs slightly.
Old Joe Coal Hole	Kanarrville	Bituminous .....	.....	"	Packs slightly.
New Harmony Coal Co.	New Harmony	Bituminous .....	.....	"
VIRGINIA					
Merrimac Mine	Christiansburg	Semi-anthracite .....	.....	None	
Belle Hampton .....	" .....	" .....	.....	Poor to medium	" Little Bed."
Belle Hampton	Belspring .....	" .....	.....	Poor	" Big Bed."
Baby Mine	Pocahontas	Semi-bituminous	Is coked	Excellent	Coal bed No. 3.
Va. Iron, Coal & Coke Co.	Georgel	Bituminous	"	Excellent	U. Banner bed.
WASHINGTON					
Northwestern Imp. Co.	Roslyn	"	Coked in lab.	Medium to good	Packs.

¹ Before the opening of the Sunnyside mine, coke was made from Castlegate coal, but this has been discontinued owing to better results having been obtained from the Sunnyside coal.

Winterquarters and Clear Creek mines are on approximately the same bed as that mined at Castlegate, and it seems probable from the tests that they would produce as good coke.

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
WEST VIRGINIA					
Elkins Coal & Coke Co....	Richard	Bituminous	Is coked.....	Excellent	U. Freeport. Packs.
Falling Rock C. C. Co....	Weir	"	"	Medium	Cannel coal.
Glen Alum C. Co....	Glen Alum	"	"	Medium	Cannel coal.
Greenwood Coal Co....	Lawton	"	Is coked.....	Excellent	Quinnimont bed.
Keeny Cr. Colliery Co....	Winona	"	"	Excellent	Sewell bed.
Star Coal & Coke Co....	Redstar	"	"	Excellent	Sewell bed.
Piney Coal & C. Co....	Stanford	"	"	Excellent	Beckley bed.
WYOMING					
Stillwell Coal Co....	Aladdin	"	"	None.	High in ash.
Cambria Fuel Co....	Cambria	"	Is coked.....	Medium to good.....	
Monarch C. M. Co....	Monarch	Subbituminous	"	None.	
Smith Mine.....	Sheridan	"	"	"	
Henn & Kahn Mine.....	Sheridan	"	"	"	
Sheridan Coal Co. No. 1..	Dietz	"	"	"	
Sheridan Coal Co. No. 3..	Dietz	"	"	"	
Roland Mine.....	Carneyville	"	"	"	
Carney Mine.....	Carneyville	"	"	"	
Groat Mine.....	Carneyville	"	"	"	
Evans Mine.....	Carneyville	"	"	"	
Moore's Mine.....	Sheridan	"	"	"	
Glen Rock C. Co....	Glen Rock	"	"	Poor.	
Cole Cr. Coal Co....	Big Muddy	"	"	"	
Cody Coal Co....	Cody	"	"	None.	
Wiley Mine.....	Cody	"	"	"	
Allison Mine.....	Cody	"	"	"	
East Mine of Wiley.....	Cody	"	"	"	
David Dickie.....	Meeteetse	"	"	"	
Horse Cr. Mine.....	Meeteetse	"	"	"	
Blake Mine.....	Meeteetse	"	"	"	

TABLE SHOWING RESULTS OF COKING TESTS ON 150 COALS.

STATE NAME OF MINE OR OPERATOR	LOCALITY	KIND OF COAL	COKING QUALITY	ADHERENCE TO MORTAR WHEN GROUND	REMARKS
<i>WYOMING—Continued.</i>					
Black Diamond.....	Meeteetse	Subbituminous .....	.....	None.	
Mayfield Mine.....	Meeteetse .....	" .....	.....	"
Gebo Mine.....	Thermopolis .....	" .....	.....	Poor.	
Price & Jones Mine.....	Thermopolis .....	" .....	.....	"
Point of Rocks Mine.....	Point of Rocks.....	" .....	.....	None.	
U. P. Coal Co. No. 1.....	Rock Springs.....	Bituminous .....	.....	Poor	Coal bed No. 1.
U. P. Coal Co. No. 5.....	Rock Springs.....	" .....	.....	None	Coal bed No. 5.
U. P. Coal Co. No. 8.....	Rock Springs.....	" .....	.....	None	Coal bed No. 7.
Cent. C. & C. Co.....	Rock Springs.....	" .....	.....	None	Coal bed No. 7.
Sup. Min. Co. B.....	Superior .....	" .....	.....	None	Coal bed No. 7.
Bethurem Mine.....	Carroll	Subbituminous .....	.....	"

Complete information regarding the coking qualities of all of the coals tested could not be obtained, but those left blank in the column headed "Coking quality" are supposed to be non-coking.

In studying the results tabulated above, the reader should keep in mind the fact that the samples tested were small,—two quarts or less. In the majority of cases the samples were prepared by the owner or operator, and consequently contain only the best coal mined, and probably represent only a small part of the bed.

To make the tests satisfactory, the sample should be as carefully prepared as one taken for chemical analysis, and it should be taken in the same manner, *i. e.*, by cutting a channel from roof to floor so as to include all merchantable coal. In sampling for coking tests each bench of coal should be sampled separately, and in case well-developed benches do not occur, the bed might be sampled one foot at a time, keeping each sample separate from the others and properly labeled. Each sample should be pulverized so as to pass through one-half inch mesh, and then quartered down to a convenient size for handling and transporting.

Sufficient work has not yet been done to determine the effect of moisture and ash on the adhesion of the coal, but it seems probable that they affect the result, especially when they are present in exceptionally large amounts. Until this is determined, it is better to have the samples in approximately the same conditions as regards their moisture content. If the ash is above 10 per cent., it will probably interfere with the adhesion of the fine coal, and this would indicate a poorer grade of coal than actually exists.

In conclusion the writer requests every geologist and mining engineer engaged in coal work to apply this test as occasion permits, keeping careful notes of the results, and if it fails or appears to fail, to publish the results. If the test is as successful as now anticipated, it should be used by all persons engaged in coal work, for its extreme simplicity puts it within the reach of all.