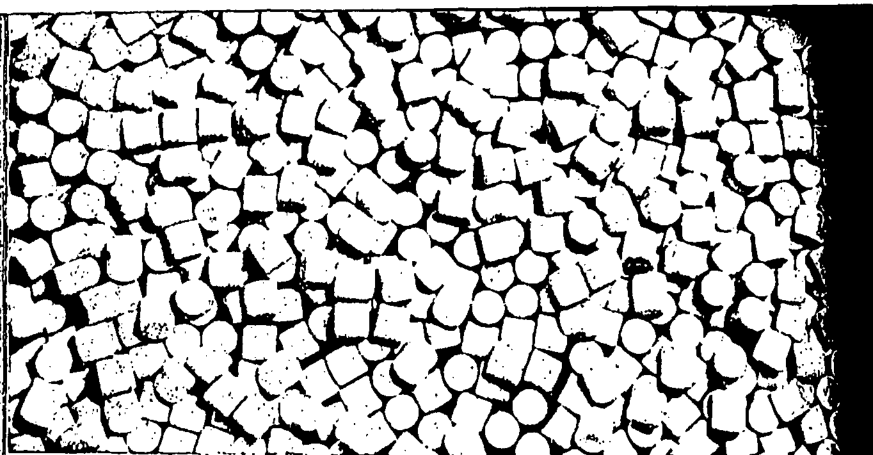
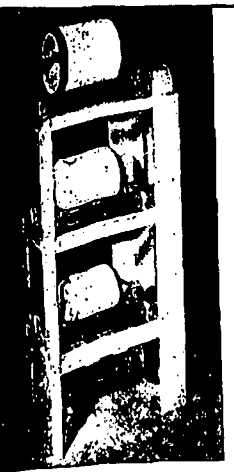


HIGH-DENSITY BURUNDUM in the form of small cylinders proves to be efficient grinding medium to reduce coal samples for analysis. Tests show insignificant contamination of sample and real time saving in length of grinding opera



MILL accommodating three pulver- jars has a variable-speed drive

High-Density Burundum Speeds Up Coa Crushing for Laboratory Analyses

Effective testing of coal characteristics calls for pulverizing samples to a given fineness. Here is a report on effectiveness of the crushing medium in ball mills, to speed up the job of preparing coal samples—possible savings in both time and money

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JAR MILLS hold coal sample and Burundum charge during grinding operations

► COAL IS ONE of the most tested materials used by industry. The coal user wants to be assured he's getting all the fuel he's paid for, and the producer has to know whether he is meeting the customer's specifications. Because of this two-way interest, numerous laboratories are kept busy just testing coal.

Test Methods. Many standard test procedures have evolved that the different laboratories use with little or no local variations. Descriptions of these tests appear in Part V of the 1949 *American Society for Testing Materials Standards*, pp 575 to 684, and in Bulletin 492 of the Bureau of Mines, *Methods of Analyzing Coal and Coke.*

Accuracy and speed of making the analysis are important for all laboratories, whether run by the coal-using or coal-producing businesses, or privately owned. An important step in the analysis concerns pulverizing of the coal sample. In present practice the coal sample received by the laboratory must be given a preliminary drying to bring its moisture in balance with atmospheric conditions.

After drying, the coal is crushed quickly by rolls to 20-mesh size and reduced by a riffle sampler to about 200 grams. The 200-gram sample is then crushed to sub 60-mesh particles. Both the Bureau of Mines and the ASTM suggest using 1-gallon ball mills, about half filled with ¾-in. diameter pebbles for this reduction process. The Bureau mentions rotational speeds of 45 to 50 rpm, while the *ASTM Standards* men tions speeds of 60 to 75 rpm.

According to these authorities, abo 10 to 20 minutes are needed to brea down bituminous coals, while about hour is needed for anthracites. The agree that from 0.2 to 0.4% of the sam ple usually remains on the screen aft the milling period. Since these coars particles are likely to be the ash-form ing substances, they are reduced by hand to pass the screen, and then mixe in with the bulk sample. The moistur ash, volatile matter, elemental comp nents, calorific value and fusibility o ash are found from this sub 60-mes material.

Ball milling, as a coal-reductio method, has certain advantages. Whi being ground the material becomes well-mixed. Moisture staying in the jar keeps the coal more nearly representative of its induced equilibrium state. The abrasion causes no significant contamination of the sample. Ball milling is a relatively clean operation. After a run the jar can be emptied quickly, brushed free of residual particles, and be ready for another sample.

Jar mills can be made even more desirable by substituting smaller sizes for the presently accepted gallon ones. This eases the handling problem. Shorter dimensions and considerable gross-weight reduction make it possible for women or physically handicapped personnel to handle the jars more easily. Smaller jars, which are less costly, make possible some savings in space and in money.

Test Comparison. Two porcelain mill jars were used for comparative testing. The 0.48-gallon jar had a volume of about 1800 cc, and the 1.3-gallon jar a volume of about 5000 cc. With covers and hardware they have an empty weight of 8 and 16 lb, respectively.

Two samples of bituminous coal were tested in each size jar. The coals were crushed to a nominal 20 mesh by the laboratory of a large coal user. Size analysis of these two coals when dry were:

Sample	*I*	*II*
On 6 mesh	0.7%	0.05%
On 8 mesh	5.6%	0.4%
On 12 mesh	15.1%	5.7%
On 14 mesh	10.8%	7.7%
On 16 mesh	8.6%	8.6%
On 40 mesh	34.3%	40.5%
On 50 mesh	5.4%	-8.0%
On 60 mesh	2.0%	3.1%
On 100 mesh	6.6%	10.8%
Through 100 mesh	10.9%	15.2%

Comparison tests were made to find the effect on particle size reduction of (1) different ratios of coal to media charges (2) rotational speed (3) time of run. Tests were run with flint-pebbles and high-density cylindrical-shaped Burundum as the crushing media. All the milling tests were run on a 3-tier variable-speed mill similar to the one in the photo above, left.

In the smaller jar, 3.5 lb of Burundum or 2.5 lb of flint with an 80-gram coal charge was best. It was decided, however, to work with 100-gram charges since it was more practical for the laboratory. The larger jar was most efficient with coal charges between 150 and 200 grams, and a Burundum charge of 10-12 lb. Loadings of over 200 grams of coal and 12 lb of media caused the effectiveness to fall off. No trials were made with flint in the larger jar.

Rotating speed proved an important factor in time needed for pulverizing with the small jars. Speed should be at least 110 rpm. Nature of the coal may have some bearing on the most effective speed. Sample I broke down more quickly and thoroughly with increasing speeds up to the machine limit of 124 rpm. Sample II reached a maximum between 110 and 115 rpm, then fell off in effectiveness, though not seriously.

Typical results, using 100 grams of coal sample II with 2.5 lb of flint and 3.5 lb of Burundum over a 20-minute milling period, were:

	% retained on 60 mesh	
Speed	*Flint*	*Burundum*
90 rpm	3.0	0.9
111 rpm	2.6	0.4
124 rpm	2.9	0.5

For the larger jar, speeds from 55 to 70 rpm seemed equally effective with 0.4% of the sample remaining on 60 mesh.

Rotation time effects were found as follows for a speed of 111 rpm with small jars:

	% retained on 60 mesh	
Time	*Flint*	*Burundum*
15 min	...	2.0
20 min	2.6	0.4
30 min	...	0.3
45 min	...	0.3
60 min	0.5	0.3

Up to 15 minutes, the sample is still relatively coarse with Burundum, while after 20 minutes there is little further gain. A time of 20 minutes was also critical with the large jar.

As a sidelight, grinding sample II up to an hour with both small and large jars did not completely pulverize the coal to pass through 60 mesh. Sample I broke up more readily.

The 60-mesh retention or passage is the most critical point in milling tests. Despite comparable size 60-mesh reduction, the larger jar produces less residue to be caught on a 100-mesh screen. For instance, in the small jars, 2.5 lb of flint with 100 grams of coal at 111 rpm left a *total* residue of about 29% on 100-mesh screen. On the other hand, 3.5 lb of Burundum under the same conditions left a total residue of 9.7%, while the large jar rotating at 67 rpm produced a residue of only 2.4% on the 100-mesh screen. Had only 80 grams of coal been used in the smaller jars, a better showing would have resulted, but this would be outside the limits imposed on this test project.

Results. Our work showed optimum conditions that will save time in preparing coal samples. Some of the conditions, such as media to coal charge ratios, when found, may be considered as constants, while that of speed may be varied as the coal differs. There is similar particle-size reduction through a 60-mesh screen of coal ground in either the 0.48- or 1.3-gallon jars.

We can conclude that for comparable results, a jar weighing no more than 11 lb, complete with charge, will do as acceptable a job as one weighing about 25-27 lb. The smaller physical dimensions expand the capacity of the mill itself.

Unloading of jars is more convenient. There are fewer pieces of crushing media in the charge and less chance of contamination from residual matter. Variable-speed drives prove desirable because optimum speeds can be used as needed. High-density media prove better in rapid pulverization than flint.