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SIZING STUDIES ON PILOT-OVEN COKE
COMPARISON WITH COMMERCIAL COKE SIZE

BY

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ABSTRACT

Coke produced in a pilot oven of commercial width may be made to compare closely in size with commercial-oven coke. Multiple drops from the shatter box cause breakage of the larger pieces, corresponding to the size degradation in plant equipment. Three drops of six feet each approximate average plant handling, but the procedure must be checked and adjusted for accurate comparison with any individual operating plant. Tumbler indices are not affected appreciably by this procedure and compare closely with plant practice.

Coke produced in the pilot-size coke ovens at the Illinois State Geological Survey compares closely with commercial coke in strength characteristics as measured by the standard A.S.T.M. tumbler test. Pilot-oven coke tends to be larger than the commercial product, however, owing to less breakage of the coke during removal from the oven and subsequent handling.

Breakage in a commercial coke plant starts as the coke is pushed from the ovens and falls ten feet or more into a hot car. After quenching, it is dumped onto a wharf, slides through gates onto a moving belt, and is conveyed to the screening plant. After screening, the coke is usually dropped into hoppers or storage piles and later transferred to skip buckets or belts for movement to final destination. Each drop or movement produces breakage, which results in a smaller size consist.

In comparison, pilot-oven coke falls a distance of from one to four feet when pushed into the quenching car. It is shoveled into drying pans and later removed, but no other handling is required before the coke is screened.

DEVELOPMENT OF A METHOD FOR SIMULATING COMMERCIAL COKE SIZE

Both the size and strength of pilot-oven coke should simulate the properties of the commercial product if test-oven results are to be of maximum value. Therefore, the pilot ovens have been operated at commercial coking rates and coke temperatures. It quickly became apparent, however, that owing to insufficient handling, the pilot-oven coke was large. To correct this condition, we dropped the coke made in the 14-inch pilot oven (Reed, 1947) a distance of 6 feet from the shatter box before screening and sizing. The size

consist of duplicate tests compared more closely, and sizing trends could be studied with more precision after this procedure was adopted. The pilot-oven coke still tended to be slightly larger than commercial coke, however, and there was a smaller percentage of fines.

Coke from 17-inch pilot oven. - A pilot oven 17 inches wide was built in our laboratory in 1953 (Jackman, 1955). Following previous practice, this oven was operated at a coking rate of one inch per hour. The resulting coke, even after the usual 6-foot drop from the shatter box, was considerably larger than that made in the older 14-inch oven. Table 1 gives comparison of the size and strength characteristics of cokes from the two pilot ovens under identical handling methods.

The 17-inch pilot oven coke was larger also than that made in commercial ovens of the same average width from the same blends at essentially the same coking rate. Several series of tests were made, therefore, to determine how the size of pilot-oven coke could be reduced to that of corresponding commercial coke. Pilot-oven cokes were dropped 6 feet from the shatter box one, two, and three times, and the resultant products were sized and compared with cokes made in commercial plants.

Effect of multiple drops on coke size. - The effect of multiple drops on the size consist of cokes made from two coal blends is shown in table 2. The high-volatile coal is from the Illinois field in one series, and from eastern Kentucky in the other. The low-volatile constituent is Pocahontas coal of 17% volatile matter.

Each additional drop from the shatter box reduces the amount of +4" and 4" x 3" coke in the product and increases the percentage under 2 inches. Only the 3" x 2" size at the center of the range may either increase or decrease depending on the coke being tested. The yield of furnace-size coke is reduced slightly by each additional drop, and there is a corresponding increase in the yields of nut and breeze.

Effect of multiple drops on coke strength. - The effect of multiple drops on coke strength measurements is shown in table 3. Shatter indices are increased by additional preliminary handling because the most fragile pieces of large coke are broken before the test is made. Tumbler indices are not affected appreciably, probably because the 3" x 2" pieces used in the tumbler drum are more stable, having been formed chiefly by breakage of larger pieces. They are not as susceptible therefore to preliminary handling as are the larger pieces that form a portion of the sample used in the shatter test.

Comparison with commercial-oven coke. - Pilot-oven coke that has been dropped from the shatter box three times checks most closely in size with plant coke. Comparisons of pilot and commercial cokes from two coal blends are shown in table 4. The coke size consist was computed on the furnace size (+1") except for blend 2 in which the commercial furnace size is plus 1 1/4 inches.

Coal blend 1, which contained 75% Illinois coal, produced coke in the pilot oven having approximately the same size consist and the same average size as that produced in commercial ovens. Pilot-oven coke made from coal blend 2, all Eastern coals, was somewhat larger than that produced commercially. To duplicate more closely the sizing of commercial coke made from

coal blend 2, our operating procedure would have to be adjusted or the coke dropped a greater distance or more than 3 times, before sizing.

The strength of the coke in each series, as indicated by the tumbler test, checks within the reproducibility of the test itself. Shatter-test indices are higher, however, on the pilot-oven coke. Yields of commercial sizes of coke, based on the weight of coal charged to the ovens, check within close tolerances.

SUMMARY AND CONCLUSIONS

The following conclusions have been drawn from this investigation.

1) Coke can be produced in a pilot oven 17 inches wide that compares closely in size and strength characteristics with commercial-oven coke.

2) Coke strength as measured by the tumbler test does not depend primarily on the width or size of the oven. Coke sizing, however, varies with oven width and with the handling received by the coke either in regular plant operation or by special treatment of the pilot-oven coke.

3) Multiple drops of the pilot-oven coke from the shatter box reduce coke size and can be used to simulate the breakage occurring when pushing coke from a commercial oven and handling it through the plant conveying and screening system.

4) Three drops of six feet each may closely simulate plant breakage. It must be understood, however, that just as coke handling varies in different plants, so the handling given pilot-oven coke must be studied and adjusted when checking size consist with an individual operating plant.

REFERENCES

Jackman, H. W., et al., 1955, Coke oven to measure expansion pressure - modified Illinois oven: preprint of paper given at Blast Furnace, Coke Oven, and Raw Materials Conference, Philadelphia, Pa., April 1955, A.I.M.E.; reprinted as Illinois Geol. Survey Reprint Series 1955-E, 16 p.

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Table 1. - Comparison of Pilot-Oven Cokes

	Coal blend 58 1/2% Ill. No. 6 (1) 21 1/2% Eagle 20% Pocahontas		Coal blend 55% Ill. No. 6 (2) 20% Ill. No. 5 25% Pocahontas	
	14" oven Runs 581-584	17" oven Run 1E	14" oven Run 589	17" oven Run 10E
No. of drops from shatter box	1	1	1	1
Coke sizing (% of total coke)				
+4"	9.3	15.2	6.6	17.0
4" x 3"	29.7	32.3	29.5	27.9
3" x 2"	40.3	36.4	42.8	37.6
2" x 1"	16.2	11.8	16.4	13.5
1" x 1/2"	1.5	1.1	1.7	1.6
-1/2"	3.0	3.2	3.0	2.4
Average size (in.)	2.73	2.92	2.67	2.90
Tumbler test				
Stability	48.3	49.6	45.6	44.9
Hardness	66.1	65.1	64.0	63.2
Shatter test				
+2"	67.4	73.0	73.0	68.2
+1 1/2"	87.5	89.9	88.5	86.7
+1"	95.5	96.2	96.6	95.7

Table 2. - Effect of Multiple Drops on Coke Sizing

	55% Ill. No. 6 (3) 20% Ill. No. 5 25% Pocahontas		
	1 6-ft. drop Run 38E	2 6-ft. drops Run 37E	3 6-ft. drops Run 36E
Coke sizing (% of total coke)			
+4"	16.6	9.6	5.3
4" x 3"	34.6	23.6	22.2
3" x 2"	31.9	44.1	45.7
2" x 1"	12.2	16.6	19.8
1" x 1/2"	1.2	1.9	2.5
-1/2"	3.5	4.2	4.5
Average size (in.)	2.96	2.63	2.49
Coke yields (% of coal as charged)			
Furnace (+1")	65.3	64.6	63.6
Nut (1" x 1/2")	0.8	1.3	1.7
Breeze (-1/2")	2.4	2.9	3.1

	65% Elkhorn 35% Pocahontas		
	1 6-ft. drop Run 53E	2 6-ft. drops Run 52E	3 6-ft. drops Run 50E
Coke sizing (% of total coke)			
+4"	9.1	4.5	2.9
4" x 3"	21.3	18.7	16.0
3" x 2"	41.3	38.9	40.2
2" x 1"	23.1	31.2	33.6
1" x 1/2"	1.7	2.3	2.5
-1/2"	3.5	4.4	4.8
Average size (in.)	2.56	2.33	2.23
Coke yields (% of coal as charged)			
Furnace (+1")	67.9	66.8	65.6
Nut (1" x 1/2")	1.2	1.6	1.8
Breeze (-1/2")	2.5	3.1	3.4

Table 3. - Effect of Multiple Drops on Coke Strength

	55% Ill. No. 6 (3) 20% Ill. No. 5 25% Pocahontas		
	1 6-ft. drop Run 38E	2 6-ft. drops Run 37E	3 6-ft. drops Run 36E
Tumbler test			
Stability	52.8	51.9	51.8
Hardness	66.4	66.9	65.0
Shatter test			
+2"	74.0	78.8	81.0
+1 1/2"	90.0	91.3	93.5
+1"	96.0	96.7	98.0

	65% Elkhorn 35% Pocahontas		
	1 6-ft. drop Run 53E	2 6-ft. drops Run 52E	3 6-ft. drops Run 50E
Tumbler test			
Stability	51.1	52.4	52.4
Hardness	71.7	71.1	70.6
Shatter test			
+2"	59.3	69.0	67.5
+1 1/2"	84.0	87.3	88.0
+1"	95.3	96.2	96.0

Table 4. - Comparison of Pilot and Commercial Plant Results

	Coal blend 1 55% Ill. No. 6 (3) 20% Ill. No. 5 25% Pocahontas		Coal blend 2 65% Elkhorn 35% Pocahontas	
	17" pilot oven av. 2 runs	commercial av. 1 month	17" pilot oven av. 3 runs	commercial av. 1 month
No. of drops from shatter box	3		3	
Furnace-size coke (+1")				
+4"	6.2	5.5	1.3	
4" x 3"	23.8	30.9	15.3	8.9
3" x 2"	48.6	39.0	40.2	34.5
2" x 1"	21.4	23.5	43.2	51.0[a]
Undersize		1.1		5.6
Av. size (in.)	2.65	2.66	2.25	2.04
Tumbler test				
Stability	53.1	53.3	52.7	54.0
Hardness	66.4	68.5	71.5	68.8
Shatter test				
+2"	79.8	67.6		
+1"	97.5	96.5		
Coke yields (dry)				
Furnace (+1")	63.9	64.1	64.5[b]	64.6[a,b]
Nut and pea (1" x 1/2")	1.5	2.4	1.8	1.9[c]
Breeze (-1/2")	3.1	2.9	3.5	2.9[d]

a. Bottom size - 1 1/4"; b. Yields corrected to coal at 5% moisture; c. 1 1/4" to 5/8"; d. Minus 5/8".

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