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MINES BRANCH INVESTIGATION REPORT IR 64-16

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**ROD MILL GRINDING OF COKE FROM
ALGOMA STEEL CORPORATION LIMITED,
SAULT STE. MARIE, ONTARIO**

by

T. F. BERRY

MINERAL PROCESSING DIVISION

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Mines Branch Investigation Report IR 64-16

ROD MILL GRINDING OF COKE FROM ALGOMA STEEL
CORPORATION LIMITED, SAULT STE. MARIE, ONTARIO

by

T.F. Berry*

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SUMMARY OF RESULTS

A 2 ft x 4 ft Marcy centre peripheral discharge rod mill was used for all of the grinding tests on the Algoma coke shipment to produce a - 1/8 in. + 100 m finished product.

In Test 1, open circuit grinding of the coke as received gave a recovery of 75.6% of the - 1/8 in. + 100 m coke. In Test 10 by comparison, with the mill in closed circuit with a 1/8 in. screen, the recovery of this fraction was 80.3%.

Using 1/8 inch coke as the feed to the mill in open circuit, Test 6 resulted in 27.1% recovery by screening and an additional 51.2% by grinding for an overall recovery of 78.3% of the coke. By comparison in Test 12 with the mill in closed circuit with the 1/8 in. screen, the recovery of - 1/8 in. + 100 m coke was 20.1% by screening of the coke plus 61.7% by grinding for an overall recovery of 81.8%.

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INTRODUCTION

On September 23, 1963, Mr. A. M. Cameron, Technical Assistant to the Superintendent of the Coke Plant of Algoma Steel Corporation Limited, Sault Ste. Marie, Ontario, requested a series of rod mill grinding tests on a shipment of small-sized coke.

Nature of Investigation Requested

Mr. Cameron outlined the following testing program for the sample of coke:

1. A dry screen test on the sample for the following fractions: + 3/4 in., - 3/4 + 1/2 in., - 1/2 + 1/8 in., - 1/8 in. + 100 m, - 100 m.
2. A sample to be ground to - 1/8 in. and a screen test on the rod mill product.
3. The + 1/2 in. coke to be screened out and the - 1/2 in. fraction to be ground in a rod mill to - 1/8 in. with a screen test on the rod mill product.
4. The - 1/8 in. coke to be screened out and the + 1/8 in. fraction to be ground in a rod mill to - 1/8 in. with a screen test on the rod mill product.

Mr. Cameron said the purpose of the tests was to investigate:

- (a) a once through grinding (open circuit) of all - 3/4 in. coke in a rod mill to produce a braize for sinter fuel.
- (b) a system that would include a 1/8 in. screen before and in closed circuit with a rod mill. The justification for this more costly procedure would be an increased quantity of coke braize in the desired - 1/8 in. + 100 m range.

Shipments

On September 27, 8 drums of wet coke weighing about 1 ton were received at the Mines Branch and on October 8 an additional shipment of 16 drums of wet coke weighing about 2 tons, was received.

Equipment

The grinding equipment used was a 2 ft x 4 ft centre peripheral discharge Marcy rod mill. When screening was necessary, a Sweco separator was used.

DETAILS OF INVESTIGATION

Open Circuit Tests 1 to 9

In all of the open circuit tests the coke was fed equally to each end of the rod mill and grinding was allowed to continue until a steady discharge rate of the ground coke was obtained. A one minute sample of the rod mill discharge was obtained for a moisture determination and for a screen test. The results of the open circuit tests are shown in Tables 1, 2, 3 and 4.

TABLE 1

Results of Open Circuit Grinding of Coke as Received

Mesh Size	Feed		Test 1		Test 2		Test 3	
	% Ret	% Pass	% Ret	% Pass	% Ret	% Pass	% Ret	% Pass
+ 1 inch	--	100.0	--	--	--	--	--	100.0
+ 3/4 inch	8.0	92.0	--	100.0	--	100.0	0.4	99.6
+ 1/2 inch	13.1	78.9	0.4	99.6	2.4	97.6	2.2	97.4
+ 1/4 inch	25.3	53.6	0.4	99.2	2.8	94.8	9.2	88.2
+ 1/8 inch	18.3	35.3	1.7	97.5	15.4	79.4	27.4	60.8
+ 100 mesh	31.0	4.3	75.6	21.9	64.6	14.8	48.4	12.4
- 100 mesh	4.3	--	21.9	--	14.8	--	12.4	--
Total	100.0	--	100.0	--	100.0	--	100.0	--
Rod charge lb	--		550		550		550	
Mill feed (lb/hr wet)	--		510		690		945	
Moisture %	--		16.9		15.1		15.7	

TABLE 2
Results of Open Circuit Grinding of -1/2 Coke

Mesh Size	Feed		Test 4		Test 5	
	% Ret	% Pass	% Ret	% Pass	% Ret	% Pass
+ 1/2 inch	--	100.0	--	--	--	100.0
+ 1/4 inch	28.3	71.7	--	100.0	0.5	99.5
+ 1/8 inch	23.8	47.9	4.8	95.2	13.4	86.1
+ 100 mesh	42.5	5.4	75.2	20.0	70.4	15.7
- 100 mesh	5.4	--	20.0	--	15.7	--
Total	100.0	--	100.0	--	100.0	--
Rod charge lb	--		550		550	
Mill feed (lb/hr wet)	--		690		960	
Moisture %	--		23.7		--	

To produce a +1/8 in. feed for open circuit tests, the coke was screened once on a 1/8 in. screen, with the following results.

TABLE 3
Results of Screen Tests on Products

Mesh Size	+ 1/8 in. Fraction		- 1/8 in. Fraction	
	% Ret	% Pass	% Ret	% Pass
+ 1 inch	--	100.0	--	--
+ 3/4 inch	21.8	78.2	--	--
+ 1/2 inch	31.2	47.0	--	--
+ 1/4 inch	29.1	17.9	--	100.0
+ 1/8 inch	10.6	7.3	0.4	99.6
+ 100 mesh	5.1	2.2	89.4	10.2
- 100 mesh	2.2	--	10.2	--
Total	100.0	--	100.0	--

This screening operation gave 69.8% of the coke as + 1/8 in. and 30.2% as - 1/8 in. Neglecting the 0.4% oversize in the - 1/8 in. fraction the screening produced 27.1% as finished - 1/8 in. + 100 m material. The + 1/8 in. fraction was ground under varying conditions to obtain the following results (Table 4).

In Test 7, 72.4% of the product was in the finished size range, this represented 50.5% of the original coke, add to this the 27.1% finished product obtained from the original screening, gives an overall recovery of 77.6% of the coke.

TABLE 4

Results of Open Circuit Grinding of +1/8 inch Coke

Mesh Size	Test 6		Test 7		Test 8		Test 9	
	% Ret	% Pass	% Ret	% Pass	% Ret	% Pass	% Ret	% Pass
+ 1 inch	--	--	--	--	--	--	--	--
+ 3/4 inch	--	100.0	--	100.0	--	100.0	--	100.0
+ 1/2 inch	1.7	98.3	1.8	98.2	2.0	98.0	1.0	99.0
+ 1/4 inch	2.4	95.9	1.3	96.9	3.8	94.2	3.8	95.2
+ 1/8 inch	4.1	91.8	1.8	95.1	12.5	81.7	21.2	74.0
+ 100 mesh	73.3	18.5	72.4	22.7	66.8	14.9	60.8	13.2
- 100 mesh	18.5	--	22.7	--	14.9	--	13.2	--
Total	100.0	--	100.0	-	100.0	--	100.0	--
Rod charge lb	550		750		750		750	
Mill feed (lb/hr wet)	450		487.5		675		870	
Moisture %	20.7		16.4		15.2		14.8	

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Closed Circuit Tests 10 to 12

Three grinding tests were done in the Marcy rod mill in closed circuit with a 1/8 in. screen on a Sweco separator. During these tests the same amount of coke was fed to each end of the mill which discharged onto the screen with the screen oversize being returned equally to each end of the mill through a separate feeding system. A test was completed when the circulating load reached equilibrium. The results of these tests are shown in Tables 5, 6 and 7.

TABLE 5

Results of Closed Circuit Grinding of Coke as Received

Mesh Size	Test 10		Test 11	
	% Ret	% Pass	% Ret	% Pass
+ 1/8 inch	--	100.0	--	100.0
+ 10 mesh	19.2	80.8	20.2	79.8
+ 28 mesh	32.8	48.0	36.5	43.3
+ 48 mesh	15.0	33.0	14.7	28.6
+ 65 mesh	6.2	26.8	5.7	22.9
+ 100 mesh	7.1	19.7	5.9	17.0
- 100 mesh	19.7	--	17.0	--
Total	100.0	--	100.0	--
Rod charge lb	550		750	
New feed (lb/hr wet)	546		636	
Circulating load (lb/hr wet)	318		336	
Circulating load, %	58.2		52.8	
Moisture %	17.0		14.5	
- 1/8 in. + 100 m recovered %	80.3		83.0	

To obtain sufficient + 1/8 in. feed for a closed circuit test a quantity of wet coke was double screened on a Sweco separator.

TABLE 6
Results of Screen Tests on Products

Mesh Size	+ 1/8 in. Fraction		- 1/8 in. Fraction	
	% Ret	% Pass	% Ret	% Pass
+ 1 inch	--	--	--	--
+ 3/4 inch	8.5	91.5	--	--
+ 1/2 inch	29.8	61.5	--	--
+ 1/4 inch	33.3	28.4	--	--
+ 1/8 inch	18.8	9.6	trace	100.0
+ 28 mesh	5.7	3.9	60.6	39.4
+ 65 mesh	1.3	2.6	24.4	15.0
+ 100 mesh	0.8	1.8	4.2	10.8
- 100 mesh	1.8	--	10.8	--
Total	100.0	--	100.0	--

This screening operation gave 77.5% of the coke in the + 1/8 in. fraction and 22.5% in the - 1/8 in. fraction. The screen test on the - 1/8 in. fraction showed 10.8% to be -100 m. Thus, 20.1% of the coke to the screen was in the desired size range of - 1/8 in. + 100 m. The + 1/8 in. fraction contained some - 1/8 in. material due to the balling action of the damp coke on the screen.

The closed circuit grinding test on the + 1/8 in. fraction was allowed to continue until the circulating load reached equilibrium. The results of this test are shown in Table 7.

TABLE 7

Results of Closed Circuit Grinding of + 1/8 inch Coke

Mesh Size	Test 12	
	% Ret	% Pass
+ 1/8 inch	--	100.0
+ 28 mesh	51.3	48.7
+ 65 mesh	21.0	27.7
+ 100 mesh	7.3	20.4
- 100 mesh	20.4	--
Total	100.0	--
Rod charge lb	750	
New feed (lb/hr wet)	570	
Circulating load (lb/hr wet)	420	
Circulating load %	73.7	
Moisture %	13.9	
- 1/8 in. + 100 m recovered %	79.6	

While 79.6% of the screen undersize was finished material, this represented 61.7% of the original coke. Since 20.1% of the coke was recovered as a finished product by prior screening, the overall recovery of - 1/8 in. + 100 m material with this procedure was 81.8%.

Crushing Tests

Attempts were made to use the Hazemag impact crusher to obtain a product in the desired size range. These tests were unsuccessful because of the high moisture content of the coke (about 14%). The finely crushed material tended to block the feed chute opening into the crusher and to build up on the walls of the crushing chamber.

CONCLUSIONS

The results of the investigation indicate that a centre peripheral discharge rod mill can be used to grind the coke to the desired - 1/8 in. + 100 m size range. Open circuit grinding of the coke as received, gave 75.6% in the desired size range in Test 1 with only 2.5% of the rod mill discharge + 1/8 in. This is a much simpler procedure than closed circuit grinding as shown in Test 10 in which 80.3% was produced.

Using + 1/8 in. coke as the feed to the mill, closed circuit grinding gave a slightly higher overall recovery than open circuit grinding.

It is believed that the high moisture content of the coke was the reason why the tests with the Hazemag impact crusher were unsuccessful. This impact crusher might do the job but it was not possible to determine this with the laboratory equipment available.

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