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PELLETIZING COPPER OXIDE ORE FROM GASPÉ COPPER MINES LTD.

by

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EXTRACTION METALLURGY DIVISION

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SUMMARY

Pelletizing experiments were performed on the -4mm material in 123 lb of copper oxide ore received from Gaspé Copper Mines Ltd. After grinding for 30 minutes 58.9 per cent of the material was -74 micron. This balled readily under controlled conditions. The green strength and the dry strength of the resulting balls were determined and appeared to be satisfactory for converter feed. Although there was not sufficient material to conduct a thorough investigation of the induration of these balls, the few experiments which were performed indicated that at the optimum temperature satisfactory pellets could be produced from balls containing 5 per cent bentonite.

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INTRODUCTION

On March 15, 1963, a 33 lb sample of copper oxide ore was received from the Gaspé Copper Mines Ltd. In a covering letter, dated February 18, 1963, Dr. D.G. Cerigo, Head, Department of Technical Economics, Noranda Research Center, requested that experiments be performed on this ore to determine whether a pelletized product, suitable for use as a converter flux, could be produced. Screen analysis of the sample indicated that the ore, without further grinding, was too coarse to pelletize and, in a letter to Dr. Cerigo dated April 4, 1963, two alternative procedures were suggested: (1) grind all of the ore to pelletizing size, or (2) screen the ore and grind to pelletizing size only that portion which was too fine to be used as converter flux. In his reply of April 22, 1963, Dr. Cerigo recommended that pelletizing experiments be carried out on that portion of the ore which was finer than 3.5mm. On May 3, 1963, a second sample of ore, weighing 90 lb, was received. The -4.0mm size material from both the first and second shipments was combined for use in the subsequent pelletizing experiments. The total weight was 15,750 grams.

EXPERIMENTAL WORK

Screen Analysis of Head Sample

The complete screen analysis of the first sample received is given in Table 1. The second sample was screened at 4mm size and found to contain 28.5 per cent -4mm, which was quite similar to the screen analysis of the first sample (29.5 per cent -4mm).

Grinding

Samples of 3500g of the combined -4.0mm ores were dry ground in a ball mill with 20 lb of 1 1/4 in. balls and 20 lb of 5/8 in. balls for 5, 10, 15 and 30 minutes. The material ground for 5 minutes would not ball when mixed with water. The material ground for 10 minutes contained 40 per cent -74 micron, and balled with difficulty while it was fed by hand, but would not ball under the controlled conditions used in automatic feeding. The material ground for 15 minutes contained 49.2 per cent -74 micron and balled with difficulty under the controlled conditions. The material ground for 30 minutes contained 58.9 per cent -74 micron and balled readily under the controlled conditions. All of the various samples were then ground for a total grinding time of 30 minutes and the products combined. Samples of this combined product were taken for density, surface area and screen analysis determinations. The results are presented in Table 2.

TABLE 1

Screen Analysis of Gaspe Copper Oxide Ore Sample No. 1

Sieve Size	Wt % (Cumulative)
+ 8.0 mm	58.1
+ 5.66 "	62.9
+ 4.00 "	70.5
+ 2.83 "	75.1
+ 2.00 "	78.7
+ 1.41 "	81.5
+ 1.00 "	83.8
+707 micron	85.6
+500 "	87.3
+354 "	88.9
+250 "	90.0
+177 "	91.5
+149 "	92.3
+125 "	92.8
+ 88 "	94.0
+ 74 "	94.9
+ 63 "	97.0
+ 44 "	98.9
+ 37 "	99.3
- 37 "	0.7

TABLE 2

Density, Surface Area and Screen Analysis of Material Ground for 30 Minutes

Density = 2.872g/ cm^3

Surface Area (using Blaine Instrument) = 1319 cm^2/g

Sieve Size	Wt % (Cumulative)
+ 2 mm	0.2
+ 1 "	0.4
+500 micron	0.6
+250 "	1.6
+149 "	12.4
+ 74 "	41.1
+ 44 "	62.7
+ 37 "	68.3
- 37 "	31.7

Balling

The equipment used in this laboratory for making small batches of balls consists of an 8"x20" diameter aeroplane tire, rotated by a variable speed drive. In the present experiments the tire was rotated at 51 rpm and the following procedure was used for making balls.

Seed pellets (-5.66+4.76mm) were produced by hand feeding the material being tested into the rotating tire and then gradually dampening the material by spraying with water to form small pellets. The undersize and oversize seed pellets were rejected by screening and then broken up by hand before being returned to the balling circuit. The sized seed pellets were used to form balls as follows. In each experiment 100g of seed pellets were placed in the tire and feed material, containing about 75 per cent of the optimum balling moisture, was fed into the tire for four minutes at a feed rate of 210 g/min. Additional moisture was sprayed onto the forming balls, as required. The balls were allowed to roll for 2 minutes after feeding had been completed. The formed balls were then screened at -1/2+7/16 inch and -7/16+3/8 inch and sampled for moisture, drop and compression strength tests. A sample of the green balls was dried overnight in an oven at 110°C and then tested at room temperature for dried strength.

Three balling experiments were performed on the material described in Table 2: (1) using no additive (2) using 1/2 per cent bentonite additive and (3) using 5 per cent bentonite additive. The green and dried strengths of balls from these experiments are tabulated in Table 3.

Drop strengths were determined by dropping 10 balls, individually, a distance of 18 inches in the case of green balls, and 6 inches in the case of dried balls, onto a concrete floor and calculating the average number of drops required to break a ball. The compressive strength was determined by compressing 10 balls, individually, in a modified Dietert core-testing machine and calculating the average compressive force required to break a ball.

Indurating Balls

Because of the limited amount of sample available, only a few small scale indurating experiments could be performed, but it was believed that these might be of some aid in assessing the value of agglomerating the ore.

A laboratory muffle furnace was used to heat treat the dried balls to form pellets. In each experiment the balls were placed in the furnace and brought up to the desired temperature over a period of about 2 1/2 hours. They were held there for 1/2 hour and then the heat was turned off and the pellets were allowed to cool in the furnace overnight. When cooled to room temperature, the pellets were tested for compression strength. The results of these tests are given in Table 4.

TABLE 3

Green and Dried Strength of Balls

Bentonite Additive (%)	Balling Moisture (%)	Green Strength				Dried Strength			
		Drop Strength (No. of drops from 18 in.)		Compression Strength (lb)		Drop Strength (No. of drops from 6 in.)		Compression Strength (lb)	
		-1/2+7/16" Balls	-7/16+3/8" Balls	-1/2+7/16" Balls	-7/16+3/8" Balls	-1/2+7/16" Balls	-7/16+3/8" Balls	-1/2+7/16" Balls	-7/16+3/8" Balls
None	11.4	3.4	3.8	2.2	1.9	>20	>20	12.9	11.2
1/2	11.8	3.3	3.6	2.3	2.0	>20	>20	16.2	12.4
5	13.7	>10	>10	3.2	3.2	>20	>20	27.5	26.7

TABLE 4

Compression Strength of Fired Pellets

Experiment	Additive	Indurating Temperature (°C)	Compression Strength (lb)	
			-1/2+7/16"	-7/16+3/8"
1	None	1300	Pellets Fused	
2	1/2% Bentonite	1000	12.4	12.2
3	1/2% Bentonite	1200	311.6	219.3
4	5% Bentonite	1100	64.5	57.9
5	5% Bentonite	1250	Pellets Partially Fused	
			693.3	550.1

In experiment No. 1 the firing temperature (1300°C) was obviously too high and the pellets fused into a solid mass, preventing any compression tests on individual pellets. In experiment No. 2 the firing temperature (1000°C) was too low and the compression strength of the pellets was lower than that obtained with dried balls. In experiment No. 3 the pellets previously heated to 1000°C and then cooled, were reheated to a higher temperature (1200°C), which caused an increase in the compression strength of the pellets. In experiment No. 4 the dried balls, containing 5 per cent bentonite, were heated to 1100°C, which gave pellet compression strengths slightly greater than those of the dried balls. In experiment No. 5 the 5 per cent bentonite pellets, previously heated to 1100°C, were reheated to 1250°C, which gave pellet compression strengths of 550 to 700 lb. In experiment No. 5

the pellets were partially fused to one another, indicating that the firing temperature of 1250°C was probably the maximum practical limit for indurating.

CONCLUSIONS

Balls and pellets, having approximately the compression strengths of commercial iron ore balls and pellets, can be produced from this copper oxide ore. In commercial iron ore pelletizing the feed material is normally finer than 70 per cent -44 micron size, with a coarser feed size giving lower ball strengths. It is therefore suspected that if the copper oxide ore used in these present experiments had been ground finer than the 37.3 per cent -44 micron size used, the green and/or dried ball strength would have been greater. Indurating at temperatures of 1300°C cause the pellets to fuse, but further experiments showed that pellets, with compression strengths of 200 to 700 lb may be produced by indurating at temperatures of 1200 to 1250°C. Although these latter experiments were performed with material containing a bentonite additive, it is expected (on the basis of experiments with iron ores) that material containing no additive would have given similar pellet strengths. It also is suspected that the previous heating of the pellets used in indurating experiments No. 3 and No. 5 had no perceptible effect on the final pellet strengths obtained.

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