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FOUNDRY TEST OF A SAND SAMPLE SUBMITTED BY RIO TINTO CANADIAN EXPLORATION LIMITED

by

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SUMMARY OF RESULTS

A sample of sand from Rio Tinto Canadian Exploration Limited was tested to determine its suitability for foundry use. The 1200-pound sample had been crushed in a cascade mill and classified in a rake classifier. The dust was removed at the Mines Branch by passing it through a wet cyclone.

The sand was tested by bonding it with western bentonite and gelatinized corn starch, and using it repeatedly to make a steel test casting. The casting quality was equal to that produced by imported U. S. sands. However, the Rio Tinto sand required about 15% more bentonite, and the moulding properties were somewhat inferior.

A test in which the used sand was scrubbed in a laboratory sand muller indicated that it could be successfully reclaimed.

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INTRODUCTION

In a letter dated January 26, 1961, Mr. R. A. Dujardin, Rio Tinto Canadian Exploration Limited, Toronto, Ontario, requested a test of a sample of foundry sand, in which the sand was to be used to make steel castings. A sample weighing about 1200 lb was received on January 30. This sample had been prepared from crushed sandstone, and was similar to samples previously tested and described in Mines Branch Investigation Report IR 60-49 and Physical Metallurgy Division Test Report PM-60-68.

METHOD OF TESTING

The sample, as received, had been crushed in a cascade mill and classified with a rake classifier. It was still dusty, and the sand was further treated by passing it through a wet cyclone, after which it was dried. The screen size after this treatment is shown in Table 1.

TABLE 1

Screen Size of Rio Tinto Sand

U. S. Screen No.	Per Cent Retained After Cyclone	Per Cent Retained Reclaimed after 10 Uses
30	1.9	0.4
40	10.9	4.8
50	36.9	29.9
70	25.5	30.0
100	14.8	20.4
140	5.7	8.3
200	2.4	4.1
270	1.0	1.3
Pan	0.8	0.7
AFS Fineness No.	54	61.5

The screen distribution of the sand after it was reclaimed as described below is included for convenience in the above table.

The sand was tested by bonding it with western bentonite (National) and gelatinized corn flour. The test batch of sand was used for 10 heats. It was mulled 1 min dry and 6 min wet before each use. The initial batch of sand was mulled with western bentonite in a weight ratio of 5 parts to 100 parts of sand. Subsequent bentonite additions were made between heats to produce and

maintain a green compressive strength of about 9 psi.

Additions of gelatinized corn flour were made to the sand in a ratio of 1 part by weight of corn flour to 5 parts of bentonite.

A test casting developed by the Steel Founders' Society of America was used in this work. Four castings from each heat were poured. Extra sand was used in the first heat, to ensure that after ten heats there would still be enough sand to make the required four moulds. This extra sand was mixed in after each use to keep the sand uniform.

The moulds were prepared to produce as closely as possible a mould hardness of 90. They were rammed with a combination of hand ramming and jolt squeezing.

The castings were poured in mild steel corresponding to about SAE1030 composition. The metal was tapped at 1670°C (3040°F) and poured at 1620°C (2950°F).

In addition to the test using the Rio Tinto sand, a series was run using an Ottawa "45" sand bonded with the same samples of western bentonite and gelatinized corn flour. The screen distribution of this sand is listed in Mines Branch Investigation Report IR 60-49.

TEST RESULTS

Sand Properties

The moulding properties of the sand mixtures, together with the amounts of bentonite added, are shown in Tables 2 and 3.

It will be seen that the bentonite additions for the Rio Tinto sand were about 15% greater than they were for the Ottawa sand. The permeability of the Rio Tinto sand decreased with use, but the decrease was not great enough to affect the castings. Green deformation, green tensile strength, and dry compressive strength of the Rio Tinto sand were also significantly lower than they were for the Ottawa sand. Lower green tensile strength and green deformation would make patterns more difficult to draw. Lower dry compressive strength may make the sand more likely to erode.

Scabbing Tendency

A rating method was used to measure the tendency to form scabs. Only scabs on the cope and drag surfaces of the scab plate were rated. The scabs were rated in three groups: small, medium, and large. Small scabs were less than two square inches on a scab plate; medium scabs were from 2 to 6 sq in. in area. Small, medium and large scabs had ratings of 1, 2, and 3 respectively. The results of these tests are shown in Tables 4 and 5.

The difference in scabbing tendency between the two sands is within the limits of error of the test, and is probably not significant. The Ottawa sand scabbed less than it did in a previous test. This is attributable to the fact that a different sample of bentonite had been used for the previous tests.

Surface Finish

The surface finish of the castings was rated with a Cast Surface Comparator. Ratings were made on four surfaces of a representative casting from each heat. Average readings were:

Rio Tinto Sand	74.75
Ottawa Sand	75.5

This difference is not significant.

Photographs of four castings from each test series are shown in Figures 1-4 inclusive.

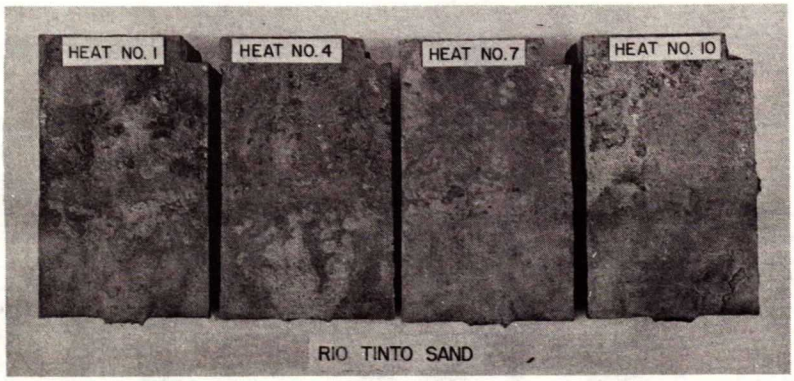

Figure 1 - Rio Tinto Sand, Cope surface

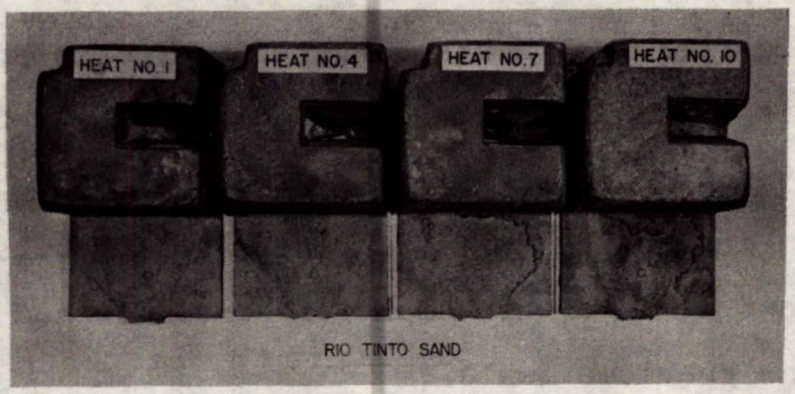

Figure 2 - Rio Tinto Sand - Drag Surface

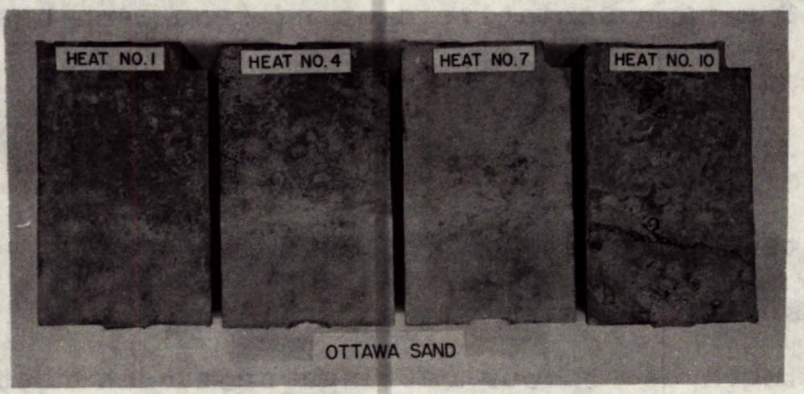

Figure 3 - Ottawa Sand - Cope Surface

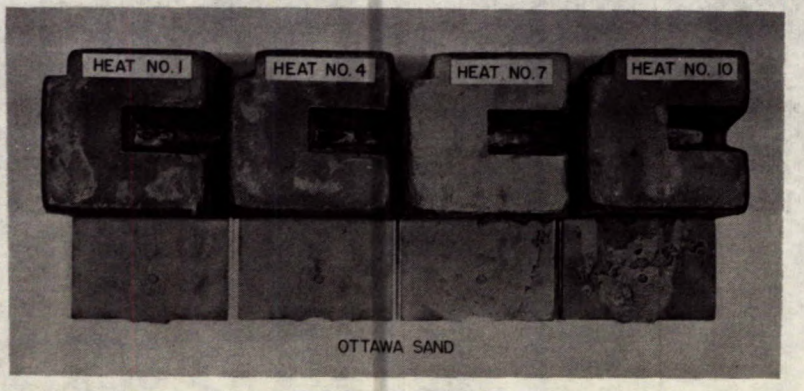

Figure 4 - Ottawa Sand - Drag Surface

TABLE 2

Properties of Rio Tinto Sand

Heat No.	Moisture %	Permeability	Green Compressive Strength, psi	Green Deformation, %	Green Tensile Strength, oz/in.^{2}	Green Shear Strength, psi	Dry Compressive Strength, psi	Bentonite Addition (National) pounds (900 pound batch)
1	3.8	264	6.4	3.79	11.3	2.0	99	45
2	3.8	243	7.2	3.86	20.0	2.3	135	7.5
3	3.8	235	7.5	4.04	19.0	2.5	158	7.5
4	3.75	235	8.8	4.17	22.6	2.9	116	7.5
5	3.65	226	9.0	3.95	21.5	2.8	105	5
6	3.9	226	9.4	3.60	24.5	2.8	116	5
7	3.75	212	8.5	3.63	22.8	2.8	118	0
8	3.65	226	9.5	3.41	23.4	3.0	114	4
9	3.65	226	9.7	3.10	23.2	2.7	106	0
10	3.85	219	9.3	3.28	21.2	2.7	131	4

Total bentonite addition - 85.5 lb

TABLE 3

Properties of Ottawa "45" Sand

Heat No.	Moisture %	Permeability	Green Compressive Strength, psi	Green Deformation %	Green Tensile Strength, oz/in.^{2}	Green Shear Strength, psi	Dry Compressive Strength, psi	Bentonite Addition, (National) pounds (900 pound batch)
1	3.85	134	8.5	4.57	16.9	2.6	155	45
2	3.55	146	8.4	4.83	23.3	2.8	174	5
3	3.4	146	9.1	4.71	26.2	3.0	159	5
4	3.1	151	8.6	3.76	24.4	2.7	130	0
5	3.15	156	8.7	4.46	25.4	2.9	136	5
6	3.25	156	9.1	4.51	23.8	3.0	138	5
7	3.35	142	9.2	3.27	23.3	2.6	142	0
8	3.55	142	9.6	4.36	24.3	3.1	125	5
9	3.6	142	10.4	4.10	27.3	3.3	143	4
10	3.8	142	9.3	4.06	25.9	2.9	144	0

Total bentonite addition - 74 lb

TABLE 4

Scabbing with Rio Tinto Sand

Heat No.	Cope Scabs			Drag Scabs		
	Small	Medium	Large	Small	Medium	Large
1	-	-	-	1	-	-
2	-	-	-	3	-	-
3	-	-	-	3	-	-
4	-	-	-	-	-	-
5	-	-	-	2	-	-
6	-	-	-	3	-	-
7	1	-	-	4	-	-
8	-	-	-	4	-	-
9	2	1	1	2	1	1
10	2	-	-	2	2	-
Totals	5	1	1	24	3	1
Ratings	5	2	3	24	6	3

Total Rating 43

TABLE 5

Scabbing with Ottawa Sand

Heat No.	Cope Scabs			Drag Scabs		
	Small	Medium	Large	Small	Medium	Large
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	2	-	-
6	-	-	-	4	-	-
7	-	-	-	2	1	-
8	-	-	-	3	-	-
9	-	-	-	4	-	-
10	1	1	2	1	1	1
Totals	1	1	2	16	2	1
Ratings	1	2	6	16	2	3

Total Rating 30

Properties of Reclaimed Used Sand

A sample of the Rio Tinto sand used ten times was reclaimed by scrubbing in an 18 in. laboratory muller for 30 min, and washing the scrubbed sand. The properties were tested and compared to those of the new sand.

Screen Distribution

The screen distributions of the new and reclaimed sand are shown above in Table 1. It is evident that there has been some breakdown of grains on use.

Moulding Sand Mixture

3000 g sand
150 g bentonite (Vol clay)
30 g gelatinized corn flour
Water to temper
Mulled 1 min dry, 6 min wet in 18-in. laboratory muller.

Table 6 compares the results obtained with this mixture with new and reclaimed sand.

TABLE 6

Comparison of New and Reclaimed Rio Tinto Moulding Sand

	New	Used 10 Times, reclaimed
Moisture, per cent	3.8	3.55
Permeability	167	163
Green Compressive Strength, psi	6.2	7.1
Green Deformation, per cent	4.25	4.8
Green Tensile Strength, $oz/in.^2$	15.2	14.4
Green Shear Strength, psi	2.3	2.4
Dry Compressive Strength, psi	232	168
High Jolts to break overhang specimen	480	452

There was no significant change in the properties of the moulding sand after use and reclamation. The slight differences could be explained by the difference in tempering moisture.

Core Sand Mixtures

2500 g sand

25 g gelatinized corn flour

25 g AFS reference linseed oil

Baked $1\frac{1}{2}$ hr at $400^{\circ}F$.

The results are shown in Table 7.

TABLE 7

Comparison of New and Reclaimed Rio Tinto Core Sand

	New	Used 10 times, reclaimed
Green Compressive Strength, psi	0.88	0.85
Baked Tensile Strength, psi	247.5	348.5
Low Jolts to break overhang specimen	3	5

The sand seems to be considerably improved for core work by use and reclamation.

CONCLUSIONS

1. There is no significant difference in the quality of castings made in Ottawa and Rio Tinto sand.
2. The Rio Tinto sand requires about 15% more clay than does the Ottawa sand.
3. Lower green tensile strength and green deformation of the Rio Tinto sand might cause some moulding difficulties with certain castings.
4. Lower dry strength of the Rio Tinto sand might cause a tendency to erode with large castings. However, this tendency was not noticed in the fairly severe test casting used.

5. In comparison to new sand, sand used 10 times and reclaimed appeared to be about equal for moulding and superior for core work. These results refer only to the test reclamation system used, and would not be duplicated by commercial systems. However, they indicate that the sand can be successfully reclaimed.

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