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STEEL FOUNDRY POTENTIALITY OF A SAND SAMPLE FROM ST. LAWRENCE INDUSTRIAL SILICA LIMITED

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY

A sample of sand from St. Lawrence Industrial Silica Ltd. was tested to determine its suitability for use as a steel foundry moulding sand. Before it was tested the sand was crushed in an Aerofall mill and washed in a classifier. This treatment proved to be sufficient to prepare the sand for foundry use.

In one of the tests the sand was repeatedly used to make a test casting. This test showed that the sand did not break down in use to any greater extent than did commercial New Jersey and Ottawa, Ill. sands. The quality of castings produced is as good as, and possibly better than, that produced with the U.S. sands.

The angular to subangular grain shape of the St. Lawrence sand makes it more difficult to work with than Ottawa sand, and makes the sand less suitable for core work.

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(5 tables, 0 illus.)

INTRODUCTION

On April 16, 1958, Mr. D. C. Matthews, St. Lawrence Industrial Silica Ltd., Toronto, Ontario, paid a visit to the Physical Metallurgy Division laboratories, and requested an examination of a sample of St. Lawrence sand to determine whether it would be suitable for steel foundry use. In a letter dated May 6, 1958, Mr. Matthews gave the location of the company's deposit as about lot 30, Concession II, Pittsburgh township, Ontario.

The Industrial Minerals Division of the Mines Branch had some of this material available from a previous test. It had been passed through an Aerofall mill, but had not been scrubbed.

A sample of about 700 pounds was required for a foundry test. Inasmuch as the Mines Branch does not have equipment to scrub this large a sample, it was decided to test a sample after washing it in a classifier. If this sample produced inferior results which could be attributed to the method of washing, an effort could be made to obtain a scrubbed sample.

METHOD OF TESTING

The sand was tested by bonding it with western bentonite (liquid limit 600). It was mulled one minute dry and six minutes wet before each use.

The test batch of sand was used for 10 heats. 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[1]. 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. The drags were rammed with a combination of hand ramming and machine squeezing. The copes were hand rammed and jolt squeezed.

The castings were poured in mild steel. A typical analysis was:

	%
Carbon	0.23
Silicon	0.59
Manganese	0.71
Phosphorus	0.018
Sulphur	0.024

The metal was tapped at 1670°C (3038°F) and poured at 1620°C (2948°F).

In addition to the test using St. Lawrence sand, a series was run using a New Jersey No. 62 sand. This sand was chosen for test over an Ottawa, Ill. sand because not enough Ottawa sand was available. However, in a previous series of tests which was done for the Steel Castings Institute of Canada, it was found that the Ottawa and New Jersey sands produced castings of about equal quality. Therefore a comparison of the St. Lawrence sand with the New Jersey sand should be equally applicable to Ottawa sand.

The average moulding properties of the sand mixtures, together with the total amount of bentonite required for 9 uses, are shown in Table 1. The two sets of results from the New Jersey sand are for the series comparing it with the Ottawa and St. Lawrence sands respectively.

Table 1

Moulding Properties of Sand Mixtures

	Ottawa	New Jersey 1st Series	New Jersey 2nd Series	St. Lawrence
Moisture	3.16	3.5	3.35	3.32
Permeability	219	138		138
Green compressive strength, psi	8.6	8.1	9.4	8.1
Green deformation, in /in.		0.0369	0.0326	0.0326
Green tensile strength, oz/sq.in.	28	23	22	22.1
Dry compressive strength, psi	69	88	98	93
Total bentonite for 9 uses, %	9.62	8.85	9.1	9.7

METHOD OF RATING

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

Table 2

Scabbing with St. Lawrence Sand

Heat No.	Cope Scabs Small	Cope Scabs Medium	Cope Scabs Large	Drag Scabs Small	Drag Scabs Medium	Drag Scabs Large
1	-	-	-	-	-	-
2	-	-	-	-	-	-
3	1	-	-	-	-	1
4	1	-	2	1	-	-
5	1	-	2	1	-	-
6	2	-	-	2	-	-
7	-	-	-	4	-	-
8	-	-	3	2	-	-
9	1	-	3	3	-	-
10	2	1	1	4	-	-
Totals	8	1	11	17	0	1
Ratings	8	2	33	17	0	3

Total Rating - 63

Table 3

Scabbing with New Jersey Sand

Heat No.	Cope Scabs Small	Cope Scabs Medium	Cope Scabs Large	Drag Scabs Small	Drag Scabs Medium	Drag Scabs Large
1	-	-	-	-	-	-
2	-	1	1	3	-	-
3	-	-	2	2	-	-
4	-	1	2	1	-	-
5	2	-	1	2	-	-
6	-	-	4	2	-	-
7	-	1	2	4	-	-
8	-	-	4	2	1	1
9	-	-	4	-	4	-
10	-	-	4	-	2	1
Totals	2	3	24	16	7	2
Ratings	2	6	72	16	14	6

Total Rating - 116

It will be noted that in this test the New Jersey sand scabbed worse than the St. Lawrence sand. Repeated tests would have to be made before it could be stated that there is a significant difference in this respect between the two sands. However, it does appear that the quality of castings produced by the St. Lawrence sand after repeated use is equal to, and may be better than, that from the New Jersey sand.

As noted above, a previous test showed that the New Jersey and Ottawa sands were essentially the same in respect to scabbing. In the present test, both the St. Lawrence sand and New Jersey sand scabbed worse than the

New Jersey sand did in the previous test. This can probably be attributed to the use of a different sample of western bentonite.

There was no noticeable difference in the surface finish of good castings produced by the three sands.

BREAKDOWN OF GRAINS

The sieve analysis of the sand is altered only slightly by repeated use. The screen distributions of the sands before and after use are shown below in Table 4. The data for the Ottawa sand were obtained from the previous test.

Table 4

Effect of Use on Screen Distribution of Sand

U.S. Screen No.	Per Cent Retained: St. Lawrence Before	St. Lawrence After	Ottawa Before	Ottawa After	New Jersey Before	New Jersey After
20	0.2	0	0	0	0.1	0.4
30	3.8	1.9	0	0	0.9	1.5
40	12.3	10.9	0.3	0.9	9.4	12.0
50	28.5	28.6	16.8	19.0	19.5	18.2
70	25.6	25.5	44.5	43.0	29.3	28.4
100	18.4	20.1	31.0	28.6	28.1	26.2
140	8.1	8.4	6.5	5.8	9.8	8.8
200	2.6	3.1	0.8	1.2	2.3	2.7
270	0.3	0.5	Trace	0.5	0.3	0.4
Pan	Trace	0.9	Trace	0.8	0.1	1.3
AFS Fineness No.	53.9	58.4	58.4	61.3	59.0	61.0

It is unlikely that the effect of slight differences in the rate of breakdown which occurred during use would be noticeable in practice.

PROPERTIES OF CORE SAND

The properties of the following core sand mixture were tested:

3000 gm sand
30 gm gelatinized corn flour
30 gm AFS reference linseed oil
Water to give 3.5%
Specimens baked 1½ hr at 400F.

With this mixture the properties were compared with those from an Ottawa, Ill. "45" sand (AFS fineness number, about 58).

Table 5

Comparison of Properties, St. Lawrence vs Ottawa, Ill.

		St. Lawrence	Ottawa, Ill.
Green Compressive Strength, psi		0.55	0.74
Jolts to Break Overhang Specimen	high jolt	2	3
	low jolt	3	6
Jolts to Break 2-inch Specimen	high jolt	10	15
	low jolt	20	24
Sag of 2-inch Specimen at Break, in.	high jolt	0.182	0.212
	low jolt	0.133	0.166
Baked Tensile Strength, psi	blown	244	296
	rammed	279	349.5

In these tests the St. Lawrence sand was inferior to the Ottawa sand as a core sand. This is caused by its more angular grain shape, which is not so favourable as is the round-grained Ottawa sand for core-making.

DISCUSSION

These tests show that the St. Lawrence sand can be used to produce castings equal in quality to those made with New Jersey and Ottawa, Ill. sands.

The St. Lawrence sand differs from the Ottawa, Ill. sand in two important ways:

1. The screen distribution is wider than that of the grades of Ottawa sand presently being marketed.

2. The grains are angular to subangular; Ottawa sands are round-grained.

The opinions of foundrymen regarding the best type of screen distribution and grain shape for moulding sands change from time to time. At present the general opinion is that, for moulding, a sand with most of the grains retained on 3.5 or 4 screens is best, and that a 3-screen distribution is best for core sands.

The angular shape of the St. Lawrence sand makes it difficult to work with. It has a tendency to pile up in the muller, it is difficult to ram, and it does not flow as well as the Ottawa sand. It is inferior for core work, as indicated by the tests.

Many foundrymen believe that angular and subangular sands produce better castings than do round-grained sands. Briggs says[2]:

> "In the period of years around 1930, it was the general opinion of steel foundrymen that the well-rounded sands were the ideal molding and core sands. This idea has since changed, and by 1943 it was the accepted belief that the subangular to angular sands were the best molding sands. This change in thought followed the discovery that the angular sands made better mold-cavity surfaces in that they could be rammed harder, with the result that there were less cutting and scabbing. The rounded grain is still considered the ideal shape for core sand."

The test results reported here do not necessarily confirm the opinion that the angular to subangular sands have less tendency to scab, but there was a trend in this direction. No difference was observed in the amount of cutting which occurred.

CONCLUSIONS

1. The sample of sand tested is suitable for steel foundry use. The quality of castings made with this sand was as good as, and possibly better than, that produced by New Jersey and Ottawa, Ill. sands.
2. The angular to subangular grain shape of the St. Lawrence sand makes it somewhat difficult to work with, and is not so favourable for core work as are round-grained sands.
3. The classifier satisfactorily cleaned the product from the Aerofall mill. Further scrubbing would not have improved the product for foundry use.

REFERENCES

(1) R. C. Thorpe, A. E. Ricardo, P. W. Widener, and P. E. Kyle, "Investigation of Properties of Steel Sands at Elevated Temperatures", Trans. A.F.S., Vol. 60, p.197 (1952).

(2) Charles Willers Briggs, "Metallurgy of Steel Castings", McGraw-Hill, New York, 1946, p.341.

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