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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

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Ottawa, January 3, 1947.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2160.

Comparison of Reclaimed Sand and New Lake Sand.

(Copy No. 6.)

Bureau of Mines

Mineral Dressing and
Metallurgy Division

Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

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Introduction:

On November 11, 1946, Mr. G. J. Gaukroger, Chief Metallurgist, McKinnon Industries Limited, St. Catharines, Ontario, addressed an enquiry to the Chief, Bureau of Mines, to determine whether the following tests could be made on core sands:

(1) Permeability (green and baked).
(2) Compressive strength (green).
(3) Shear strength (green).
(4) Tensile strength (baked).
(5) Transverse strength (baked).
(6) Hot deformation.
(7) Gas content.
(8) Fusion point.
(9) Screen analysis.
(10) A.F.A. clay content.
(11) A.F.A. grain distribution number.
(12) A.F.A. fineness number.

Mr. Gaukroger wished to use these tests to compare Michigan Lake sand with reclaimed sand, to determine the

(Introduction, cont'd) -

advisability of installing a sand reclamation unit in their foundry.

Upon learning that these Laboratories were equipped to carry out the above tests, Mr. Gaukroger forwarded samples of unused and reclaimed sand to the P.M.R.L.'s Sand Laboratory to be tested. These samples were received on December 14, 1946.

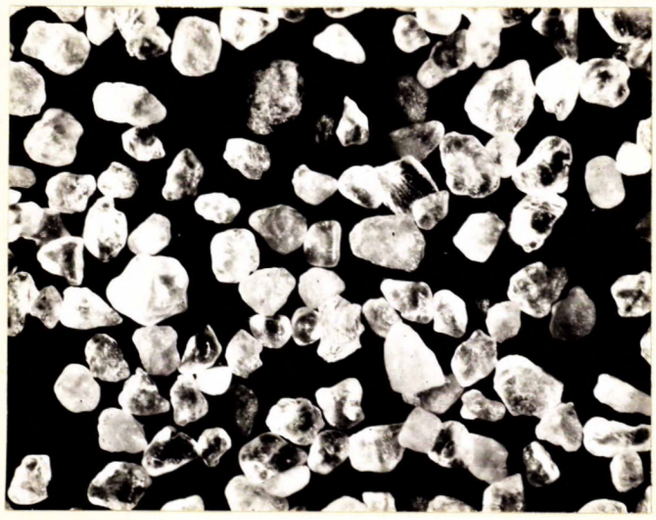
Method of Testing:

Procedures and equipment recommended by the American Foundrymen's Association (Foundry Sand Testing Handbook, 1944 Edition, A.F.A.) were used in testing the sands.

Microscopic Examination:

The sand samples were examined under the microscope. The only visual difference between the two sands is that the reclaimed sand is somewhat darker than the unused sand (see Figures 1 and 2).

Figure 1.



X20.

MICHIGAN LAKE SAND.

(Microscopic Examination, cont'd) -

Figure 2.

X20.

RECLAIMED SAND.

-

Screen Test:

The sands were found to have the following screen analysis:

TABLE I. - Screen Analysis.

U.S. Screen No.	PER CENT RETAILED: Michigan Lake Sand	PER CENT RETAILED: Reclaimed Sand
20	Nil.	Nil.
30	0.1	0.2
40	1.4	1.8
50	13.6	16.8
70	58.2	59.8
100	26.1	19.4
140	0.4	0.7
200	Trace.	0.2
270	Trace.	Trace.
Pan	Trace.	Trace.
A.F.A. Clay	0.2	0.8
A.F.A. Fineness Number	53.8	52.2

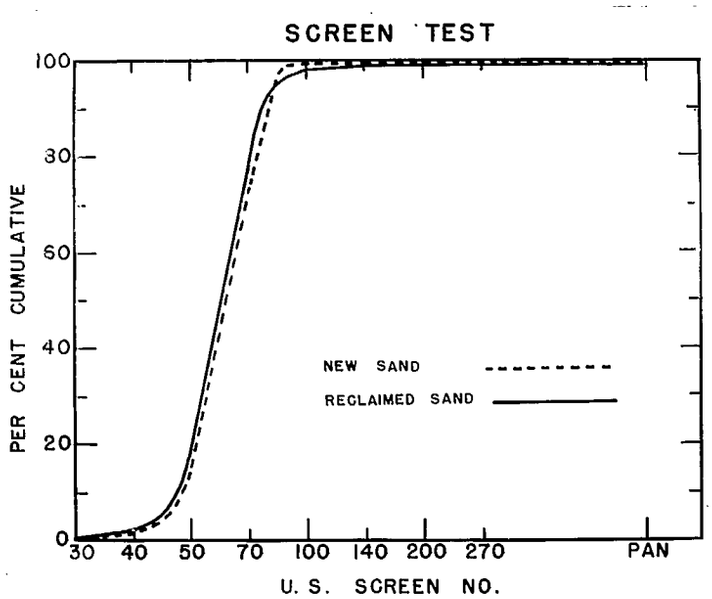
These results are shown in the form of a per cent cumulative curve in Figure 2. In making a per cent cumulative curve, the per cent retained on each screen is added

(Screen Test, cont'd) -

to the sum of the percentages retained on all the coarser screens, and this sum is plotted as the cumulative per cent on that screen. Thus, if the figure plotted on the No. 70 screen is 73 per cent, it means that 73 per cent of the sand by weight is coarser than 70 mesh.

The screen distribution curve is recommended by the A.F.A. as the simplest and clearest method of expressing grain distribution. The use of semi-log graph paper is recommended. As the dimensions of the screen apertures of the standard screens decrease logarithmically, allowing equal spaces between screens on the chart does, in effect, represent a logarithmic scale of decreasing grain size, and follows the recommendations of the A.F.A. (Foundry Sand Testing Handbook, p. 76).

Figure 3.



CUMULATIVE PER CENT RETAINED CURVE
FOR NEW AND RECLAIMED SAND.

Core Tests:

The mixtures suggested in Mr. Caukroger's letter of December 6, 1946, were used in making the tests. These were:

Mixture #1 -

2,000 gm. sand.
20 gm. corn flour (Casco).
20 gm. core oil (Linoil #4).
40 gm. water.

Mixture #2 -

2,000 gm. sand.
25 gm. core oil (Linoil #4).
No water.

Mixture #3 -

2,000 gm. sand.
37 gm. core oil (Linoil #4).
28 gm. corn flour (Casco).
34 gm. water.

These mixtures were made up in a Baker-Perkins paddle-type laboratory sand mixer. The oil and corn flour were mixed with the sand before the water was added. Test cores were baked in a laboratory core oven for 2 hours at 400° F. This baking cycle was chosen because the oil has a flat baking curve at this time and temperature.

The results of these tests are shown in Table II.

(Table II follows,
on Page 6.)

TABLE II. - Core Test Results.

	AS RECEIVED		MIXTURE NO. 1		MIXTURE NO. 2		MIXTURE NO. 3	
	Lake Sand	Reclaimed	Lake Sand	Reclaimed	Lake Sand	Reclaimed	Lake Sand	Reclaimed
Green Permeability	-	-	167	167	163	167	167	175
Baked "	-	-	205	205	167	170	205	219
Green Compression, p.s.i.	-	-	0.3	0.5	0.1	0.1	0.5	0.6
Flowability	-	-	89	89	90.5	90.5	90	90
Green Shear, p.s.i.	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Baked Tensile Strength, p.s.i.	-	-	151	147.5	272.5	250	224	243
Baked Transverse Strength, pounds	-	-	39.8	37.8	60.8	61.0	58.4	65.5
Hot Strength -								
2100° F.	-	-	Nil.	Nil.	-	-	-	-
2200° F.	-	-	3	3	-	-	-	-
2300° F.	-	-	3	3	-	-	-	-
2400° F.	-	-	3	3	-	-	-	-
2500° F.	-	-	2	2	-	-	-	-
Hot Deformation:								
2100° F.	-	-	Collapsed.	Collapsed.	-	-	-	-
2200°-2500° F.	-	-	Plastic flow.	Plastic flow.	-	-	-	-
Sintering Point	2575° F.	2575° F.	-	-	-	-	-	-
Core Gas, c.c./gm.:								
½ minute	0.4	2.4	9.6	10.4	3.6	4.2	14.8	15.3
1 minute	1.2	3.8	11.6	12.8	6.0	7.0	18.2	19.4

Discussion:

The tests indicate that there is little significant difference between the two samples submitted. The slight difference in screen size could be attributed to experimental error or to the normal variation which may be expected in sand shipments received. The difference in baked strength is also so slight that it falls within the limits of experimental error. The reclaimed sand develops a slightly higher green bond than does the unused sand.

No difference could be detected in the refractoriness of the two samples. The "F" sintering point of both was found to be at 2575° F. Baked core specimens of both samples were soaked for 12 minutes in a nitrogen atmosphere in a dilatometer furnace. These specimens did not have any hot strength at 2100° F. Between 2200° F. and 2500° F. the specimen flowed plastically under a load of 2 or 5 pounds; that is, the load remained constant while the specimens were compressed. This incipient fusion is an inherent property of the sand, caused by impurities which it contains. Under these conditions, any figure for hot deformation would be meaningless.

The most significant difference between the two sands is in the amount of core gas evolved. This difference is greater in the sand samples as received than it is in baked core specimens. This indicates that if cores were underbaked, the ones made with reclaimed sand would be most likely to cause trouble from excess core gas. The excess gas evolved by the baked specimens of reclaimed sand is so slight, however, that little difficulty should be encountered if cores are well baked. The baking time, which depends upon the physical characteristics of the sand and oil, would, of course, be unchanged.

Conclusions:

If the sample of reclaimed sand submitted is assumed to represent the normal expectancy for the reclaiming unit, the following conclusions may be drawn:

1. There is little significant difference between the unused lake sand and the reclaimed sand.

2. The reclaimed sand develops a slightly higher green bond than the new sand.

3. The reclaimed sand possibly has slightly lower baked strength than the new sand.

4. The reclaimed sand evolves slightly more core gas than the new sand. The amount of excess gas is so slight, however, that little difficulty should be encountered from this cause if the cores are well baked.

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