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OTTAWA May 9, 1945.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1859. c.1

Investigation of Synthetic Moulding Sand from British Columbia.

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Origin of Material and Object of Investigation:

On February 16, 1945, Prof. F. A. Forward, of the British Columbia War Metals Research Board, University of British Columbia, Vancouver, B.C., submitted a sample of synthetic moulding sand produced by floating silica sand from an impure bank sand. The following tests were requested:

(1) Check suitability for core in steel casting.
(2) Screen analysis.
(3) Chemical analysis.
(4) Refractoriness (sintering test).
(5) Permeability.
(6) Effect of flotation reagent, if any.

Procedure:

Chemical Analysis -

The sand was found to have the following chemical analysis:

		Per Cent.
SiO_2 (by difference)	-	98.71
Fe_2O_3	-	0.05
Al_2O_3	-	0.70
CaO	-	0.40
MgO	-	0.08
K_2O	-	Nil.
Na_2O	-	Nil.
TiO_2	-	0.06

Grain Shape -

The sand was sub-angular in shape, as shown in Figure 1, a photomicrograph at X10 magnification.

Figure 1.

X10.

SUB-ANGULAR GRAINS OF B.C. SYNTHETIC SAND.

Fineness Determination:

The results of the fineness determination were as follows:

U.S. Screen No.	Per Cent Retained
6	Nil.
12	Nil.
20	0.7
30	7.2
40	28.1
50	31.8
70	21.7
100	7.9
140	2.0
200	0.1
-200	Nil.
"AFA" clay	Nil.
AFA Fineness No.	39
Per cent on three adjacent screens	81.6 per cent
Base permeability	151
Base permeability after washing with sodium carbonate solution	172

Note: The base permeability is the permeability of packed dry sand grains containing no clay or other bonding substance. The permeability is obtained on a 2-inch-long specimen, rammed in a 2-inch-diameter tube between 100-mesh screens.

Effect of Flotation Reagents:

The sand as received was found to contain flotation reagents which interfered with the bonding action of the bentonite.

A sample was washed with warm water and another with a solution of sodium carbonate. These samples, as well as the sand as received, were mixed with 6 per cent bentonite and 1½ per cent corn flour, and tempered with water. The following is a comparison of the properties of the sand as received with those of the washed material:

(Continued on next page)

(Effect of Flotation Reagents, Cont'd) -

	As Received	Washed With Warm Water	Washed With Sodium Carbonate Solution
Moisture required to temper, per cent	2.5	2.7	2.8
Green compression	4.5	7.2	7.6
Permeability	313	287	300

To determine whether the flotation reagents would interfere with the use of the sand in cores, a core mixture consisting of 2 per cent oil, 1½ per cent corn flour, and 1½ per cent bentonite was prepared and a comparison made of the sand as received and after washing with a solution of soda ash. The mixture made from the sand as received had a slightly lower greem bond than the one made from the washed sample. Tests on the baked cores were not completed, however, as the mixture from the unwashed sand stuck to the core box, and test specimens could not be made.

Specimens could be made from the washed sand, which was not so sticky.

Sintering Point:

The sintering point of the sand (point where 1/3 of a platinum ribbon was covered with loose grains) was found to be 2910° F.

A sample was mixed with 2 per cent bentonite and 1½ per cent corn flour. A standard A.F.A. specimen made from this mixture had the following sintering points:

A	-	2200° F.
B	-	3000° F.

Note: The "A" sintering point is the lowest temperature at which the ribbon used in the sintering test makes a "V" when lifted off the sand. This is the point where the bond starts to sinter. The "A" sintering point of a sand that peels perfectly from a casting may be 800° F. lower than the

(Sintering Point, cont'd) -

pouring temperature of the metal.

The "B" sintering point is the lowest point at which the smaller grains can be seen at low magnification (20 to 25 diameters) to show signs of fusion. The "B" sintering point seems to be more closely associated with the "burning on" of sand in the foundry than does the "A" sintering point.

Expansion and Contraction:

The sand was mixed with varying amounts of western bentonite, silica flour and corn flour, and the expansion and contraction were measured at elevated temperatures. The curves obtained were compared with similarly obtained curves from a sand which is being used successfully in a commercial steel foundry. Figure 2 is a graph comparing the expansion and contraction of the B.C. synthetic material with that of the sand in use in the commercial foundry.

Discussion:

The sand has a very good grain distribution, as over 80 per cent is found on three adjacent sieves. It is somewhat coarser than that usually used in steel foundries, which is about 50-70 A.F.A. fineness.

The flotation reagents are detrimental and should be removed before the sand is used. The material will not develop its maximum bond while these reagents are present. These reagents also make the sand unsuitable for use in cores, as they make it stick to the core boxes. The reagents may be removed by washing with hot water, although the use of caustic soda or sodium chromate accelerates the washing action.

The grains are sub-angular in shape. Their properties would be mid-way between round and angular sand. Round sand-

(Discussion, cont'd) -

grains have higher permeability and require less bond than angular sand, but have a greater tendency to wash. Angular sand grains are more likely to fracture, but unless this tendency is marked it is not very detrimental, as new sand is always being added to a sand system through the use of cores.

The sand is very refractory, as shown by the sintering test. The high permeability and high sintering point would combine to make it suitable for very heavy steel castings. There would probably be greater mechanical penetration in medium-sized steel castings, however, but this would be remedied by producing a finer sand. Penetration is less with finer sand, but heavier castings are prone to other types of defects if sand is too fine. Sand for heavy castings also must have a higher sintering point than that of small castings, as the sand is heated to higher temperatures and the metal is fluid for longer periods. This high sintering point is associated with coarse grain-size, as in the sand under discussion. There is, therefore, an optimum fineness for each type of casting, and this sand is thus more suitable for heavy castings.⊕

The expansion curves of Figure 2 are normal for silica sand. Variations in the curve are caused by additions to the sand, and the success of the sand depends upon its use by experienced foundrymen, who are able to proportion the additions to match the conditions in their plants.

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⊕ Discussion to "A Study of Steel Moulding Sands" - H. W. Dietert, E. G. Woodliff and J. A. Schuck. Trans. A.F.A., 1938, Vol. 46, p. 277.

(Discussion, cont'd) -

Figure 2.

Conclusions:

1. Flotation reagents interfere with the successful use of this sand in the foundry, both as a facing sand and as a core sand.

2. When the flotation reagents have been removed the material is a satisfactory steel foundry sand.

3. The grain size and sintering point of the sand make it more useful for large steel castings. For making medium-sized castings a finer sand is recommended.

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