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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, May 6, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2045.

Investigation of Baking Characteristics of Oil Sand Moulds at Hull Iron and Steel Foundries Limited, Hull, Quebec.

(Copy No. 10.)

Bureau of Mines
Division of Metallic Minerals
Physical Metallurgy Research Laboratories

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DEPARTMENT OF MINES AND RESOURCES
Mines and Geology Branch

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Origin of Request and Object of Investigation:

On April 17, 1946, a verbal request was received from Mr. Don Caplan, chemist of the Hull Iron and Steel Foundries Limited, Hull, Quebec, for an investigation to determine whether oil sands from a location in their foundry designated "centre floor" were being properly baked. Two samples of baked sand were received on April 17, and four additional samples on April 20. Measurements of the amount of gas generated by these sands were made, to determine the degree of baking they had received.

Description of Samples:

All samples were from "Oil Sand for Centre Floor" and described as follows:

(1) April 16 - Mould baked overnight.
(2) " - Baked tensile specimens.
(3) April 24 - Baked oil sand mould.
(4) " - Baked tensile specimens.
(5) April 25 - Baked oil sand mould.
(6) " - Baked tensile specimens.

The tensile specimens and moulds for the same day were not necessarily from the same batch, but were made from the same formula. This formula was as follows:

2 wheelbarrows #57 sand (50 gallons).
100 lb. silica flour.
4 gallons bentonite.
1½ gallons cereal.
2 gallons core oil.

The tensile specimens had not been baked in the same oven as the oil sand moulds, nor for the same length of time.

Method of Testing, and Test Results:

Samples of sand were placed in the cold section of a furnace and the furnace flushed out with nitrogen. A magnetic pusher arm was used to push the sand into the hot zone of the furnace, which was at 2500° F. The volume of gas generated was collected and measured over water. The following results were obtained:

Sample	GAS (c.c. per gram) 30 Seconds	60 Seconds	Moisture in sample per cent
(1) Mould - April 16	12.8	15.6	-
(2) Tensiles - "	10.6	13.8	-
(3) Mould - April 24	16.0	18.6	-
(4) Tensiles - "	13.4	15.6	-
(5) Mould - April 25	21.8	25.0	0.6
(6) Tensiles - "	8.8	11.6	-

DISCUSSION:

Degree of Baking -

An examination of the test results shows that the

(Discussion, cont'd) -

large oil sand moulds at Hull Iron and Steel Foundries are not being well baked. In every case the amount of gas liberated was greater for the moulds than for the tensile specimens from the same day. P.M.R.L. Investigation Report No. 1935, dated Sept. 15, 1945, and entitled "Report on Properties of Mould and Core Sands Used at Hull Iron and Steel Foundries Limited, Hull, Quebec," gives the normal gas content of cores made from mixtures used at HISCO. According to this report, the gas content of well-baked tensile cores made from "Oil Sand for Centre Floor" averaged 12.4 c.c. per gram for 30 seconds and 15.5 c.c. per gram for 1 minute. Thus it will be seen that the samples taken from the moulds baked on April 24 and April 25 have a higher than normal gas content, and therefore are underbaked.

In baking, an oil sand undergoes five temperature stages:

(1) Heating to boiling point of water.

(2) Remain at boiling point of water until moisture is driven off.

(3) Heat to temperature of oven.

(4) Remain at temperature of oven until removed.

(5) Cooling off after removal from the oven. During this time air is absorbed by the mould, and further baking may occur.

Oil sands depend upon an oxidation action to develop their strength, and must be heated to about 400° F. to 450° F. to bake properly. No baking of the oil occurs in the first two temperature stages. As the sample from the mould baked on April 25 contained 0.6 per cent moisture, it is evident that the temperature never exceeded the boiling point of water and the oil did not bake at all. This explains why the mould was so soft and crumbly. This mould would have been just as strong if the oil had been left out of the mixture.

(Discussion, cont'd) -

Use of Indicators -

Aniline dyes may be used to indicate the degree of baking a sand has received. A small quantity of the dye is added to the sand mixture to colour it. These dyes change colour in the baking temperature range and are used as a simple means of checking the baking cycle given cores.

Oil Sands vs. Dry Sand Moulds -

The main reason for using core oils in the foundry is the need for cores which are strong enough to be handled and yet will collapse under the heat of molten metal. Collapsibility of cores prevents the metal from cracking, and enables the sand to be shaken out of the casting easily. Another incidental advantage of oil sands is the production of a neutral gas which prevents metal penetration. Moulds, however, usually do not require collapsibility to prevent castings from cracking, and the only advantages of oil are the production of a hard mould, easy shake-out, and the evolution of a neutral gas. These conditions can be met by the use of such binders as bentonite, cereal, sulphite residue (Copacite) and wood flour (Akro).

Baking Requirements of Binders -

Oil sands depend upon an oxidation action to develop their strength, and must be heated to about 400° F. to 450° F. to bake properly. Resin binders do not depend upon an oxidation action to bake, but they do need to be heated till they are sufficiently plastic to enable them to flow around the sand grains. The makers of Truline (a resin sand binder) recommend a bake at 450° F. for this purpose. Binders such as bentonite, cereal and Copacite, however, do not depend upon a chemical action, and develop their full strength as soon as the moisture has been driven off. For this reason, dry sand moulds are much more economical to

(Discussion, cont'd) -

bake than oil- or resin-bonded moulds.

Efficiency -

The use of oil in moulding sands is not efficient, because it is absorbed by the other binders. When bentonite and silica flour are used to develop hot strength, the mould is soft after it is baked, because the oil used covers their surface instead of the surface of the sand grains. Cereal and Copacite are not absorbed to the same extent, and produce harder moulds.

Requirements for Dry Sand Mixture -

The mixture should be adjusted to give approximately the same green bond and deformation as possessed by the oil sand mixture used at present. The dry bond should be sufficiently high to hold a mould wash under the shock of molten metal. It should be noted that bentonite alone will not do this, but that organic binders such as cereal and Copacite are required. These materials have the additional advantage of making the sand easy to shake out. If the amount of cereal and Copacite used does not supply sufficient neutral gas to prevent metal penetration, wood flour may be used as a gas-forming constituent.

Type of Mixture for Dry Sand -

The dry sand mixture used would be almost the same as the oil sand used at present, with the substitution of Copacite for core oil, and possibly the addition of a small amount of Akro (wood flour) to produce additional gas. Possibly the use of Copacite would require the use of somewhat less bentonite to prevent the sand from becoming too plastic.

Baking -

Moulds made from a dry sand mixture require less baking than the oil sands at present in use at HISCO, and

(Discussion, cont'd) -

care should be taken not to overbake small cores. However, in view of the fact that the present mixture is being underbaked, a dry sand mixture could probably be used with little modification in the baking procedure.

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Conclusions:

1. Oil sand moulds at HISCO are being underbaked.
2. In some of the moulds the baking is not sufficient to develop any of the strength from the oil.

Suggestions:

1. Substitution of dry sand for oil sand in large moulds should result in the following improvements:
   (a) Production of more well-baked moulds.
   (b) Harder moulds.
   (c) Lower costs, resulting from cheaper materials.
2. Aniline dyes may be used to indicate the degree of baking given to sands at HISCO. These dyes are added in small quantity, and change colour in the baking temperature range.

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