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CASTING PROCESS FOR FERROALLOYS

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The present invention relates to the casting of ferroalloys. More particularly, the present invention relates to a casting process whereby the cast material is obtained in a form especially well suited for subsequent sizing. Up to the present, the practice for producing ferroalloys in industrially useful forms has involved the casting of molten ferroalloy into vessels which provide, upon solidification of the metal, massive shapes such as slabs, pigs and ingots. These massive shapes are then subsequently crushed into particulate form and prepared for delivery to the customer.

As is well known, however, standard crushing techniques, when applied to the usual ferroalloy castings, result in the formation of a relatively large number of irregularly shaped lumps which have unequal dimensions. As a result, such particles for example in the form of slivers, often pass through a given screen opening although such particles are undesirable since they can result in the clogging of automatic feed systems.

It is therefore an object of the present invention to provide a method of casting ferroalloys whereby the cast material can be readily crushed into particles having a predetermined thickness and substantially equal lengths and widths.

Other objects will be apparent from the following description and claims.

A casting method in accordance with the present invention comprises an interrupted pour of molten ferroalloy material into a vessel whereby the depth of the pour corresponds to the thickness or edge dimension of the ultimately desired ferroalloy particles e.g. about ½ to 8 inches. The molten metal after pouring is allowed to solidify and to oxidize at its upper surface for a suitable time e.g. 1–10 minutes to thereby form a thin oxide layer. This oxide layer forms upon exposure of the metal to the atmosphere and ranges, in the practice of the present invention, from 1 micron up to 0.5 mm. When the oxide layer is formed, the pour is resumed following the same procedure. The foregoing procedure is repeated until the vessel is filled thereupon the resulting solidified material is removed in one piece from the vessel for example by tongs or other suitable lifting equipment. After removal, the solidified ferroalloy is conveniently separated into layers for example by dropping the material from a height sufficient to cause fracture at the interfaces between the layers resulting from the separate pours. For example, with solidified ferromanganese masses on the order of 100 lbs. a drop from about 1–3 feet is greatly satisfactory.

The layers thus obtained correspond to the separate pours of molten material. That is, the thickness of layers is substantially the same as the depth of the respective pours of molten ferroalloy.

The layers of material thus obtained are subsequently particulated, for example by being dropped onto a spiked grid on which the spikes are equally spaced for example between 1 and 6 inches apart. The resulting crushed material is substantially in the form of uniform rectangular-shaped particles, and is free of sliver-like pieces.

The following example will further illustrate the present invention.

Example I

Molten ferromanganese (74.5% Mn, 6.5% C, 0.6% Si, bal. Fe) in the amount of 120 pounds was prepared. The temperature of the melt was about 1330° C.

About 40 pounds of the molten ferromanganese were poured into a pig mold providing a depth of about 1 inch. The mold had the configuration of a trapezoidal prism 5 inches deep with an upper cross-section of 20 inches x 8 inches and a lower cross-section of 18 inches x 5 inches. The metal solidified in the mold and a thin oxide layer of about 0.1 mm. developed on the surface of the solidified metal. About 4 minutes after solidification 40 pounds of molten ferroalloy were poured into the mold on top of the solidified layer to provide a depth of about 1 inch. The metal solidified and a similar thin oxide layer developed on the surface of the solidified metal. The presence of the oxide layers can be detected visually.

About 4 minutes after solidification of the previously poured metal, the remaining 40 pounds of molten ferromanganese were poured into the mold on top of the solidified metal to provide a depth of about 1 inch. The metal solidified and after cooling to about 900° C., the solidified metal was removed from the mold in one piece by tilting the mold on its side and removing the ingot in one piece with a pry bar.

After removal from the mold and cooling to room temperature the layers of ferromanganese corresponding to the separate pours were separated by blows on the side of the ingot with a ball pean hammer.

The resulting 1" thick layers of material were further sized by dropping onto a spiked grid having spikes equally spaced at 2 inch intervals.

The product thus obtained was in the form of uniformly shaped particles 1 inch thick and averaging 3 inches x 3 inches in area. No slivers or grossly irregularly shaped particles were formed.

In the present invention, in addition to ferromanaganese other materials that form a suitable oxide film upon solidification can be similarly processed. Such materials include ferrochromium, ferrosilicon, ferrovanadium, ferrocolumbium, silicomanganese, ferrotitanium, and ferrochrome silicon.

The usual compositional ranges for the aforementioned alloys is in Table I.

TABLE I

Ferromanganese—74 to 90% Ma, 0.07 to 7% C, bal. Fe.
Ferrochromium—55 to 91% Cr, 0.01% to 11% C, bal. Fe.
Ferrosilicon—47 to 98% Si, up to 1% C, bal. Fe.
Ferrovanadium—50 to 65% V, 0.2 to 3% C, bal. Fe.
Ferrocolumbium—50 to 60% Cb, 0.01% max. C, bal. Fe.
Silicomanganese—50 to 65% Ma, 12 to 27% Si, bal. Fe.
Ferrotitanium—27 to 68% Ti, 0.1% max. C, bal. Fe.
Ferrochrome-silicon—33 to 62% Cr, 8 to 48% Si, 0.05% C, max., bal. Fe.

What is claimed is:

1. A process for casting and particulating ferroalloys which comprises:

(1) providing molten ferroalloy material,

(2) pouring only a predetermined amount of molten ferroalloy into a vessel to provide a predetermined depth of molten metal therein,

(3) allowing said molten ferroalloy to solidify and form an oxide layer at its upper surface,

(4) repeating the foregoing steps to provide a plurality of solidified ferroalloy layers,

(5) removing the ferroalloy from the vessel in which it has solidified,

(6) separating said layers and
(7) crushing said layers to provide particulated ferroalloy.

2. A process for casting and particulating ferromanganese which comprises:
(1) providing molten ferromanganese,
(2) pouring an amount of molten ferromanganese into a vessel so as to provide a depth of molten metal of from about ½ to 8 inches therein,
(3) allowing said molten ferromanganese to solidify while exposing the upper surface of the solidified ferromanganese to air for about 1 to 10 minutes to cause the formation of an oxide layer,
(4) repeating the foregoing steps to provide a plurality of solidified ferromanganese layers,
(5) removing the ferroalloy from the vessel in which it has solidified,
(6) separating said layers and
(7) crushing said layers to provide particulated ferromanganese.

3. A process for casting and particulating ferroalloys which comprises:
(1) providing molten ferroalloy material,
(2) pouring only a predetermined amount of molten ferroalloy into a vessel to provide a predetermined depth of molten metal therein,
(3) allowing said molten ferroalloy to solidify and form an oxide layer at its upper surface,
(4) repeating the foregoing steps to provide a plurality of solidified ferroalloy layers,
(5) removing the ferroalloys from the vessel in which it has solidified,
(6) separating said layers and
(7) particulating said layers by causing essentially point impact on said layers at predetermined spaced locations on the surface thereof whereby the resulting particulated material is substantially all in the form of uniform rectangular-shaped particles.

4. A process for casting and particulating ferroalloys which comprises:
(1) providing molten ferroalloy material,
(2) pouring only a predetermined amount of molten ferroalloy into a vessel to provide a predetermined depth of molten metal therein,
(3) allowing said molten ferroalloy to solidify and form an oxide layer at its upper surface,
(4) repeating the foregoing steps to provide a plurality of solidified ferroalloy layers,
(5) removing the ferroalloy from the vessel in which it has solidified,
(6) separating said layers and
(7) particulating said layers by individually dropping said layers onto a grid surface having raised points at predetermined locations whereby the resulting particulated material is substantially all in the form of uniform rectangular-shaped particles.

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