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METALLURGICAL PROCESS AND PRODUCT
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ABSTRACT OF THE DISCLOSURE

A process for combining fine metal particles with a molten metal mass by placing a quantity of molten metal in a mixing vessel, adding the fine particles and any desired alloying material, stirring the mixture until the additives have been dissolved into the molten mix, placing the mix in a holding furnace for subsequent mixing with a molten metal discharge from a cupola for forming a casting mixture for pouring in a mold.

This invention relates to a metallurgical process and product, especially for incorporating fine metal particles such as metal chips, shavings and the like, in molten metal and has for an object the provision of improvements in this art.

The basic aim of the invention is to provide efficient and economical use of small metal particles which heretofore have been difficult and expensive to handle. In the practice of the invention it has been found that the desired efficiency and economy have been fully attained.

In order to provide a background for an understanding of the existing problems and the aims and accomplishments of the present invention, it will be helpful to discuss some of the existing conditions which are related to the situation.

For a basis of product comparison, it may be noted that blast furnace pig iron suitable for economical use in cupolas to furnish molten cast iron for making castings, sells for about \$60 per ton; that baled scrap sheet sells for \$36 per ton; and that commercial chips and shavings in bulk sells for about \$23 per ton. Intrinsically, the metal in the chips and shavings is just as suitable for making castings as the pigs or other larger pieces of metal although it may require some alloying agents or additives to attain the particular composition which is being used for casting. The reason for the much lower price for substantially the same metal when in small particles is that it is so difficult and wasteful to convert the smaller particles to the molten form ready for casting.

When small particles are charged into a cupola, even along with pigs or other large pieces, the small particles will either be blown out or burned out to a large extent by the hot gas blasts maintained in the cupola. They also form thick scum or slag on top of the body of molten metal in the cupola. Both the small particles and the scum restrict the flow of gases through the charge and greatly reduce the efficiency and melting rate of the cupola.

In order to maintain the desired composition of the molten metal for pouring, it is often desirable to add alloying components or additives with the small particles and this is almost impossible since the alloying additives are usually in the form of powder or other small particles which will be blown out or left incompletely mixed in the bath. Consequently, when using small particles in a cupola it is practically impossible to maintain a predetermined desired composition of the molten metal.

There have been various proposals for using metal in small particle form for melting in a cupola. One proposal is to compress the particles into briquettes and charge these into the cupola; but such briquettes break up before

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melting without greatly relieving the situation. The cost of briquetting must be added into the total cost. Another proposal is to force the material by mechanical devices, such as rams, into the cupola; but the installation is expensive; the amount of material so chargeable is limited; and there is still considerable loss, up to about 10% or more. About the most that can be charged into a normal cupola by such rams is about 2 tons per hour; the present invention provides that a great deal more particulate material can be charged, up to 30 tons per hour.

It will also be helpful to consider casting procedures now prevalent. The pouring rate from a cupola can very seldom be constant; whereas the melting capacity of the cupola must be sufficient to accommodate for the maximum pouring rate. As a consequence, over a day, a week, or any long period of time, the cupola has a melting capacity and operating efficiency rate considerably in excess of the demand for molten metal for casting. It would obviously be economical if the cupola could be run continuously at full capacity and the off-peak supply of molten metal used for other purposes. The present invention provides profitable use of the off-peak supply of metal from the cupola, as will be seen.

The present invention also provides a convenient process for introducing such additives or alloying ingredients as may be desired with assurance that they will be fully incorporated in the final molten metal to be cast. Thus the quality of the particular metal being made from particulate material can be brought up to the quality of the metal being melted in the cupola or can even be formed into a superior quality of metal for other uses.

The objects of the invention, as well as various novel features and advantages, will be apparent from the following description of certain specific exemplary embodiments now to be described.

A body of molten metal is drawn off from a metal melting furnace, such for example as a cupola which is supplying molten metal such as cast iron or the like, for making castings, and deposited in a mixing vessel of suitable shape and suitably coated for dumping metal which solidifies therein. The vessel is only partly filled with molten metal, leaving space for additional material which will be added. The metal in the vessel outside the cupola will be in a quiet state so that fine material, when added, will not be blown out or burned up.

To the molten metal in the mixing vessel there is added the desired quantity of particulate metal together with such other ingredients as may be desired to produce a final alloy metal of the desired composition.

The amount of particulate metal which is added at a given temperature and the amount and temperature of the molten metal will be in such ratio that when the particulate metal is thoroughly stirred into the molten metal there will be formed a thick mush which fuses all solid particles into the molten metal to form a coherent body of metal which will not break up when exposed as a solid pig in the gas blasts of a cupola.

It is not necessary that all of the solid particles or pieces which are added shall be fully melted so long as they are all fused into the molten metal sufficiently to resist break-up when placed in the blast of a cupola. In fact, it is desirable to add as much particulate material as can be assimilated by fusion into the liquid metal. A first advantage of using this ratio is that the mixture in the vessel will quickly solidify to the point where it can be dumped from the mixing vessel as a pig to be used wherever needed like commercial pig metal. Another advantage of using such a ratio is that it avoids the cost of melting excess metal whose heat is lost when cooled in the mix.

The ratio of solid particulate material to liquid metal

will obviously vary according to the size of the solid particles, the temperature of the particles when added, and the temperature of the molten metal; but, as an example, it has been found that when using a commercial grade of cast iron chips and turnings at room temperature with molten cast iron at approximately 2800° F. it is possible to obtain thorough incorporation and fusion and rapid solidification by using about one part of solid particles to about two parts of molten metal, 30% solid to 70% liquid having been found to give especially good results with the particular materials used. It is estimated that molten metal which was at about 2800° F. in the cupola will be at about 2600° F. to 2650° F. in the mixing vessel by the time the solid metal particles are introduced into the vessel. After stirring, the mixture in the relative amounts just specified will be at a temperature of about 1900° F. and will quickly solidify to a body or pig which can be dumped from the mixing vessel. If larger particles are used it will be possible to use a large ratio of solid material in a given quantity of liquid metal.

Before stirring, the desired amounts of alloying ingredients are added so as to be stirred in at the same time. They will be fully incorporated because there is no blast to blow them away, as would be the case if the attempt should be made to add them in a cupola. The type of materials to be added is very diverse but such additives are well known and it is not necessary to specify the kind and amount since such small quantities are used that the ratios of the present invention are not materially affected. Examples of such additives for cast iron are silicon, manganese, chromium, tungsten, nickel, carbon and the like.

While the kind and amount of additive alloying ingredient to be used is not a part of the present invention, such additives are mentioned because the present invention provides for their successful and efficient incorporation into the mixture without substantial loss so that the composition of the mixture pig and the final mixture of molten metal for casting can be very accurately predetermined.

In practice, with a cupola regularly used for producing cast iron automotive brake drums, the excess metal during off-peak periods was poured into suitably tapered and coated buckets about 18" in diameter and about 12" deep. The mix in the ratios mentioned was stirred thoroughly and allowed to solidify and then dumped from the buckets and stored. The pigs so produced were used like or in admixture with commercial pig in a cupola and it was found that the results were as satisfactory as with commercial pig. That is, the usual losses and operational difficulties encountered in the use of particulate material alone in the cupola were entirely eliminated by practicing the present process for utilizing the particulate material. A continuous line of such vessels is feasible because the time of solidification is so short and can be so accurately predetermined that the metal will regularly be ready to dump by the time the vessels travel a predetermined distance from the cupola. It is readily possible to provide automated means along the line for dumping, coating, stirring and the like.

As a modification, the metal temperatures and ratios may be such that the mixture will remain molten so as to be poured at about 2100° F. to 2500° F. into a hold-

ing furnace from which the molten metal can be directly taken for pouring into molds to make castings or added to the molten metal in a cupola from which molten metal is taken for making castings.

It will thus be seen that the present invention provides for the efficient, convenient, and economical use of low cost particulate material to make high cost casting material and at the same time provides for economical use of the off-peak capacity of cupolas which are used to supply molten metal for casting. As stated, the heating cost of using a cupola to supply molten metal during off-peak periods is not great because it is more economical to run the cupola regularly near its peak production rate than it is to operate it in on-off cycles. Additionally, the added labor cost is not great because the cupola operators are commonly almost idle during off-peak periods.

While emphasis has been placed on the economy of using a casting cupola to make a valuable by-product, so to speak, the process would be profitable enough to employ a cupola solely for utilizing low cost particulate material to make high cost solid or alloyed molten material. The cupola could be run on commercial casting pig or on a reserve accumulated supply of pig metal (or molten metal from a holding furnace) from the present process to convert further quantities of particulate material into high priced material suitable for casting.

While certain embodiments of the invention have been described for purposes of illustration, it is to be understood that there may be various embodiments and modifications within the general scope of the invention.

I claim:

1. The process for utilizing low cost particulate material with the molten metal from a cupola, which comprises the steps of:

- (1) placing a predetermined amount of molten metal into a mixing vessel,
- (2) placing a predetermined amount of fine particulate material in the mixing vessel, wherein the amount placed therein is controlled by the amount and temperature of molten metal placed in the mixing vessel in Step 1,
- (3) stirring the particulate material thoroughly into the molten metal,
- (4) placing the resulting mixture in a holding furnace,
- (5) mixing a predetermined amount of the holding furnace mixture with a predetermined amount of molten metal from a cupola,
- (6) casting the resulting molten metal mixture in suitable molds.

2. The process as claimed in claim 1 which further comprises the addition of a predetermined amount of alloy material with the addition of the fine particulate material in Step 2.

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