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# METHOD FOR REFINING A METAL

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## ABSTRACT OF THE DISCLOSURE

In refining a metal by heating to the temperature of melting and blowing a gas over the surface of the melt, it is preferable that the blowing start when the metal is still solid and continue through the melting stage. While the metal is still solid, the blown gas should be an inert gas containing a small amount of oxygen; however, once the meta is melted the presence of oxygen is excluded.

The invention is concerned with a method for refining a metal. The invention is based upon the known method for degassing a molten metal which is disclosed in British Patent No. 772,515 and which comprises blowing one or several streams of a nonreactive gas onto the surface of the molten metal, said nonreactive gas acting as a vacuum for gases dissolved in the molten metal. It is the objective of the invention to provide a refining method which removes undesired gases, such as hydrogen, from the metal, and which also removes certain other undesired elements from the metal, such as lead, arsenic, molybdenum, tin, zinc, antimony. It is a particular object of the invention to provide a refining method for stainless steel, allowing a reduction of its molybdenum content.

It has been found, according to the present invention, that a superior refining action can be obtained if an inert gas is blown onto the metal not only when the metal is in molten form but also when it is being heated in solid form. The method of the invention comprises heating the metal in solid form up to its melting point, blowing during said heating a stream of an inert gas onto the solid metal, said inert gas containing 0.005–10 percent by volume of oxygen, continuing the heating until the metal has become molten, and blowing a stream of an inert gas onto the surface of the molten metal.

The inert gas should be one of the gases belonging to class O of the periodic system of the elements, or a mixture of such gases. We prefer to use argon.

The oxygen content of the inert gas shall be 0.005–10 percent by volume, preferably 0.5–10 percent by volume.

The blowing of the inert gas onto the solid metal should preferably begin when the metal is at normal temperature. The metal may be heated continuously up to its melting point. However, it may be advantageous to heat the metal in a discontinuous way, viz. to make a halt at a temperature at which some impurity leaves the metal, i.e., to interrupt the progressive heating of solid metal.

When the metal begins to melt we prefer to cut off the supply of oxygen, thus blowing with a pure inert gas. However, if it is desired to reduce the carbon content of the metal, the continued blowing may also take place with a mixture of an inert gas and oxygen. It is also possible to blow the inert gas in a continuous stream onto the molten metal, while adding now and then a small percentage of oxygen to the inert gas. This blowing process with the inert gas is continued until the percentage of gaseous impurities in the metal has reached the desired low value.



If it is desired to add a solid material to the metal, for instance an alloying constituent, said solid material may be supplied as a fine powder to the stream of inert gas.

The above-described refining process when applied to the refining of molybdenum-containing stainless steel scrap proceeds as follows: The solid scrap metal is heated whilst there is blown onto its surface a gas mixture consisting essentially of an inert gas 99–98% by volume and oxygen 1–2% by volume. This treatment is continued until the temperature of the scrap metal reaches 750–850° C., whereupon the progressive heating is interrupted to allow molybdenum to escape from the steel. Thereupon, the heating is continued, with continued blowing of the inert gas-oxygen gas mixture, until the steel melts and the melt attains a temperature within the range 1600–1700° C. At this point the composition of the gas being blown onto the surface of the melt—to remove gaseous impurities therefrom— is altered in such manner that the gas contains less than 0.01% by volume of oxygen.

## EXAMPLE

The example is concerned with the refining of stainless scrap steel for the production of valuable stainless steel. The scrap steel had the composition:

| | Percent |
|---|---|
| C | 0.05 |
| Cr | 18 |
| Ni | 14 |
| Mo | 3.5 |
| Fe | Bal. |

The scrap steel was heated in an electric high frequency furnace. Argon containing 1.2 percent by volume of oxygen was blown through a plurality of tubes towards the solid scrap steel. When the temperature reached approximately 650° C. the solid steel started emitting a brown smoke. The formation of smoke was most intense at approximately 800° C., and this temperature was maintained until no smoke was formed. The temperature was now increased until the steel began to melt. The percentage of oxygen in the argon was now reduced to 0.005 percent by volume. The temperature was increased to 1650° C. and was maintained at this value for 8 minutes, while the argon-oxygen mixture was continuously blown onto the surface of the molten steel. While still being protected by argon the steel was poured into an ingot mould and allowed to solidify. The finished steel contained no hydrogen or other gaseous impurities and less than 0.5% molybdenum.

The smoke emitted by the steel was condensed, forming needle-shaped crystals consisting of $MoO_3$. This fact indicates that the probable mechanism of the refining of the solid steel is as follows. The molybdenum atoms lying on the surface of the solid steel are oxidized to form $MoO_3$ by the oxygen in the inert gas. The oxide has a certain volatility, and is therefore swept away from the surface of the steel by the inert gas which is vigorously blown onto the steel surface. A concentration difference is thus created between the molybdenum in the surface layer of the steel and that in the interior of the steel. Said concentration difference causes the molybdenum atoms to move by diffusion to the surface of the steel, where they are oxidized and removed from the steel as described. It is to be emphasized that molybdenum cannot be removed in a corresponding way from molten steel.

What is claimed is:

1. A method for refining molybdenum-containing

stainless scrap steel, comprising heating the solid scrap steel while blowing onto its surface a mixture of an inert gas and 1–2% by volume of oxygen, interrupting the heating at 750–850° C. to allow molybdenum to escape from the steel, resuming the heating until the steel has become molten and the molten steel has reached a temperature of 1600–1700° C., and blowing an inert gas containing less than 0.01% by volume of oxygen onto the surface of the molten steel to remove gaseous impurities therefrom.

2. A method for refining a metal containing a normally solid impurity having a vaporizing temperature lower than the melting temperature of the metal, comprising progressively heating the metal, by high frequency heating, in solid form up to its melting point, blowing during said heating a stream of a gas mixture onto the solid metal, said gas mixture consisting of an inert gas containing 0.005–10 percent by volume of oxygen, continuing the heating until the metal has become molten, and blowing a stream of a pure inert gas onto the surface of the molten metal to remove gaseous impurities therefrom.



3. The refining process defined in claim 2, in which progressive heating of the metal is interrupted at a temperature at which such solid impurity becomes vaporized and escapes from the solid metal, whereupon progressive heating of the solid metal is resumed and continued until the solid metal has become molten.

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U.S. Cl. X.R.

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