METHOD OF REFINING FERROCHROME

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4 Claims

ABSTRACT OF THE DISCLOSURE

A method of refining silicothermic and converter ferrochrome from carbon, gases and non-metallic inclusions, wherein the ferrochrome is subjected to a thermal treatment at a temperature of 1250 to 1500°C (preferably 1500°C) and at a residual pressure which is lower than 1 mm. Hg. The method provides superfineferrochrome (70% carbon) containing less than 0.015% of carbon, 0.02% of nitrogen, (5–8) × 10⁻⁴% of hydrogen and 0.04% of oxide inclusions.

The present invention relates to the field of metallurgy, and more particularly to a method of refining ferrochrome, obtained by the silico-thermic and converter processes, from impurities, such as carbon, hydrogen, nitrogen, oxygen and non-metallic oxide inclusions. Known in the prior art are a number of methods for manufacturing refined ferrochrome containing carbon in the range from 0.02 to 0.04 percent; that is, for example, aluminothermic, carbon-reducing, silico-thermic, etc.

The silico-thermic method of making ferrochrome by melting an ore-like mixture with the subsequent reduction of the liquid silico-chrome melt by silicon outside the electric furnace enables one to manufacture ferrochrome containing carbon up to 0.02 to 0.04 percent.

The converter process of making ferrochrome, consisting in reducing chromium from ore by carbon and in blowing it with gaseous oxygen, enables one to manufacture ferrochrome containing up to 1 percent carbon. An additional vacuum treatment of the liquid ferrochrome in the converter under the residual pressure of 5 mm. Hg is likely to reduce the content of carbon of 0.07 to 0.05 percent.

A disadvantage of the processes consists in that fact that ferrochrome obtained by the aluminothermic, silico-thermic and converter production processes contains a comparatively high proportion of carbon, nitrogen, hydrogen, oxygen and non-metallic oxide inclusions, which, in a number of cases, makes it unsuitable for making high-quality grades of steel alloyed with chromium.

An object of the present invention is to develop a method of refining ferrochrome obtained by the silico-thermic and converter production processes, which permits the making of ferrochrome containing carbon less than 0.02 percent.

Another object of the present invention is to develop a method of refining ferrochrome obtained by the silico-thermic and converter production processes, which enables one to reduce the content of nitrogen, hydrogen, oxygen and non-metallic oxide inclusions in the ferrochrome.

In conformity with these and other objects, the method of refining ferrochrome obtained by the silico-thermic and converter production processes, from carbon, gases and non-metallic oxide inclusions, consists in that, according to the invention, said ferrochrome in the form of ingots is subjected to an isothermal treatment at a temperature of 1250 to 1500°C under a residual pressure of up to 1 mm. Hg.

A gaseous oxidizer, preferably oxygen, must be supplied into the furnace for reaching a stoichiometric ratio when refining ferrochrome containing carbon in excess of 0.15 percent.

The proposed method is carried out in the following manner. The ingots of ferrochrome, which are obtained by the silico-thermic and converter production processes are placed on a movable carriage of a vacuum resistance furnace, which may be of the batch-type or continuous action type.

In the batch-type furnace, the ingots of said ferrochrome are heated to a temperature of 1250 to 1500°C. Then the process is carried out under isothermal conditions, that is to say, the ingots of ferrochrome are held at the above-mentioned temperature for a period of 8 to 12 hours.

The ingots are held in the furnace under a residual pressure not exceeding 0.1 mm. of Hg. On completing the heating process in the vacuum, electric power is ceased to be supplied into the furnace, and the ferrochrome ingots are cooled down under the same residual pressure.

In continuous-action electric furnaces, which are more economical and more suitable for carrying into effect the process of decarburization and eliminating nitrogen and hydrogen, the ferrochrome is first preheated in a first chamber. Then the cars with ferrochrome are transferred under a vacuum into a second chamber where the isothermal vacuum annealing is to be effected. The cooling of ferrochrome is effected in a third chamber.

The proposed method of manufacturing a high-quality ferrochrome may be realized by using ferrochrome, not only in ingots, but also in the form of granules, which presents a number of advantages in the stage of casting ferrochrome.

The proposed method may be also employed with a view to obtaining lower contents of carbon, nitrogen, hydrogen, oxygen and non-metallic oxide inclusions in metalic chromium.

Decarburization of ferrochrome, obtained by the converter process, is carried out under a residual pressure lower than 1 mm. of Hg. The content of carbon in the ferrochrome ranges from 0.01 to 0.015 percent.

In the case of refining ferrochrome obtained by the silico-thermic and converter production processes, with the initial carbon content in excess of 0.15 percent, the proportion of oxygen contained in the ingots is insufficient to enable the process of carbon oxidation (decarburization) to occur.

In this case, oxygen, deficient as to the stoichiometric content, is introduced into the electric furnace in the process of isothermal holding in the vacuum in the form of gaseous oxidizers, such as oxygen, carbon dioxide, water vapor or, air, preferably oxygen.

This technique may be also employed for refining ferrochrome containing less than 0.15 percent carbon with a view to speeding up the refining process.

Ferrochrome subjected to the vacuum-thermal treatment according to said manufacturing process, possesses a minimum amount (less than 0.02 percent) of not only carbon, but also of non-metallic inclusions (less than 0.03 to 0.04 percent), gases (less than 50 cc. cm. per 100 g.). This favorably affects the quality of high-chromium steels and alloys. This property as to the oxide inclusions, carbonitrides and gases is increased, which contributes to an increase in the corrosion resistance of stainless steels and considerably improves the plasticity of steels and alloys that are difficult to be worked.

The proposed method may be rendered more apparent from a consideration of the following exemplary embodiments thereof.
EXAMPLE 1

Ingots of ferrochrome 20 mm. thick, obtained by the silico-thermic production process, are held in vacuum of 0.1 to 0.05 mm. of Hg in an electric resistance furnace at a temperature of 1450° C. for a period of 12 hours. The initial content of constituents in the ferrochrome was as follows: chromium, 70.1 percent; carbon, 0.12 percent; nitrogen, 0.083 percent; hydrogen, 9·10⁻⁴ percent; oxygen, 0.086 percent; and non-metallic oxide inclusions, 0.063 percent. Upon completing the vacuum-thermal annealing, the content of constituents in the ferrochrome ingots was as follows: chromium, 70.1 percent; carbon, 0.012 percent; nitrogen, 0.026 percent; hydrogen, 3·10⁻⁴ percent; oxygen, 0.038 percent, and non-metallic oxide inclusions, 0.027 percent.

EXAMPLE 2

When heating ferrochrome in the vacuum and containing carbon in excess of 0.15 percent, oxygen is introduced into the vacuum furnace.

Ingots of ferrochrome 20 mm. thick, obtained by the silico-thermic production process, in which the initial proportion of constituents is as follows: carbon 0.16 percent; chromium 69.7 percent; nitrogen, 0.072 percent; hydrogen 8·10⁻⁴ percent; oxygen 0.073 percent; oxide inclusions 0.057 percent, are to be held in the electric resistance furnace in a vacuum of 0.3 to 0.05 mm. of Hg for a period of 8 hours at a temperature of 1450° C. Then, oxygen is supplied for a period of 30 min. into the furnace with the subsequent maintenance of the above conditions for an additional period of 4 hours (i.e., a temperature of 1450° C. and under a pressure of 0.3 to 0.05 mm. of Hg). Thereupon, the content of the constituents in the ferrochrome ingots was as follows: carbon 0.008 percent; nitrogen, 0.023 percent; hydrogen, 2.7·10⁻⁴ percent, oxygen, 0.042 percent, and oxide inclusions 0.03 percent.

What is claimed is:

1. A method of refining ferrochrome which is obtained by the silico-thermic or converter production processes, from carbon, gases and non-metallic inclusions, said method comprising subjecting ingots of ferrochrome containing carbon as an impurity to an isothermal treatment at a temperature of 1250 to 1500° C. under a residual pressure lower than 1 mm. of Hg for 8 to 12 hours, whereby a product containing less than 0.02% of carbon is obtained.

2. A method according to claim 1, wherein said isothermal treatment is effected in the presence of a gaseous oxidizer when refining ferrochrome containing more than 0.15 percent carbon.

3. A method as claimed in claim 2 wherein the gaseous oxidizer is oxygen.

4. A method of reducing the carbon content of metallic chromium which contains carbon as an impurity comprising subjecting metallic chromium to an isothermal treatment at a temperature of 1250° to 1500° C. under a residual pressure lower than 1 mm. of Hg for 8 to 12 hours to reduce the carbon content to less than 0.02%.

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