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MIXTURE FOR PROTECTING SURFACE OF METAL IN PROCESS OF CASTING

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ABSTRACT OF THE DISCLOSURE

A mixture for protection of the surface of a metal during the casting of this metal comprising graphite in the amount of 5 to 90 percent by weight used as a heat-insulating material and cryolite in the amount of 5 to 30 percent by weight used as a flux-forming material and taken in combination with a boron-containing compound in the amount of 2 to 30 percent by weight.

The present invention relates to metallurgy and more particularly to mixtures for protecting the surface of metal in the process of casting thereof.

The proposed invention can be most effectively used in the process of continuous casting of metals, particularly when casting large (400–500 t.) quantities of metal.

The known mixtures for protecting the surface of metal during the casting thereof comprise heat-insulating and fluxing materials.

The heat-insulating material in the known mixtures consists of graphite in an amount of 45 to 55 percent by weight and the fluxing material consists of cryolite in an amount of up to 6.6 percent by weight in combination with a glass powder, accounting to 5.5 percent by weight, and bentonite or clay in an amount of up to 33 percent by weight.

The known mixture is disadvantageous in a low assimilation capacity of the slag composition, a high viscosity of the slag (higher than 1.5 poise) within the working temperature range of 1100 to 1200° C. due to the stiffening action of the aluminium oxide fed together with bentonite or clay. The stiffening of the slag, particularly in a mould, results in an intensive growth of the slag component which, in turn, leads to a disturbance in the heat transfer within the mould and thinning of the solidified skin of the ingot. This may be a cause of destruction of the mechanically weak skin of the ingot being withdrawn and an emergency breakdown of the metal under the mould.

When casting steels, for example, nickel-chrome steels, or nickel-chrome-titanium alloys alloyed with elements prone to formation of carbide compounds, the use of the known mixture for protection of the metal surface is limited due to possible formation of high-melting chrome, titanium and vanadium carbides deteriorating the quality of the surface of the molten metal, therefore, considerably reducing the quality of the ingot.

The use of the known mixture during the casting of low-carbon steels is associated with intensive carbonization of the cast metal (surface carbonization on austenite steels comes up to formation of iron).

Furthermore, the above-said known composition of the mixture does not allow the granularity of the cast metal to be controlled by means of modification of this metal.

Also known in the art are mixtures for protecting the metal surface during the casting of low-carbon stainless steels comprising the following components (percent by weight): nickel 18–20, chrome 10–20, titanium up to 1.0. These known mixtures contain the following components (percent by weight): powdery aluminium 14.5, silicocalcium 5.5, sodium nitrate 9.0, iron scale (rolling) 19.0, fluorite 26.0, silicate lump 20.0, blast-furnace slag 9.0. The presence of aluminium powder in this mixture is a cause of an increased content of aluminium oxides in the slag and this deteriorates the assimilating capacity thereof, disturbs the heat transfer in the mould, thus thinning the skin of the solidified ingot, which fact, in turn, increases the probability of emergency breakdowns of the metal in the mould.

This composition of the known mixture also does not allow the granularity of the cast metal to be controlled.

In view of the above-stated, an object of the invention is to eliminate said disadvantages.

Another object of the invention is to provide such a mixture for protecting the surface of metal during the casting thereof, the flux-forming material of which would contain components which in combination with a heat-insulating material would contribute to good assimilation of the high-melting inclusions coming to the surface of the metal being cast.

Still another object of the invention is to provide a protecting mixture having a low viscosity within the range of working temperatures (the viscosity should be not higher than 1.5 poise at 1050 to 1200° C.).

Yet another important object of the invention is to provide a mixture for protecting the surface of a metal being cast which would make it possible to change the granular structure of the cast metal.

Other objects and advantages of the present invention will be apparent from a description of the proposed mixture in which, according to the invention, the heat insulating material is composed of graphite in an amount of 5 to 90 percent by weight and the flux-forming material conists of cryolite in an amount of 5 to 30 percent by weight in combination with a boron-containing compound in an amount of 2 to 30 percent by weight.

The most favourable solution of the above mentioned problem, particularly under conditions of continuous casting of low-allow carbon steels, is obtained by using a mixture containing the following components (percent by weight): graphite 40–90, cryolite 5–30, and a boron-containing compound 5–30.

The mixture containing the following components (percent by weight):

Graphite	5–15
Cryolite	15–20
Boron-containing compound	2–10
Silicocalcium	25–40
Sodium nitrate	5–15
Rolling iron scale	15–30
Silicate lump	5–15

is preferably used during the casting of high-alloy low-carbon steels, particularly if the alloying elements (Ti, Cr, etc.) are prone to carbide formation. The terms "rolling iron scale" and "silicate lump," as used herein, are well known in this art. "Rolling iron scale" refers to a thin outer iron oxide layer, removable as peel or flakes, formed on the outer surface of iron when heating for processing by rolling. The term "silicate lump" refers to a lump or mass of alkaline silicate ($3\ SiO_2 \cdot Na_2O$) allowed to cool slowly at ambient temperature from the molten state.

The boron-containing compound in the proposed mixture may consist of boron anhydride or boron ore.

The invention is further described by way of example.

In the proposed mixture for protecting the surface of metal during the casting, according to the invention the heat-insulating material is composed of graphite in an amount of 5 to 90 percent by weight while the flux-forming material is composed of cryolite in an amount of 5 to 30 percent by weight in combination with a boron-containing compound in an amount of 2 to 30 percent by weight.

The heat-insulating material, i.e., graphite improves the heat conditions on the surface of the metal being cast preventing thermal losses of metal due to the radiation and convection of the gas medium. Besides, the graphite served as a lubricating agent both for the mould and for the ingot being withdrawn therefrom in the process of continuous casting.

The flux-forming material, that is, cryolite, in combination with a boron-containing compound develops a low-melting slag on the surface of the metal being cast. The melting point of the slag is about 900° C. and this fact provides for its high assimilation capacity in relation to the high-melting inclusions even under conditions of casting a non-ageing steel for deep drawing stabilized with aluminium wherein the residual metallic aluminium in the metal comes to 0.05 to 0.07%.

The viscosity of the slag during the continuous casting of this steel does not exceed 1.5 poise within the range of working temperatures of 1050 to 1200° C. and this provides for a good balance in the consumption of slag in the mixture when continuously applying it onto the surface of the metal being cast in the mould.

Furthermore, in this case it is possible to change the granular structure of the cast metal by the quantity of the boron-containing compound in the slag composition.

The critical amount of the boron-containing compound in the mixture is equal to that in the slag which in the process of hot rolling would lead to red shortness.

The components of the proposed mixture must be ground to a fraction of $\leqslant$0.5 mm., carefully stirred and dried at $t \approx 350°$ C. during 4 to 6 hours. The dried and hermetically sealed mixture may be stored during 45–60 days. If the time of storage of the mixture exceeds 60 days, the drying should be repeated.

The most advantageous mixture used during the casting of low-allow carbon steels, particularly in the process of continuous casting, contains the following components (percent by weight):

Graphite	40–90
Cryolite	5–30
Boron-containing compound	5–30

An increase of the content of a flux-forming compound, i.e., cryolite and of a boron-containing compound, improves the assimilation capacity of the slag. Any increase of the quantity of a boron-containing compound disintegrates the cast structure of the metal, i.e., intensifies the effect of its modification.

Thus, the composition of a mixture developed for casting of non-ageing steel stabilized by aluminium and intended for deep drawing (steel sheets for stamping car bodies) comprises, in percent by weight: graphite 50–70, cryolite 16–20 and a boron-containing compound 12–25.

The limits of the percentage ratio of the components in the mixture are determined depending on the cross section of the continuously cast ingots. The more is the cross section of the ingot, the less is the amount of a flux-forming compound in the mixture.

When casting a silicon-manganese steel for high-diameter tubes (higher than 1.5 m.) intended for main pipelines, it is advisable to use a mixture having the following components (percent by weight): graphite 90.0, cryolite 7.0, a boron-containing compound 3.0.

When casting high-alloy low-carbon steels, the selection of a mixture for protection of the metal surface should be made taking into account the following:

The alloying elements are prone to formation of high-melting carbides which deteriorate the quality of the surface of the metal being cast, develop a floating skin impairing the quality of the metal and increase the probability of emergency penetration of the metal into the space under the mould.

The probability of carbonization is increased alongside with reduction of carbon in the steel.

In this connection, a mixture for protecting the surface of a metal during the casting has been developed, which in addition to (percent by weight) graphite 5–15, cryolite 15–30, a boron-containing compound, 2–10 includes the following components:

Silicocalcium	25–40
Sodium nitrate	5–15
Rolling iron scale	15–30
Silicate lump	5–15

An increase of silicocalcium in the mixture from 25 to 40 percent by weight is used in the process of continuous castnig of thin ingots.

During the continuous casting of stainless steel containing chrome 23%, and nickel 18% by weight, a mould with a cross section of 150 x 1200 mm.[2] has been charged with a mixture of the following composition (percent by weight):

Graphite	6.0
Cryolite	20.0
Boron-containing compound	10.0
Silicocalcium	27.0
Sodium nitrate	7.0
Rolling iron scale	20.0
Silicate lump	10.0

During the continuous casting of the same steel in a mould having a cross section of 220 x 220 mm.[2] a mixture has been used which had the following composition (percent by weight):

Graphite	5.0
Cryolite	15.0
Boron-containing compound	3.0
Silicocalcium	35.0
Sodium nitrate	10.0
Rolling iron scale	22.0
Silicate lump	10.0

The viscosity of the above slags within the range of working temperatures does not exceed 1.3 poise.

The boron-containing compound may be composed of boron anhydride B_2O_5 or a boron ore $Na_2B_4O_2$.

The proposed mixture of the above-said compositions intended for protection of the metal surface during the casting provides for a good quality of the surface and macrostructure of cast ingots produced by means of moulds. The use of this mixture under conditions of continuous casting makes it possible to provide a good quality of a continuous ingot during the casting of large amounts of molten metal (up to 700–800 tons) without troubles (penetration of metals, sagging of ingots, etc.).

The composition of the flux-forming material of the composition, according to the invention, makes it possible to practically avoid formation of a floating skin, to completely assimilate all inclusions coming to the surface of the molten metal, and this provides for a high quality of the surface and macrostructure of the cast metal. The good viscous properties of the slag within the working temperature range (1.3 to 1.5 poise at t=1050 to 1200° C.) provide for alignment of the front of solidification of the ingot envelope in the mould, and this eliminates external longitudinal and transverse fractures.

In the process of casting the slag compound under these mixtures has a thickness not higher than 1.0 to 1.5 mm., and this results in a thinning of the ingot skin.

It has been found that due to an increase of the heat transfer in the lower portion of the mould the thickness of the skin of the mould at the outlet thereof is practically 10 to 15% higher than under the mixture of the known composition.

The presence of boron-containing compounds in the mixture makes it possible to affect the cast structure of the ingot.

Thus, the mixture having a composition according to the present invention makes it possible to obtain a granular cast structure in nickel-chrome stainless steels containing chrome 23% and nickel 18% and having tendency to transcrystallization.

We claim:

1. A mixture for protection of the surface of metal during the casting comprising graphite in the amount of 5 to 90 percent by weight used as a heat-insulating material and cryolite in the amount of 5 to 30 percent by weight in combination with a boron-containing compound in the amount of 2 to 30 percent by weight used as a flux-forming material.

2. A mixture as claimed in claim 1 containing in percent by weight:

Graphite	40–90
Cryolite	5–30
Boron-containing compound	5–30

3. A mixture as claimed in claim 1, which, in addition to the above-said component taken in percent by weight: graphite 5–15, cryolite 15–30, a boron-containing compound 2–10, is provided with the following components (percent by weight):

Silicocalcium	25–40
Sodium nitrate	5–15
Rolling iron scale	15–30
Silicate lump	5–15

4. A mixture as claimed in claim 1, in which a boron anhydride is used as the boron-containing compound.

5. A mixture as claimed in claim 1, in which a boron ore is used as the boron-containing compound.

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