PRODUCTION AND EQUIPMENT

NEW GENERATION OF STARTING MIXES

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Requirements are formulated for a starting mix for metal pouring. A starting mix is developed satisfying the contemporary needs of ferrous metallurgy. The behavior of individual components of the starting mix during operation is analyzed.

Start-up of the majority of melting units is unavoidably connected with use of a starting mix, i.e. a filler, preventing emergence of metal through the delivery opening (nozzle, window, etc.). The role of the starting mix has increased in recent years in view of the more extensive use of pouring steel in CBCM. A starting mix serves once, it is impossible to replace it and it is not amenable to repair.

Stopperless pouring of metal gave rise to the start of development of starting mix compositions. A number of examples have been described, used in slide gates in the first stages, but their use has not become widespread [1]. The complexity of a structural solution and a number of requirements whose fulfilment is not monitored makes it impossible to introduce them into production. In publication [2] bottom (window) delivery of metal from an arc furnace is considered with which the steel delivery channel was filled with periclase or dunite powder of a prescribed grain size composition. Almost all main functions and requirements of a starting mix, taking account of overseas experience, have been given in [3] in which two main requirements are formulated: the starting mixture should empty freely from the upper nozzle with channel opening and it should not sinter with thermal and chemical action of molten. metal. Thus, the powder should exhibit good fluidity, be neutral with respect to metal and slag and it should not sinter. The grain size composition should be selected taking account of formation of a finely-porous structure into which metal and slag should not enter. As already noted, in order to prevent mix sintering it should not contain fractions finer than 0.063 mm.

Thus, the following main requirements are laid down for staring mixes:

- a starting mix should have high fluidity to transport it (without hanging) through a small diameter metal feeder (pipe) over the upper edge of a ladle, through the whole of its height to the pouring opening (filing of the pouring channel in a ladle between pours in a hot condition) and to fill it effectively avoiding falling molten metal in a different channel during filling a ladle and metal processing in a ladle;
- the starting mix should not sinter under the action of molten metal in the ladle and should freely liberate the pouring channel (independently empty) at the instant of opening the channel (slide or window gate);
- the starting mix should have low thermal conductivity in order to avoid extreme heating of the steel pouring channel.

Domestic starting mixes based on SiO_2 and graphite or imported mixes are used in domestic enterprises. The main disadvantages of mixes based on SiO_2 are their high tendency towards sintering in the steel pouring channel and the probability of reaction with the melt, a consequence of which is closing of the pouring channel and arch formation in the layer of mix beneath this channel. These disadvantages are due to the following factors:

- the possibility of burning part of the graphite during ladle heating before pouring, which in turn leads to sintering of the mix in the steel pouring channel;
- the possibility of development of the arch formation effect at metal pouring temperatures due to residual expansion of the quartz-containing component with polymorphic transformation of it;
- formation in freely poured refractory mix of a large number of pores, not filled at the metal pouring temperature, filled with liquid ceramic phase or graphite into which molten metal or slag may penetrate with formation of highly

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viscous compounds preventing free emptying of the mix from the steel pouring channel during its opening.

Thus, the problem of improving the operating properties of starting mixes consists of increasing the fluidity of the refractory mix, increasing its lay-up density in the freely poured state, increasing resistance of the mix to the action of iron-containing melts, reducing the probability of arch formation and sintering capacity of the mix, and providing unhindered emptying from the steel pouring channel during opening of it without use of mechanical action and burning through with oxygen. This is achieved by the fact that the starting mix contains a chromium-containing component with a grain size of less than 3 mm and an organic surfactant. The quartz-containing component has a grain size less than 3 mm, and graphite less than 1 mm. Introduction into the refractory mix composition of a chromium-containing component increases refractoriness and resistance of the mix to iron-containing melts, it reduces the tendency towards arch formation and sintering under the action of high temperature as a result of the exceptional chemical inertness and high melting temperature of the Cr_2O_3 itself and its compounds with iron oxide (various chromium spinellids) and silicon dioxide. In the spinellids a melt starts to develop at a temperature above 1700°C. In the presence of SiO_2 chromium spinellids do not form chemical compounds and solid solutions with it, and above 1840°C in a mixture of chromium-containing component and quartz only two immiscible melts are present hardly reacting with each other, as a result of which the refractory mix does not sinter at the metal pouring temperature (1600 – 1800°C).

During reaction of components of the starting mix with iron oxides and metal at high temperature (both chromium- and quartz containing) there is an increase in the molar volume as a result of a change in the valency of iron and chromium oxides during spinel formation, and this also prevents sintering of the mixture and penetration into the volume of iron-containing melts. Presence within the composition of the refractory mix of graphite and secondary carbon at its service temperature leads to their reaction with components of the refractory mix with formation of chromium, iron, aluminum and silicon carbides and oxycarbides that also have a high melting temperature and resistance to iron-containing melts, and they form with an increase in volume that is an additional hindrance to refractory mix sintering.

Introduction into the starting mix composition of surfactants provides uniform distribution of graphite over the surface of the mineral part of the mix as a result of low surface tension and development of capillary forces at the surface of porous bodies which increases fluidity and lay-up density for grains of the mixture due to development of a double electric layer at the surface of mineral particles and it provides formation of an additional secondary finely-dispersed carbon over the surface of mineral particles of the mix during heating as a result of surfactant coking.

OOO Stroikhim together with the faculty of KhTKiO GOUVPO UGTU-UPI has developed and patented the composition and preparation technology and application of starting mixes grade Tempa for ferrous metallurgy pouring units. The physicochemical properties of Tempa starting mix are given below:

Average density, g/cm^3	2,80 – 3,40
Refractoriness, °C, not lower than	1750
Fluidity, sec, not more than	40
Sintering capacity, °C, not lower than	1700
Storage life, month	3

The starting mix has entered industrial tests in OAO NTMK, OAO Spetsstal’, OAO A. K. Serov Metallurgical Plant, OAO Northern Pipe Factory and has demonstrated no fewer than 60% openings of a pouring channel without burning with oxygen; in the rest of the cases the duration of burn-through was not more than 5 sec.

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