Control System of Multifunctional Melting Unit

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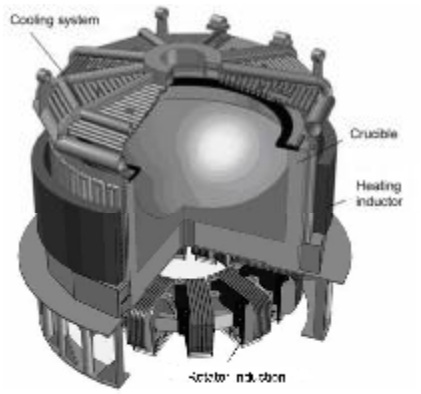
I. EXTENDED ABSTRACT

Multifunctional melting unit (MMU) is a device created on the base of induction crucible system. The examined variant (pic.1) includes the following structural elements: a crucible, a heating inductor, a rotator inductor of frontal construction, and a cooling system. Electrical facilities of the multifunctional melting unit also include power supplies, designed for supply of the rotator inductor on the underfrequency and supply of the heating inductor on the overfrequency. This device enables to start the process of liquid-phase metallic oxide reducing that can also be named as "melting process with rotation and liquid-phase reducing" (MRLPR). In addition to the stirring effect the smelt rotation during MRLPR process enables to obtain the following results: 1) during the rotation of the smelt including metallic and drossy phases, a parabolic cup of metallic phase is created. The drossy phase is located in this cup and is not in contact with the refractory material of the melting chamber; 2) backing metal enables to control the process of reducing and energy distribution that appears during high-temperature reactions.



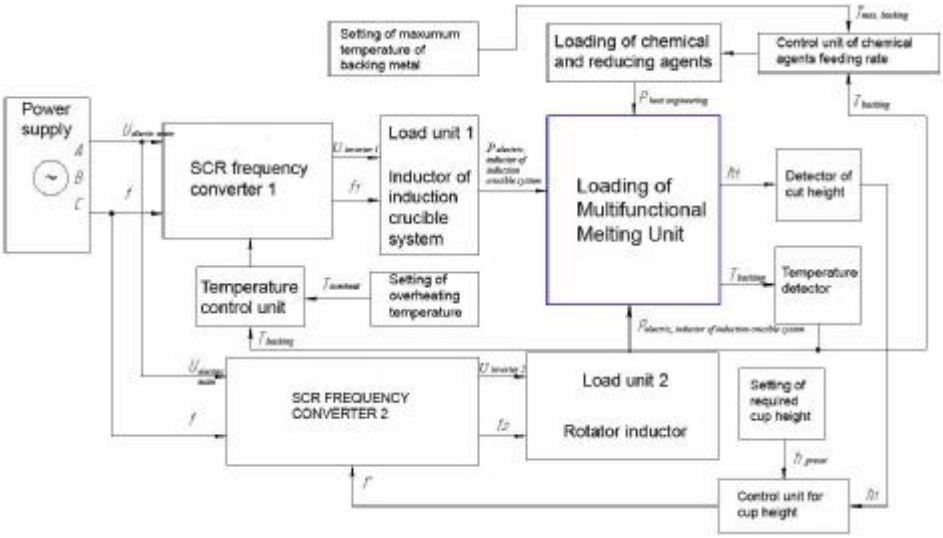
Pic. 1. Multifunctional melting unit

Metal of backing is built up in the melting unit before the beginning of the basic process. Cast iron and ferrous alloys, that contain strong reducing agents (aluminium, titanium, selicium), are used as a backing. Formation of the cup in liquid metal is created with an induction rotator. The rotator is an inductor of frontal construction that creates a rotating magnetic field in the backing metal.

After building up of the required chemical composition and formation of the cup, dosed supply of an oxide-containing charge is performed. When the charge is heated to the reaction temperature, the efficient product is derived and then it dissolves in the backing. Metal reducing from oxides of drossy smelt can be started at once if the backing is a smelt of cast iron. Cast iron carbon will reduce metals from oxides, but additional energy for endoergic reducing reaction is required. This energy is transferred to the backing with the use of the side heating inductor and the rotator inductor.

The operating regime of the melting unit at the initial stage is similar to the operating regime of the induction crucible system and it is well understood [1]. The stage of liquid-phase reducing is of great interest for scientists. At this stage the main problems of control are the following: creation and keeping of the required cup depth; keeping of the cup at the required level during various disturbances (the change of the cup mass and electrical conduction), limit of the upper temperature level of the backing (if strong reducing agents are used), or keeping of the preset temperature level in the melting unit (during endoergic reducing reactions).

At this stage (pic.2) it is possible to use the following



Pic.2 Functional diagram of melting unit control

forces for controlling of the unit: rate of oxide-containing charge feeding (the rate is connected with the intensity of heat generation or the intensity of heat absorption, it depends on the type of the reducing agent); voltage of the inductor winding and current frequency of the rotator inductor. The voltage ant the current frequency influence on the power transferred to the backing metal, the rate of rotation, the backing level in the near-wall region, the contact area of chemical agents with the backing, and the generated power. The functional diagrams of the control system, based on these forces, are described in the article.

[1] S.M. Fatkullin, V.E. Frizen, “Mathematical modelling of operation of an induction crucible system as a part of multifunctional melting unit,” *Industrial power engineering No5, Moscow 2010. P. 14-18*