RECYCLING OF STEEL USING THE ESR METHOD IN THE CONDITIONS OF LIMITED RESOURCES OF RAW MATERIALS TO PRESERVE THE CHEMICAL COMPOSITION AND PROPERTIES

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The paper examines the possibilities of modern electroslag remelting technology and modern electroslag furnaces for recycling alloyed steel grades. The expediency of the EES according to the two-circuit scheme of electrodes with non-constant length geometric parameters and non-compact metal charge materials is shown. It has been experimentally proven that the two-circuit EPC allows for efficient recycling of spent small-sized tools, both assembled into consumable electrodes and in the form of a non-compact charge, while preserving the chemical composition of the metal and obtaining ingots with a high-quality surface.

Keywords: electroslag remelting, double-circuit scheme, recycling, tool, high-speed steel, ingot, remelting productivity, ingot quality

Introduction. Electroslag remelting is one of the effective methods of recycling waste of alloyed steel grades [1–2]. During remelting, there is a minimal loss of alloying impurities with oxidation, which allows the original chemical composition of the metal to be preserved, and the metal is refined. In addition, the conditions of metal hardening in a water-cooled crystallizer make it possible to obtain a physically and chemically homogeneous ingot with a high surface quality.

Since non-compact tool steel waste is collected into one electrode by welding individual parts together, it will not have the same lengthwise cross-sectional area and the degree of its filling with metal. As a result, during remelting of such an electrode, the electrical resistance, filling factor, and electrical mode of remelting will change unpredictably. Accordingly, electroslag remelting of such an electrode according to a direct scheme with obtaining a high-quality ingot is technologically difficult to perform due to the instability of the remelting process.

The problem of the instability of the melting process during the remelting of electrodes with non-constant length geometric parameters can be solved by the use of remelting according to a two-circuit scheme [3]. It is implemented through the use of a crystallizer of a special design (current-conducting crystallizer), which allows additional electrical power to be supplied to the slag bath through it. Additional supply of current to the slag bath through a conductive crystallizer allows to largely neutralize the negative impact of an unpredictable change in the geometric parameters of the consumable electrode on the remelting result.

Experimental consumable electrodes were made by welding individual parts into a single structure. For the manufacture of electrodes, small-sized used tools were used - drills, broaches, cutters and cutters, with a maximum size of up to 0.2 m, which, according to the marking, were made of P6M5 steel (P6M5K5, P6M5K5-MP, P6M5F3-MP, 10R6M5U-MP). ANF-29 flux was used during remelting.

Using a current curing mould (CCM), it is possible to remelt a non-compact used tool [4]. As such, disposable medical instruments made of stainless steel were used (needles, lancets, scalpels, etc. - the so-called "surgical steel").

Melting was carried out exclusively at the expense of a CCM. The batch was loaded in portions on the mirror of the slag bath. ANF-28 flux was used during remelting. The supplied power to the CCM was constant, and the rate of melting of part of the charge depended on the loaded volume. Since the bulk density of the charge is less than the density of weak slag, the charge was constantly on its surface. Melting occurs from the walls of the current-carrying section to the center of the slag bath. With an increase in the loaded portions of the charge, the melting performance also increased, this is explained by the fact that part of the current is shunted by the charge and the Joule heat removal occurs under it, and not only on the periphery of the crystallizer due to the current-carrying section.

Conclusions. Electroslag remelting according to a two-circuit scheme allows efficient recycling of spent small-sized tools, both assembled into consumable electrodes and in the form of a non-compact charge, while preserving the chemical composition of the metal and obtaining ingots with a high-quality surface.

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