TREATMENT OF MELTS AND ALLOYS UNDER SOLIDIFICATION BY THE DIRECT CURRENT

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The contents of gases both in nonmetallic inclusions in liquid and crystallizing metals decreases under the effect of a constant electric current. Thus the conditions of dissolution and mastering of modifying agents, micro- and macrostructure and physical and mechanical properties of metals are improved. The shape and sizes of graphite inclusions in pig-iron castings change.

Introduction. Special ways of exposure on the metal during its crystallization are perspective methods for improving the quality of castings and ingots. It is possible rather easily to adjust electromagnetic methods of effect on the metal, the influencing of which without application of composite and expensive equipment deserves special attention. The relevant value is given to selection of optimum parameters of electromagnetic processing, installation of time and duration of imposing of an electrical field on a crystallizing metal, that in a maximum measure to render positive influencing on the quality of metal.

1. Experimental results. At electroslag heating and, especially, replenishment rolling (3–8 t) and forge (19 t) ingots (Fig. 1) with application of a basic flux and at passing of a constant electric current (I = 100 A, U = 50–60 V) through steel, which crystallizes in steel molds (graphite or steel electrodes of the same elemental composition are placed, in a sinkhead of ingots as the steel in steel molds with hooking up to them of a negative pole – cathode), is an appreciablly improved frame and quality of ingots (Fig. 2) with less expressed axial central looseness, gas shrinkage porosity.

First 10–15 minutes of replenishment or heating the sharp increase of concentration of hydrogen in a profitable part of ingots is observed. The presence in a profitable part of ingots (in tie-backs) liquid slag and advanced convective flows of metal promotes removal of hydrogen from steel, crystallizing in a steel mold. The contents of hydrogen decreases in 2 m.

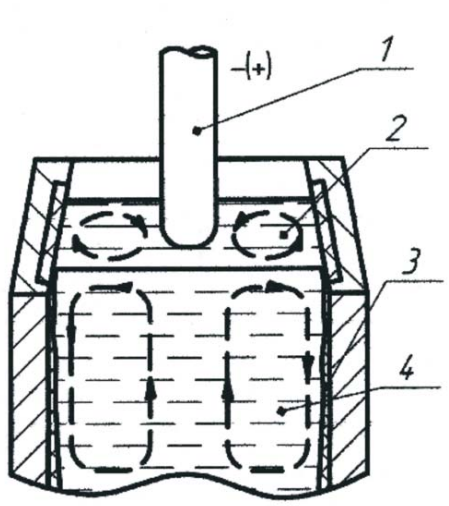
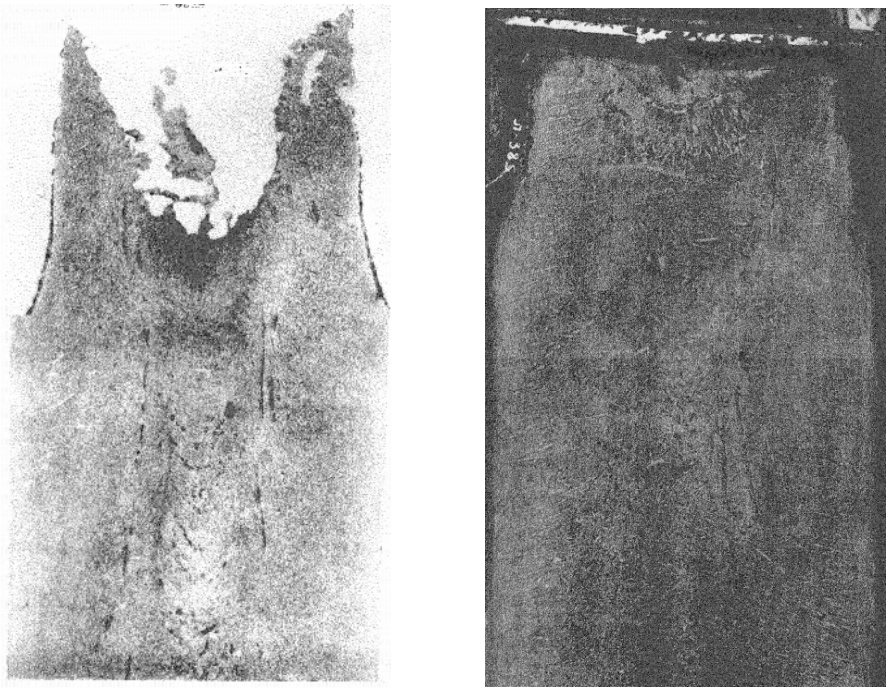


Fig. 1. The scheme of electroslag heating of ingots: 1 – graphitized welding rod; 2 – liquid slags; 3 – crystallizing metal; 4 – liquid metal.



(*a*) (*b*)

Fig. 2. Macrostructure of ingots: crystallizing without replenishment (heating) (*a*) and after electroslag replenishment (*b*).

At heating of an ingot with application of the direct current of reverse polarity (hooking up to a welding rod of a positive pole) conditions are created, which counteract to the moving of hydrogen in a profitable part of the ingot. At hooking up to welding rods of a positive pole – anode, the contents of sulfur decreases and its exudation is reduced.

The electroslag heating promotes equalization of elemental composition, reduction of the inclusion content in ingots, increase of the plastic properties of rolled metal.

Passing of the direct current at crystallization of pig-iron castings of different elemental composition in sand-clay forms is accompanied by change in hydrogen and carbon transfer processes. As a result, the contents of hydrogen (Fig. 3) de-

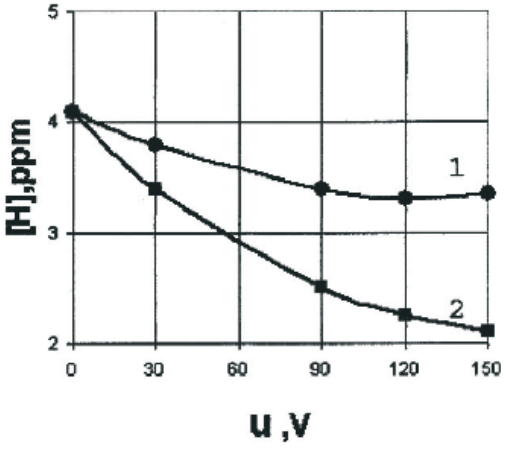
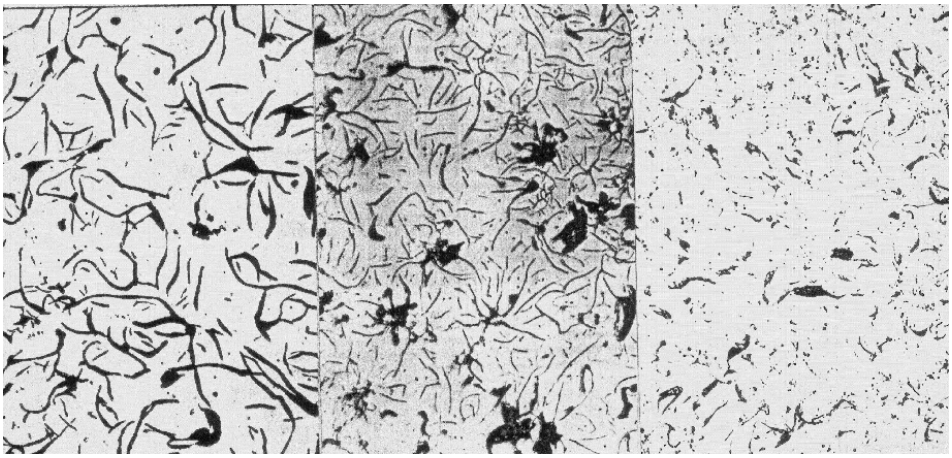


Fig. 3. Changes of the contents of hydrogen depending on the polarity of hooking up of welding rods on casting: 1 – positive pole; 2 – negative pole.



(*a*) (*b*) (*c*)

Fig. 4. Graphite actuations in gray pig-iron ×100: (*a*) – initial sample; (*b*) – casting treated by the alternating current ($U = 127$ V); (*c*) – casting treated by the direct current ($U = 120$ V).

creases by 25–35% and that of nitrogen decreases by 7–15%; the shape changes, the value and nature of distribution of graphite actuations in grey (Fig. 4) malleable iron, high-tensile and alloyed cast irons increase the strength of cast iron at elongation tests by 20–25% (Fig. 5). The more largely graphitic actuations, the higher is the contents of hydrogen – this relation is conditioned by an activated adsorption of hydrogen by graphite actuations. The best outcomes at simultaneous reduction of the contents of hydrogen during the crystallization of pig-iron, mincing of graphite actuations, increase of strength properties are observed at processing of castings by the direct current (hooking up to casting negative, to a flask – positive pole).

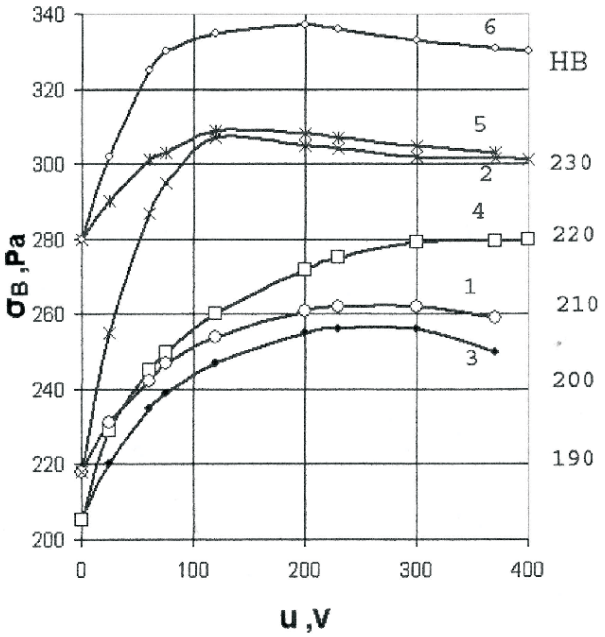


Fig. 5. The influence of voltage of constant (2, 4, 6) and variable (1, 3, 5) currents on the strength at gap (1, 2, 5, 6) and hardness (3, 4) of castings from grey pig-irons.

Optimum value has been found for a voltage 100–150 V at a current density 4–5 mA/cm^2 of a surface having cast.

2. Conclusion. At electroslag to replenishment with the charge of the electric power 18–25 kW-h per ton of steel the output suitable is increased by 6–8% at simultaneous improvement of the quality of metal.

It is economically most expedient to apply electroslag heating or replenishment of ingots of qualitative steel with the constant current of direct polarity with connection to an electrode of negative pole of the cathode.

At electromagnetic processing in the process of pig-iron crystallization having cast the durability is increased at a bend by 10–15%, durability at break by 20–25%, will be minced of inclusion of graphite.