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SECONDARY ELECTRO-THERMAL ALLOYING AND AFFINAGE OF METAL WITH PARTICIPATION GAS PHASE

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There is presented the study of the influence of the specific charge for slag on the pressure of the gas phase, the content of impurities and alloying elements in the process of secondary electro-thermal alloying and refining (SEAR). It was established that the increase in external pressure can significantly increase the efficiency of doping-steel alkaline earth metals due to reduced their loss in the gas phase. The main SEAR parameters for low-alloy steels have been determined.
Keywords: steel, alloying, refining, gas phase, thermodynamics, calcium, magnesium.

In a number of works on results experimental and theoretical researches is were expounded possibilities of the secondary electro-thermal alloying and affinage of metal (SETAA) for the effective alloying and affinage of liquid steel [1-3]. It was shown that one of technological features of SETAA is a substantial diminishing of slag mass on motion a process in which an electric charge of slag is positive. As theoretical calculations show, this effect is accompanied by not only passing of anions to the metal but also formation of gas phase at the increase of charge of slag higher than some threshold level. The higher charge of slag allows not only to lower content of sulphur, oxygen and nonmetallic insertions in a metal to the ultralow sizes but also get the modified steel with content of calcium and magnesium over 0.04 %. As is generally known, in absolute majority of brands became content of these elements is not regulated and 0.001 % does not exceed actually.

Appears expedient to choose as a universal independent variable the relation of charge of slag, shown in Faradays, to the number the moths of clothes of slag. Such variable in future will be named the specific charge of slag, designated as q and to have a dimension of F/moth of clothes.

Raising of task. In-process set the task to execute the thermodynamics modeling of the system "metal-slag-gas" in the process of SETAA taking into account possible gassing is; to work out technology of diminishing of losses of alloying elements at the increase of positive charge of slag/

Basic part of researches. As an object researches there is chose deoxidized liquid steel of marks of 09Г2С, 12ГС and 30ГС at a temperature 1600 °C, covered by the layer of balanced slag. Mass of metal was accepted by equal 150 t, initial mass of slag – 1.5 t. Composition of the stove slag, %: 45 CaO, 20 FeO, 20 SiO_2, 10 MnO, 3 MgO, 1.5 Al_2O_3, 0.3 S and 0.2 P_2O_5. In addition, besides low alloyed steels, investigated carbon intermediate of composition, %: 0.120 Mn, 0.050 C, 0.035 S, 0.015 P. and 0.001 Si, which is used for the making of low alloyed steels.

It is set that at the change of size of specific charge of slag q for each of the examined marks of steel there is an area of quiet metal with complete absence of gassing, which expands at the increase of external pressure. This fact can be examined as an apparent element of technology of diminishing of losses of anions in a gas phase at a positive process.

Giving to the slag of negative charge allows to execute a scarification which is accompanied by passing of oxygen cations to the metal and oncoming transition of anions, including phosphorus, in a slag. At such negative process there is an increase of mass of slag due to oxidization of iron and other admixtures. In addition, a gas phase appears with dominance monoxide carbon from oxidization of carbon in a metal.

Obviously, that is relative high partial pressure of calcium steams does not allow to get its high content in steel at ordinary atmospheric pressure, so that 0.04 % calcium is a limit for all investigated marks steel. Increase of external pressure to 200 кПа appears sufficient, to lead content of calcium in steel to 0.30-0.35 %. In this case greater part of calcium of slag phase passes not to the gas phase, and in a metal.

If content of calcium in steel with the increase of positive charge of slag monotonically grows from very small values to the head limit, then content of magnesium passes through maximums 0.020-0.026 %, approximately corresponding to minimum pressures formations of gas phase. At the further increase of charge of slag content of magnesium substantially diminishes and stabilized at the level of 0.01 % at q > 1,25 F/moth of clothes. For a receipt became with higher content of magnesium it is necessary to increase the part of MgO in a slag.

Interestingly to mark that the modified steel with high content of calcium and magnesium, and also ultralow content of sulphur and oxygen, it is possible to get even with the use of unalloyed intermediante and converter slag.

In theory by means of SETAA it is possible practically fully to delete sulphur and oxygen from a metal due to effective displacement of balance in the system "metal-slag-gas". However at the satiation of slag by oxygen and sulphur a slag phase becomes thermodynamics unstable and its evaporation can begin before, than complete moving away of sulphur will happen. A question about thermodynamics stability of non electro neutral of slag phase is difficult enough and requires separate research, including considerations of function of stability ψ, entered by Lupis [4].

Conclusions. It is set that in the process of SETAA the increase of both positive and negative specific charge of slag on an absolute value is accompanied by formation of gas phase, the volume of selection of which depends on external pressure. At atmospheric pressure in a positive process considerable part of calcium passes to the gas phase, that does not allow to get its content in steel over 0.04 %. Increase of external pressure to 200 кПа at the specific charge of slag ≥ 1.0 F/the moth of clothes increase the top limit of content of calcium in steel to 0.35 %. For alloying steel askaline-earch metals technology of SETAA allows to use metallurgical slags instead of expensive powder-like wire.

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