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THE HIGH-EFFICIENT TECHNOLOGY OF STEELS MODIFYING BY COMPLEX MASTER ALLOYS

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Introduction

As practice shown the modifying of steel is .one of most efficient way of steel service characteristic improving as modifying can be able to provide the set totality of necessary properties and structure of metal [1-3]. The change of high-alloyed cast steels on more cheap structural modifying steels is actual because lasts have the more efficient technology of receiving and processing and provide higher level of special service properties. Efficiency of practicable measures for improving a processing steel quality in many depends of chemical compound of used master alloy, ways of input its in liquid melt and conditions of interaction of added materials particle with steel components.

1. Initial reason for efficiency of modifying technique improving

The additives of rare earth and alkali earth and other active elements (in various masteralloys kind) provide effective influence on compound and morphology of non-metal inclusions which defined anisotropy degree and mechanical properties of steel.

The input of mentioned reagents in melt is usually carried out in kind of granules, powder or cored wires on final stage of steelmaking production - during steel output in ladle or by steel teeming. Master alloys losses and stability of reagent distribution in crystallising metal are in many defined of steadiness of service characteristics of proportioning device that is used for input of addition. Efficiency of modifying technology depends also of intensity of heat- and mass-transfer processes which occur during interaction of additives particles with melt flows in ladle bath and mould volume. This demands to undertake the special measures for providing steady feed of modifying reagents in liquid steel and favourable conditions of their melting and dissolving in volume of processed melt. For providing the special properties of casts goods of different purpose the necessity arises of modifying steel manufacture with high-active elements that were input by complex master alloys.

2. Designed proportioning device and results of proposed technology using

Researches of non-uniformity of active components distribution during teeming and modifying in ladle by steel output from furnace shown essential deviation of chemical composition of steel and instability of adoption of deoxidation and modifying reagents. As rule the metal keeping in ladle stipulates the loss of active elements through contact of metal with air oxygen and ladle lining. For correction the microalloying addition content is necessary to add small supplementary quantities of modifying elements in kind of briquette or packet by portion teeming in intermediate ladle. This may be accompanied by increasing of steel pollution with coarse oxide inclusions.

Figure 1 presents the scheme of designed device for input of reagents mixtures in liquid metal during out-furnace (ladle) processing of steel. It includes hermetic hoppers 1 and 2 with screw proportioners 3 and 4 are situated in common body 5. Screws of proportioning devices are set on coaxial shafts 6, 7 which have different diameters and

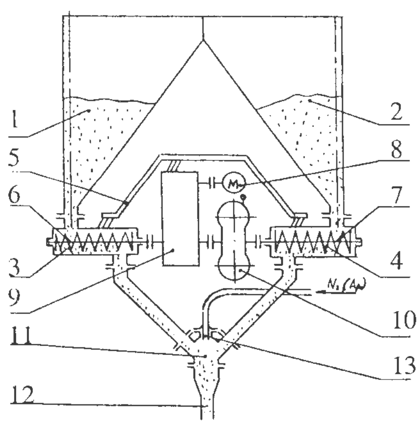

Fig. 1. Scheme of device for complex master alloys feeding in liquid metal.

direction of winding –on of turns. Simultaneous screws rotation was fulfilled by means of electromechanic drive contenting electric motor 8, reductor 9 and speed variator 10. Due to designed scheme of drive the work of screw proportioners allowed to provide the necessary (set) proportion of mass expenditures of materials which forming complex modificator in mixing chamber 11. It had been connected through flexible pipe with distributor which had been secured -in dependence of used type of teeming device- on the body of nozzle-collector of ladle discharge gate or on the bottom of ladle near nozzle. For providing of stable transportation of modificator material particles to issuing from ladle steel stream and reducing of secondary oxidation intensity (by air oxigen) the gas nozzle 13 (for force feed of inert or neutral gases) was set in top part of mixing chamber body [4].

Short specifications of proportional device:

1. Control range of mass expenditures of inputted reagents ratio (1:1)...(1:4)
2. Granulometric composition of proportioned mixtures, mm 1...3.
3. Drive power, kWt.

Maximal efficiency of designed device using has been provided by input of reagents in liquid metal during teeming steel in ingot's or large casting moulds. Proportioning device with the help of special holding attachment was fastened on stiffening girdle of steel teeming (casting) ladle. Drive of proportioner is switched on electrical network of steel teeming crane.

At moment of opening of nozzle of steel teeming (casting) ladle the electromechanical drive of device was started. The screws simultaneously had began the feed (from hoppers) of materials which were mixed in necessary proportion in the chamber. Farther, the materials mixture with jet of gas through flexible pipe was fed under stream of steel that was issuing from steel-teeming (casting) ladle into metal receiver (intermediate ladle or mould). This way of steel processing (as compared input of reagents in ladle) allows to except a modifying steel contact with final cover slag and ladle's lining and to reduce intensity of metal secondary oxidation.

Such steel microalloying technique named "late modifying" was realized by way of masteralloys feeding in melt immediate before beginning of crystallization. Two components mixture of high-active masteralloys in grinding kind (1-3 mm) was used. Intensity of feeding is 0.15-0.25 kg/s.

This case the grade of adoption is more 1,3-1,4 fold in comparison of ladle input variant. Uniformity of modifying addition distribution in steel had increased (figure 2) that guarantees necessary complex of mechanic properties of materials of all batch (melting) of ingots and casts.

For efficiency estimation of proposed modifying technique effect on increasing of cast steel quality, the test of mechanical properties and metalographic examinations of structure on experimental and compared (ladle modifying) steels were carried out.

Study of mechanical properties of modifying steel (in that number after hardening and temper) on the samples from receiving casts was fulfilled.

Table 1 presents the results of mechanical properties. Tests shown that most effect of metal strengthening (by modifying of complex master alloys) was received by way of

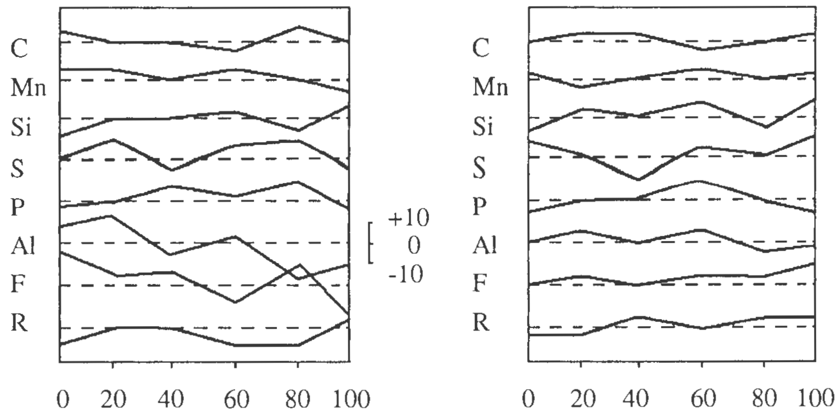

Fig. 2. Distribution of elements in samples that was took during teeming of experimental melting (a- by addition of modificator in ladle under stream outputted from furnace; b) - by "late modifying" technique with designed input device).

"late modifying" (compound 1) and heat treatment (hardening and temper by 200-230 °C). The comparison steel – without modifying (compound 2).

Table 1. Mechanical properties of experimental steels samples

Compound number	Temper temperature, °C	Tensile strength, MPa	Impact strength, (Sharpy-U), J/cm^2	Hardness, HRC	Relative wear resistance , %
1	200	1580	18,0	52	4,8
1	250	1530	24,4	49	4,0
1	300	1510	30,6	46	3,4
2	200	1650	26,1	54	6,1
2	250	1600	32,6	50	5,2
2	300	1540	49,4	47	4,3

Conclusion

The proposed technology using allows to increase the strength characteristics of steels and to improve the ductility (Sharpy–U test) due to reducing of coarse non-metal inclusion content and formation of dispersed carbonitride phase. Tests of experimental steels on friction about non-rigid secured particles shown the essential increasing of relative wear resistance of modifying steels. This causes the increasing of common reliability and service durability of casts made from microalloyed steel.

The marked improvement of mechanical properties of modifying steel was stipulated, in first, of their microstructure change: the reducing austenite grain size, high dispersed uniform distributed strengthening carbonitride phase formation, the change of physical properties of metal matrix.

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