UDC 669.013:669.013.6.7

A.V. Kharchenko, associate professor, c.t.s.

OPTIMIZATION FOR PROCESS OF DESOXYDATING STEEL WITH APPLICATION HARDWARILY-PROGRAMMATIC COMPLEX «MASTER»

Zaporozhe state engineering academy, Ukraine

Use of a hardwarily-programmatic complex «Master» in the open-hearth shop of OAJ «Metallurgical combine «Zaporozhstal» allowed to get economy of costns due to optimization of expense of ferroalloys and materials for desoxydating of unkilled and semikilled steel, and also decline of flaw of rerolling-quality metal. Optimization of expense of ferro-alloys and materials is arrived at the use of algorithm of simolex-method for the linear programming in combination with the thermodynamics model of the system «metal-slag-gas». The decline of flaw of rerolling-quality metal is reched due to stabilizing of its oxydation level and more exact prognostication of chemical composition of ladleman sample.

Keywords: desoxydating, the system «metal-slag-gas», ferroalloys, programmatic complex, optimization, thermodynamics model

Introduction. It is known that the prime price of martin steel exceeds an analogical factor for modern another ways of its smelting. In instance where the martin workshop of OAJ «Metallurgical combine «Zaporozhstal» will making products yet during a few years to beginning of producing of converter steel (evaluation, to 2018), a plant is forced to search the methods of reduction in cost of production for providing of competitiveness of the products in this period. One of reserves on the decline of prime price of the smelted steel and increase of its quality is optimization of charges of deoxidants and alloying additions. The decision of this task requires, from one side, bringing in of the last achievements of theory of metallurgical processes, from other are the uses of possibilities of the modern computing engineering.

Raising of task. The existent methods of calculation of deoxidants do not take into account the row of key parameters: temperature of metal in a furnace before producing, oxidation metal before producing from a furnace and in a ladle after producing, content of carbon, manganese, sulphur and phosphorus on producing from a furnace, composition of slag, getting in a ladle on producing from the furnace and other. The problem to offer the methods of calculation for expense of deoxidants taking into account the above-stated parameters and inculcate an instrument-programmatic complex for its realization is in work set.

Technical and programmatic facilities imput in the complement of instrument-programmatic complex (IPC). The tachnical facilitiess IPC include automatize working place (AWP) for masters of furnaces, AWP forf laboratory assistants of chemical express lasboratory, engineer station-server and complex of telecommunication facilities.

To the number programmatic facilities IPC belong program «Master» for the optimal calculation of deoxidants; program «Chemicallaboratoryassistent» for the competence of electronic magazine of metal tests, and also program «Converter» for periodic imput of actual data.

The program «Master» serves as the main component of IPC for the calculation of optimal quantity of deoxidants and alloying materials at the production of steel in the martin workshop of OAJ «Metallurgical combine «Zaporozhstal» and

is by a science capacious product. Basis of program algorithm is made by positions of theory of metallurgical processes [1-4] as it applies to a martin process.

On the functional setting the program «Master» is adviser masters of furnace. Basic tasks, decided by this program: optimization of expense of materials, loaded in a ladle for desoxydating and alloying steel, and also prognostication of chemical composition of metal in a ladle test.

By a criterion of optimality of serves a minimum as cost set of materials, providing implementation of all set limitations on chemical composition of steel, degree of oxidization of metal in a ladle, and also mass of gas and materials.

In calculations, executable the program «Master», stated factors are taken into account, having influence on mastering of elements from ferroalloys:

- is a temperature of metal before producing from a furnace and in a ladle after producing;
- is mass and chemical composition of metal, including the degree of its oxidization, before producing from a furnace and in a ladle after producing;
- is a cross-coupling of additions and content of one element on mastering and content of other elements;
- is mass and average chemical composition of slag, getting in a ladle;
- is chemical composition of the used materials;
- is a quantity and composition of gas, marking out in the volume of metal, taking into account hydrostatic pressure of fusion.

The program «Master» has an intuitional friendly interface, that to the allow to work with its for user effectively, leaning minimum theoretic preparation in area of metallurgy of black metals and informatics. In the program there are two regime of work interactive regime accessible only to masters of furnaces, and regime of the passive viewing of melting for all other users. The interactive regime is basic, with its help master executes next actions:

- is chooses a furnace and melting;
- is corrects if necessary an order on the brand of steel, setting steel ГОСТ (ТУ);
- is corrects if necessary the express-analysis of test of metal and temperature metal, if after the express-analysis of test of metal and measuring of temperature continued the intensive blowing out of metal;
- is optimizes the expense of materials, used for desoxydation;
- is imputs or corrects the expense of materials and virtually проплавляет them, getting the prognosis of chemical composition of the prepared metal here;
- is imputs remarks on melting;
- is accepts melting (brings information about melting in a database).

Interactive regime of work are accessible to master only for the active (id est not accepted) melting. After the acceptance of some melting (id est adding of information to the database) reflection of information about its possibly only in the regime of the passive viewing for all users, including masters of furnaces. In this regime an user can choose furnace melting; to man-hunt and viewing of melting on a temporal period, groups, brands and setting of steels, and also to masters; to optimize expense of materials used for desoxydating; to imput мате-риалы, virtually to

desoxydate a metal, get the prognosis of chemical composition of the ready steel. The user interface of the program «Master» is projected thus, that all its basic components were presented on a main form. The general view of main form of the program is brought on a fig. 1.

In the table of chemical compositions (pos. 1) there are a few lines, in which represented chemical composition of metal test, regulated by a standard overhead and lower limits of content of elements, prognosis of chemical composition of metal of ladle test and actual composition of ladle test from data of central chemical laboratory. All chemical compositions are measured in percents on mass.

The table of planned and actual factors of melting (pos. 2) serves for the reflection of brand steel, its setting and standard is ГОСТ or ТУ. Before producing, teems and rolling of melting in a table (in a column «Plan») are contained only planned factors of melting: brand steel, its setting and ГОСТ (ТУ).

Brand and setting steel master accepts to execution, however can them correspond some ГОСТ (ТУ). In this case planned ГОСТ (ТУ) mark by a grey color, and master gets possibility to choose a necessary standard from a «falling» out list. In addition, in the case of operative change of sequence of ordering fulfillment master has the opportunity to choose a brand steel and to look over all permissible settings and corresponding standards. At an interactive choice brands steel, setting or standard the program automatically calculates the optimal set of materials, if to this time data acted express-analysis tests of metal, containing the quantity of carbon and manganese at least.

A line of materials (pos. 3) is the multifunction element of form, consisting of six pour editing and reflections of mass of materials in kilos-grammes. As a result of optimization the optimal set of materials which are recommendation for master is represented in these fields. At a manual input or editing of mass of materials there is automatic virtual deoxyding metal in a ladle with the reflection of corresponding prognosis in the table of chemical compositions.

1 is a table of chemical compositions; 2 is a table of planned and actual factors of melting; 3 is a line with the edited fields for an input and/or reflections of optimal mass of materials; 4 is block of management; 5 is a panel of search of melting; 6 is a switch of furnaces; 7 is a temperature of metal; 8 is the last name of master, producing melting; 9 is a status line; 10 are remarks of master on melting; 11 is a chronometer (date and time)

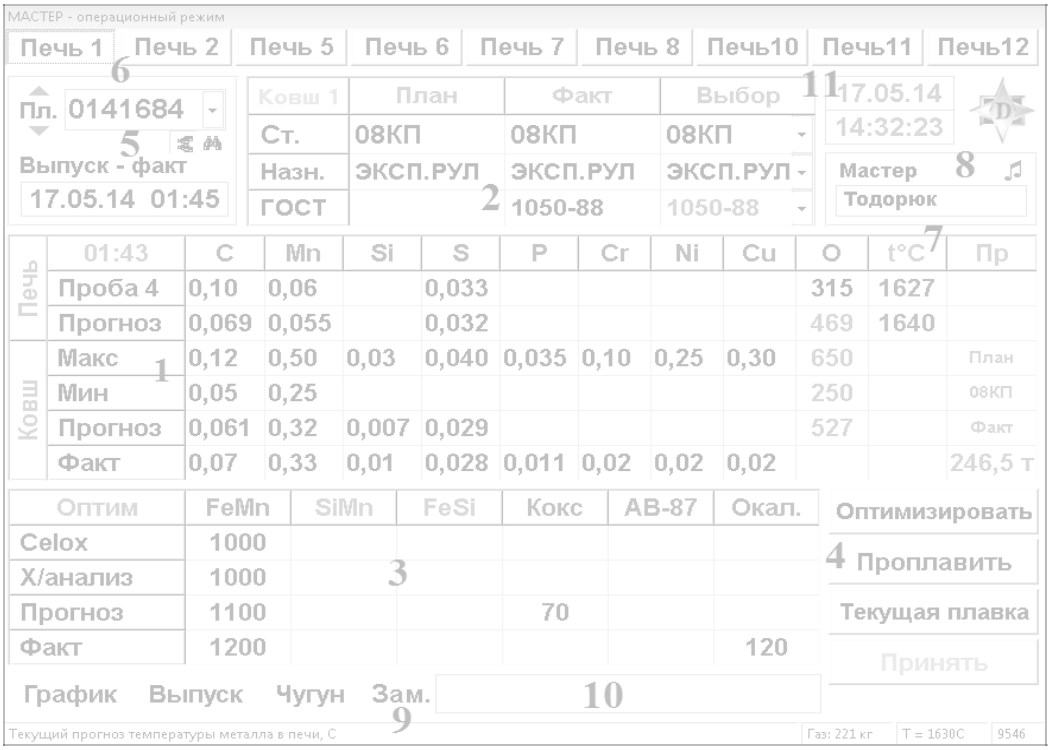

Figure 1 - Main form of the program «Master»

Block of management (pos. 4) contains the large buttons, by means of which master executes basic actions at work with the program. Combinations of «hotkeys» correspond some buttons.

The panel of search of melting (pos. 5) contains the «falling out list» of numbers of meitings, field for the reflection of date and time of producing of melting and button for the search of melting on the date of producing, groups and brands of steels, their setting and masters.

Depending on that, melting is produced or no, either fact or planned time of producing is represented. Accordingly the label of date and time of producing has text, «Producing is a fact» or «Producing is a plan».

By means of «falling out list» of melting (pos. 5) it is possible to represent information about any melting for the last two twenty-four hours. Accessible information about chosen melting thus is represented on a form. The regime of reflection of melting depends on that, whether this melting was accepted master or no.

In the regime of search of meltings it is possible to look over information about any great number melting for all the time of work of IPC with the use of simple and difficult кри-териев search.

IPC «Master» also has row of user facilities, such as visual control of the temperature-carbon regime on motion melting, control of quality and quantity of imputing the furnace flight cast-iron, conduct of bases given on main descriptions of melting with possibility of their viewing for previous periods with laying out on masters, groups, brands and setting of steels. All these functions are accessible to masters of all furnaces of martin workshop.

Prospects of development of instrument-programmatic complex. With the purpose of improvement of technical and ecionomy factors of martin workshop, expansions of its information infrastructures IPC is assumed «Master» to equip improvement pressductors and expense of natural gas and oxygen, that allow: exactly and for certain to control the expense of natural gas and oxygen on a workshop, on every furnace and brigade of

steelmakers with maintenance of data in a computer base; to reduce the specific expense of natural gas and mean time of melting due to more exact prognostication of chemical composition of liquid metal and its temperature in the period of polishing and on producing, and also optimization of the temperature-carbon regime of melting; to reduce the specific expense of ferro-alloys due to the decrease quantity of overblowns and middle degree of oxidization of metal on producing from a furnace; to reduce the percent of marriage of pig metal and percent of rejection of slabs, promote the output of suitable metal due to optimization of degree of oxidization of metal on producing from a furnace.

Conclusions. The use of IPC «Master» allows to get cost effectiveness due to optimization of expense of ferro-alloys and materials for desoxydating of simmer and semiquiet steel, and also decline of marriage of pig metal and enhanceable head clipping. The decline of marriage is arrived at due to stabilizing of degree of oxidizion metal and more exact prognostication of chemical composition of metal of ladle test.

REFERENCES

1. *Харченко*, *А. В.* Дифференциальные коэффициенты усвоения в компьютерных системах управления плавкой и внепечной обработкой стали [Текст] / А. В. Харченко, А. Г. Поно-маренко, С. В. Довгонюк // Металлургическая и горнорудная промышленность. – 2002. – № 10 (215). – С. 131-137.
2. *Казаков*, *С. В.* Прогнозирование состава стальных расплавов во время выплавки и вне-печной обработки [Текст] / С. В. Казаков // Металл и литье Украины. – 2005. – № 3-4. – С. 17-20.
3. Развитие интеллектуальных систем управления технологическими процессами выплавки стали [Текст] / *А. Г. Пономаренко*, Р. В. Синяков, С. В. Довгонюк и др. // Труды Седьмого конгресса сталеплавильщиков. – Магнитогорск, 15-17 октября, 2002. – М. : , 2003. – С. 293-297.
4. Разработка информационно-технологической системы «Форвард» для управления металлургическими процессами в реальном масштабе времени [Текст] / *А. В. Харченко*, А. Г. Пономаренко, С. А. Храпко, Е. Н. Иноземцева // Известия вузов. Черная металлургия. – 1991. – № 12. – С. 89-91.