

Steelmaking Method with Deep Air-Gas or Gas-Oxygen Mixture Blowing through a Steel-Tapping Hole

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Practical results of technology of steel-smelting bath blowing by air-gas or gas-oxygen mixture through uncooled spraying nozzle in the steel-tapping hole and opening tapholes without heavy hand work implemented at Rustavi Iron & Steel Works are summarized in the paper.

Keywords: DEEP BLOWING OF STEEL-SMELTING BATH, OXYGEN, NATURAL GAS

Results and Discussion

Bath deep blowing experiments were carried out at Rustavi Iron & Steel Works. After steel tapping, a special gas-oxygen spray head (**Figure 1**) is installed in the steel-tapping hole. Gunned material powder or refractory mixture covers this spray head, and gap between the spray head and hole is filled with refractory mixture from the back side of the furnace [1, 2]. The blowoff spray head is fixed on a steelmaking unit construction, and air or oxygen and natural gas starts blowing under pressure 3 and 2 atm. respectively. Heavy breakage and nonmetallic charge are put on a steel-

tapping hole with burning flame from the forward side of the furnace (open-hearth, two-bath, electric furnace, etc.) or from above. Prior to liquid slag phase formation, molten or cold iron is added in 10-15 minutes after charging. As the spray head is heating the molten part of metal charge straight from below, heat flows towards the forward wall of the furnace and molten steel vortex flows accelerate oxidizing reactions and promote bath melting, its boiling. In our experiments as well as in other processes, silicon is oxidated at once even prior to bath melting-down. And only traces of Si are specified in the first sample after melting-down in analysis of express laboratory.

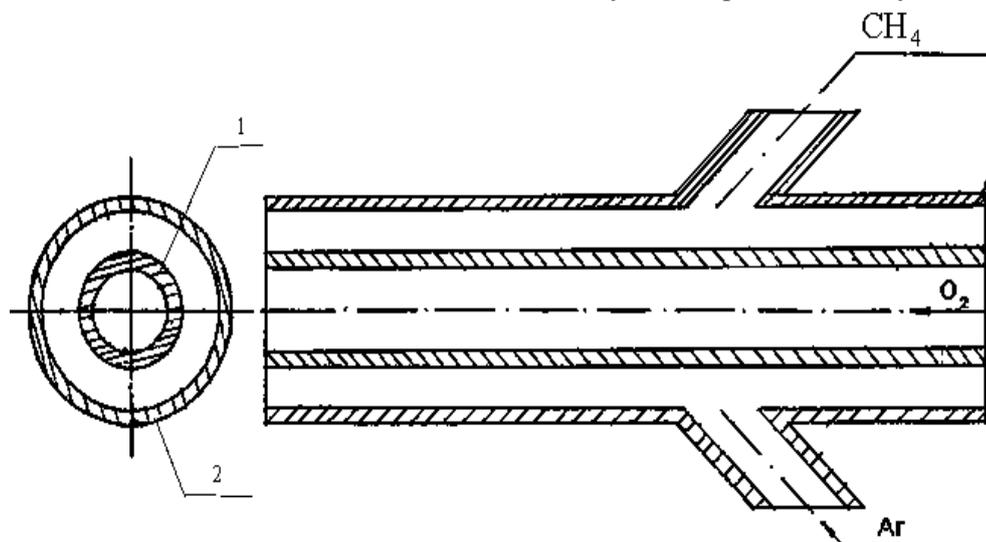


Figure 1. Gas-oxygen spray head: 1 - inner tube; 2 – outside tube

First slag is runoff from a slag hole from the back side of the furnace in the slag pan and second slag is formed in the furnace by addition of burned lime and bauxite. The basicity of slag is defined by following expression:

$$K_s = \frac{CaO + MgO + FeO + MnO}{SiO_2 + P_2O_5 + Al_2O_3} \quad (\text{Eq. 1})$$

For open-hearth and tandem furnaces $K_s \geq 2.3-2.5$. For electric steel furnaces $K_s \geq 3.0-3.5$. Impurities burn-out faster when air-gas or gas-oxygen mixture blowing. When blowing from the top by water-cooling tuyere or through the back wall, carbon is burning fast and tapping of high-carbon and medium-carbon steel is hampered.

Carbon behaves unusually at deep bath blowing through the steel-tapping hole. Carbon concentration did not change in several samples, but then sharply reduced.

Steelmaking experiments for pumping and compression pipes showed that after melting-down at 1500-1530 °C, carbon content grew from 0.56 to 0.64 %, and its content was 0.64 % at 1560 °C in three samples.

The specified feature of deep blowing allows tapping carbonaceous and medium-carbon steels under technological specification for steel quality improvement.

Deep blowing by air-gas, gas-oxygen mixture through the steel-tapping hole has the following advantages:

1. When blowing through the steel-tapping hole, flame is heating metal of bath and furnace bottom, furnace space is not overheated, which saves coal equivalent.

2. Acceleration of process of Si, C, Mn, S and P burning-out, reduction of melting duration in two times.

3. Mechanization of the most labor-intensive process of opening the tap hole.

4. Steel-tapping hole diameter does not change, which provides a normal metal tapping within 10-15 minutes.

5. Regular feeding of natural gas and oxygen despite strong bath boiling, it is possible to maintain carbon content at set level as long as it is required for metal boiling and heating.

6. Ecological condition is improved as compared to top blowing by oxygen spraying apparatus with water cooling since natural gas protects iron from strong charcoal fumes, and while dusty smoke goes through the layer of liquid

metal and slag, a great amount of dust precipitate in the liquid bath, particulate emission is diminished and recovery is increased.

7. Blowing through the steel-tapping hole is easier as compared to top blowing through the cooled lance

8. The specified features of carbon burning-out depending on temperature at metal blowing by gas-oxygen mixture through the steel-tapping hole were awarded a scientific discovery diploma.

Conclusions

An idea of new steelmaking method in steel-teeming ladle (ladle-furnace) was invented as a result of experiments on deep blowing through a steel-tapping hole and molten steel treatment by inert gases and slag-forming mixtures through sliding shutter of steel-teeming ladle. This method will increase productivity, combine processes of smelting, finishing, boiling and deoxidation of melt with out-of-furnace metal treatment - blowing by inert gases and slag-forming mixtures with improvement of industrial quality and ecological indexes.

References

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Способ выплавки стали с глубоинной продувкой через сталевыпускное отверстие газовоздушной или газокислородной смесями

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Приведены практические результаты технологии по продувке жидкой сталеплавильной ванны газовоздушной или газокислородной смесью через вставленную неохлаждаемую форсунку в сталевыпускное отверстие и открыванию лётки без тяжелого ручного труда, внедренной на Руставском металлургическом заводе.