Constructive and functional modernization of EAF

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Abstract. This article presents the main constructive and functional modernization of Electric Arc Furnace (EAF). Schwabe is the creator of UHP (Ultra High Power) EAF. We present in this article the optimal use of EAF power and time aspects. These two main factors determine the increase in the productivity of the Electric Arc Furnace. Electric arc furnace operation can be based on either the short arc (with high intensity and low voltage) or long arc version (with low intensity and high voltage). Introduction of vault walls and water cooled has resulted in major reductions in the consumption of refractory bricks from electric arc furnace. Another important technological evolution inserted in the process of elaboration of steel in electric arc furnace is lowering the temperature of the exhaust. Using a system of intensive oxygen insufflation during melting can get many technological advantages. Another constructive and functional modernization is EAF inflatable sealing device for retention of slug.

1. Introduction

The increasing delivery capacity of steel furnaces with converters as the twin goals of productivity increase and the regulatory process required reassessment of strategy (both in terms of quantity but especially in terms of quality) of all steel products [1], [2], [6], [7].

Electric arc furnace became able to take full advantage of higher aggregate scrap resulting from the processing of the metal or from the recovery, which has seen a series of greenhouse modernization. One of the most important breakthroughs in this field has been the shift to accelerate melting through the use of high power transformers.

W.E. Schwabe, creator of UHP (Ultra High Power) EAF, has the merit of being demonstrated the capability of electric arc furnace to produce larger amount of steel through the use of short bows, of great power and by applying a high index of power and use of time [3], [4].

2. About EAF Evolution

The optimal use of electrical power and elaboration time are the two main factors that determine the increase in the productivity of the electric arc furnace. Use of power (P_u) is reflected by the ratio between the average level of power integrated in various stages of thermal cycle ($\sum_{i=1}^{n} P_i$) and the maximum possible level of power (P_{max}) [5], according to the relationship (1)

$$P_u = \frac{\sum_{i=1}^{n} P_i}{P_{\max}} \cdot 100\,[\%] \quad (1)$$

Optimal use of electrical power is given by:

$$P_u = 80...90\% \quad (2)$$

Electric arc furnace operation can be based on either the short arc (with high intensity and low voltage) or long arc version (with low intensity and high voltage).

Functional improvements (technology) of electric arc furnace are conditioned greenhouse modernization construction of this aggregate.

Thus, the operation of the furnace with longer arcs with high power (high-voltage, medium intensity) was possible after the development and introduction of walls and vaults have been cooled with water.

Moreover, this constructive results in upgrading another technological improvement of the policy-making process in the electric arc furnace and reducing the consumption of the electrodes.

Also, the same type of modernization (introduction of vault walls and water cooled) has resulted in major reductions in the consumption of refractory bricks from electric arc furnace (figure 1, [2]).

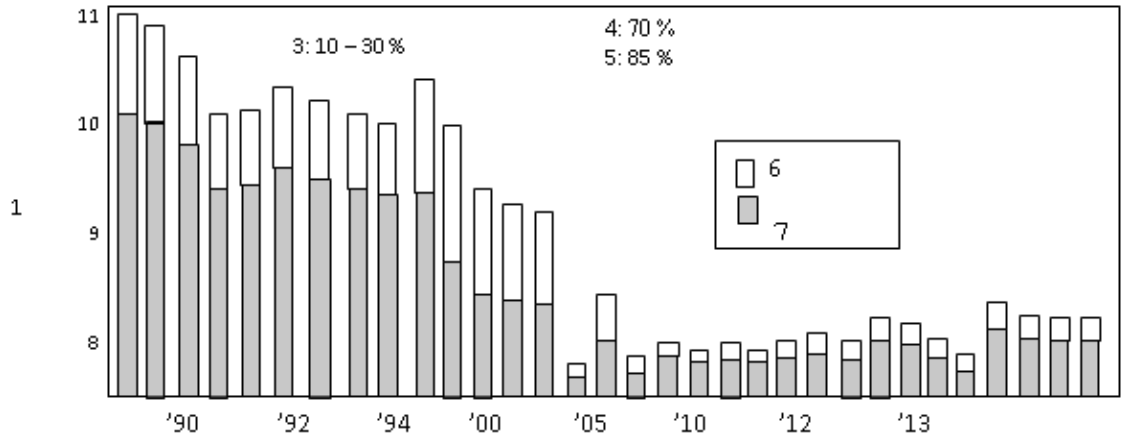

Figure 1. Reducing the consumption of refractory bricks after entering the vault walls and water cooled (ISCOR)
1 - use of bricks, kg/t; 2 - quarterly media; 3 - scrape walls with water-blocks of cast; 4 - scrape walls with water (KORF - FUCHS); 5 - arches are cooled with water (KORF - FUCHS); 6 - arches, kg/t; 7 - scrape walls, kg/t.

Specific power installed and the default operation of electric arc furnace at higher values of currents was conditioned by the increase, coupled with electrodes of siderurgy. In this area were carried out research both in terms of determining the driving technology of continuous baking furnace Riedhammer, including type of employment automation of baking in the oven, as well as for modernization of electrodes of siderurgy in baking ovens staple.

The main factors which is both siderurgy and electrode capacity efficiency economic and technical process of ripening, are:

- the thermal regime and the dynamic gas-oven baking;
- the correct and complete evacuation of volatiles of products subject to ripening;
- stripping and restoration without the baked electrodes in metal boxes of baking;
- preparing appropriate packing material;

- advanced mechanization difficult operations of technological flow of installation.

Another important technological evolution inserted in the process of elaboration of steel in electric arc furnace is lowering the temperature of the exhaust. This has direct implications for upgrading both the quality of steel produced and the efficiency of the regulatory process. Thus, steel produced has a lower content of gases ([O],[H],[N]), because the high temperature favors dissolving gases in steel. It also increases the productivity of the process of elaboration with 5...10% by shortening it, along with lower specific energy consumption (with 10°C reduction in temperature leads to exhaust a subtract with approx. 5 kWh/t of specific energy consumption).

The lowering the temperature of the exhaust requires preheat the container outlet (casting, VOD, cooker etc.) at higher temperatures. To this end, a team of scientists from the Institute for Scientific Research-ICEM Metallurgical S.A. Bucharest, laboratory of Fuel Economy and energy-L.E.C.E., conceived, designed, executed and experienced pilot and a wide range of different dimensions of recuperative burners for preheating and drying of casting ladles of iron and steel, with the following nominal thermal power: 63kW, 100 kW; 160kW; 250kW and 400kW.

There are also, nationally, a series of research in the field of regenerative burners. Taking into account energy efficiency regenerative combustion system, it is useful to study opportunities for the implementation of this type of burner in thermal intake facilities serving electric arc furnace.

Intensification of heat melting regime is another technological modernization of electric arc furnace. Research carried out in this area are mainly the following aspects highlighted:

- using a system of intensive oxygen insufflation during melting (approx. 15 m^3_N/h) you can get the following advantages:
  - increased productivity by about. 15t/h;
  - increasing the removal. 2%;
  - reducing the consumption of electric energy 25kWh/t.
- using oxy-fuel burners in the melting period is supported by the following test results:
  - maximum power burners 3MW;
  - natural gas flow rate: max. 300 m^3_N/h;
  - oxygen flow rate: max. 700 m^3_N/h;
  - technology: Bcc. 50% of the duration of melting, simultaneously with the electric arc;
  - economic efficiency: reduce specific energy consumption. 30kWh/t.

Excentric evacuation (by hearth furnace) and retention processes of slug constitute other greenhouse modernization construction and technological beneficial both in terms of quantity (increased productivity), and quality (high-purity of steel). Are successfully used in practice for closers for retention of slug, operated via electromagnetic detectors.

In Figure 2 we present schematic an inflatable sealing device for retention of slug.

The using of computer for management (optimization) process of steel is another level of modernization of the electric arc furnace. In this area, the world has been at the helm of the "on-line". Nationally, there were Council and develops research in this sector aimed mainly:

- electrical parameters measurement of the process;
- the study and determination of P-Q diagram;
- elaboration of the algorithm of electric system;
- determination of optimization of management system of melting.

Thus, in figure 3 we presents the evolution of specific electric power installed furnaces ("Danieli DANARC furnace") and comparative performance of different types of electric arc furnaces, and in Figure 4 is a new scheme presented electric arc furnace "Danieli" DC.

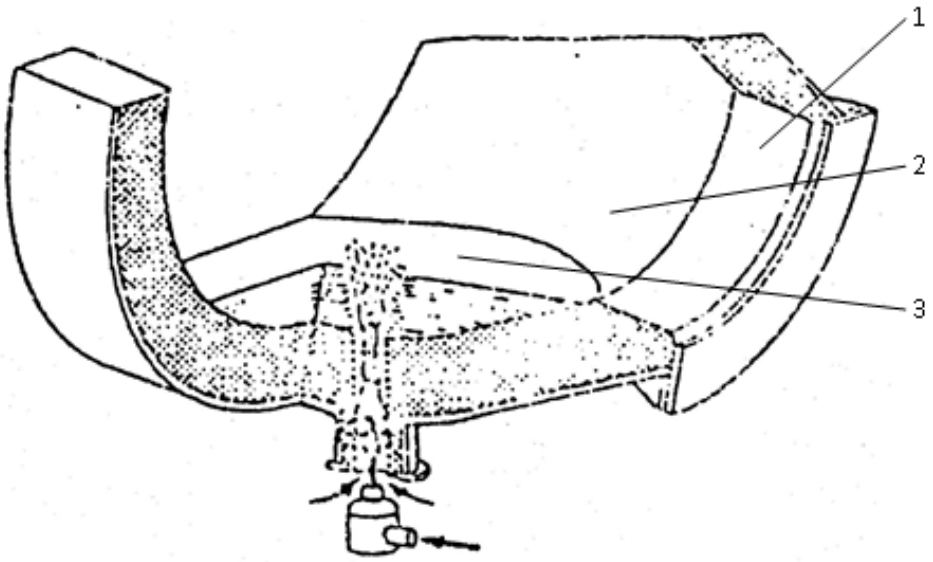

Figure 2. EAF inflatable sealing device for retention of slug
1 - Refractory lining; 2 - Metal bath; 3 - Device for retention of slug.

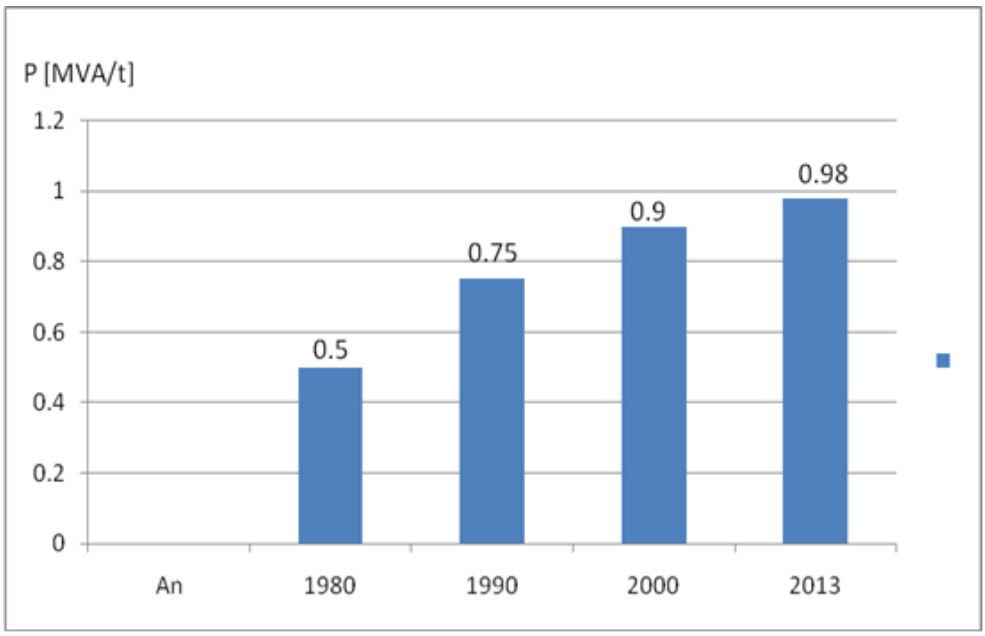

Figure 3. Evolution of specific electric power installed furnaces ("Danieli DANARC furnace").

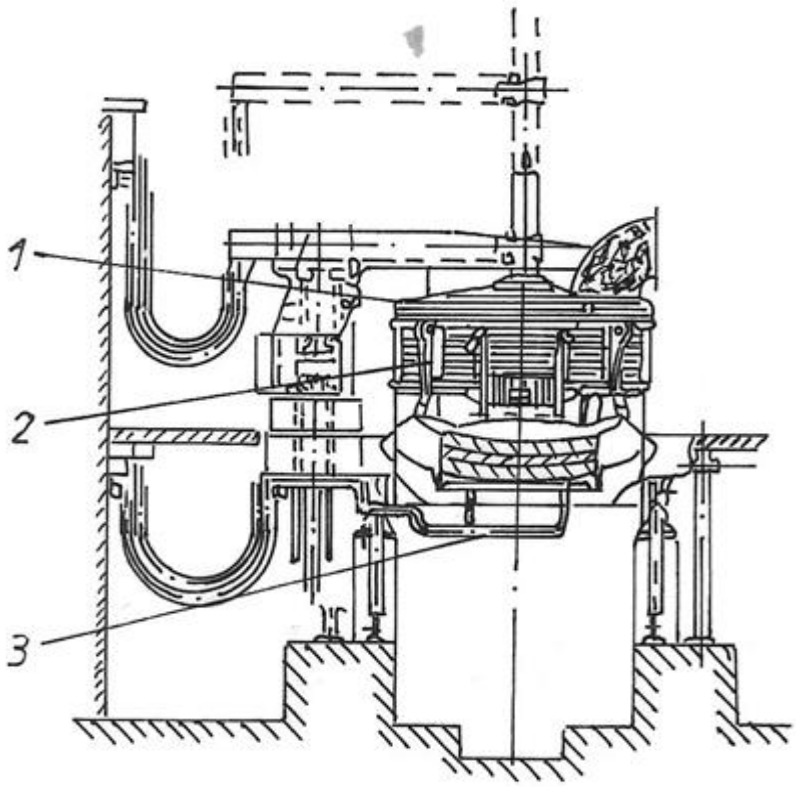

Figure 4. Scheme of EAF "Danieli" DC
1 - Chilled vault; 2 - Wall (panels) caught to cold; 3 - Installation of bulk materials supply.

3. Conclusions

Functional improvements (technology) of electric arc furnace are conditioned greenhouse modernization construction of this complex aggregate.

The most important constructive and functional modernizations of EAF are:

- Optimal use of electrical power and time of elaboration.
- Introduction of vault walls and water cooled.
- Lowering the temperature of the exhaust.
- Using of recuperative burners for preheating and drying of casting ladles of iron and steel.
- Using a system of intensive oxygen insufflation during melting.
- Using oxy-fuel burners in the melting period.
- EAF inflatable sealing device for retention of slug.

The using of computer for management (optimization) process of steel is another level of modernization of the electric arc furnace.

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