MODELS USED REFINING PROCESS MADE OF STEEL TREATED CLAY AND INSERT GAS

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Abstract: This paper presents issues related to the use in steel refining of specific computational models used in synthetic slag process. Thus, specific sizes have different views and different parameters that determine the effectiveness of secondary metallurgy operations, based on factors predictable flow patterns.

Keywords: synthetic slag, refining, calculation models

1. INTRODUCTION

Refining steels by treatment with synthetic slags and inert gas is a technological operation indispensable for quality requirements at high levels and reproducible, being either middle senior technology, which ensures the quality or an element of technology, integrated and realized a complex configuration of the equipment.

Name generally aggregates and technological equipment in this category, with the term metallurgical reactors, or units ladle, refining processes that realize are identified as complex physico-chemical processes in which they play an important role mixing processes; they are produced by the action of the flow of steel, and the induced turbulence developed and diffusion. From all this mixing by shaking, produced by bubbling the inert gas introduced through the lance or porous plug, play a major role in secondary metallurgy operations. Significant energy input to the system stirring and mixing slag-metal bath brings to the formation of vapors of metals used for various treatments deoxidation and desulphurization of the steel, such as calcium and magnesium. Analysis of flow regimes and those related blending and creates the possibility of identifying specific simulation processes, different models and getting consistent information about the behavior of real systems with extremely low cost and building predictive models, ballistic type, the development of refining processes, treatment of steels, including synthetic slag.

2. SPECIFIC SIZE AND PARAMETERS DETERMINING THE EFFICIENCY OF OPERATIONS LADLE, PREDICTORS BASED FLOW PATTERNS

Practical data that confirms the theoretical, have concluded that secondary metallurgy operations efficiently depends on the consideration of the following:

1. - regime movement velocity distribution of steel in ladle treatment (or metallurgical reactors considered) and movement speed values in certain points or areas thereof;
2. - feather development area in relation to the pot of treatment and pumping capacity of the steel, which has the area;
3 - flow type, macroscopically, initiated by the failure, in the pots of different sizes (particularly interested in the ratio between the height and the diameter of the ladle);
4. - death volumes appearance and weight (without service or with very poor circulation);
5. -influence the flow regime on various metallurgical reactions of clarification and of the particle entrainment and dispersion of slag in steel.

On the basis of this data is determined by mixing a reasonable time, with respect to thermodynamic parameters of the steel bath and the slag treatment (temperature and chemical composition), as well as some physico-chemical characteristics of these two phases, which depend on the parameters thermodynamic; Further, in terms of technological measures can be established solutions bubbling argon argued at controlled rates, the mode of introduction of inert gases through porous plug in the bathroom or lance injection, its location and duration of treatment, applied differently after goals and when possible. In all these issues play a major role dissipating module stirring gas into liquid steel pot to be treated, especially specific relatively large and very large flow of inert gases formation occurs when a specific area called wedge area, an area that is fundamentally consists of a suspension of gas and liquid steel per section uneven at different levels, known as three-phase area. It is interesting characteristics of this region, presented below.

3. CHARACTERICS OF THE AREA WEDGE

The characteristics of this area are indispensable for the study and evaluation of the mass transfer efficiency of the various refining processes and therefore have known the following:

a) - the distribution of speeds, number and size of gas bubbles in the wedge;
b) - scope (development) areas by steel bath;
c) - transmission capacity (called pumping) failure area.

These features must be expressed in terms of access to measurement parameters and have good technological relevance. The data set can be obtained by treating the problem in various ways, such as:
a) - the design and use of simple physical models for the study of flow processes [1], [2], [3], this distinguished model of cell movement within Mamut pump, developed by Bulson [3].
b) - dimensional analysis application in order to use models to achieve and to transfer measurement results thus obtained on an industrial scale [4], [5], [6], [7];
c) - flow calculations of areas on the Navier - Stokes, with appropriate boundary conditions established [7], [8], [9].

4. ESTABLISH PARAMETERS INFLUENCE BY VARIOUS METHODS AND MODELS

By using different methods and models have various relations resulting calculation, which includes representative factors influence relations presented below. They were established:

4.1. The calculation formulas of the parameters established by using empirical model of cell movement within Mamut pump. Relationships proposed treaty applicable to steel pot are:
1) - the height of cell free L, given by:

$$L = K\, H_0 \ln\left(1 + h_{im} / H_0\right) \tag{1}$$

where: K – is the coefficient equal to 0.32;
H_0 - steel bath height in meters;
h_{im} - immersion depth of the hole sparging porous plug or dart in meters; if porous plugs located in the bottom of the pot, $h_{im} = H_o$;
$D_c = 2r_c = (0{,}6 - 1{,}2)\, h_{im}$ - cell movement is the diameter in meters.
Cell velocities are given by the relations:

$$u_s = 1{,}79\,(\alpha \cdot g \cdot Q_{Ar})^{1/3} \tag{2}$$

in which the meanings of the parameters in equation (2) are the following:
us - velocity at the surface of the steel cell;
α - the coefficient of thermal expansion of argon, between the initial temperature T_o input (usually considered to 298.15 K) and the temperature of molten steel to be treated, T; $\alpha = T / T_o$;
g - acceleration due to gravity, 9.81 m/s^2;
Q_{Ar} - bubbling argon flow in Nm^3 / s;

2). $$\bar{u} = 1.46(\alpha \cdot g \cdot Q_{Ar})^{1/3} \tag{3}$$

where u is the average speed of the turbulence in the cell feature movement, and the meanings of notations are the same as those of the equation (2).

$$Q_0 = \bar{u} \cdot A \cdot \rho_0 = \bar{u} \cdot \pi \cdot D_c \cdot L \cdot \rho_0 \tag{4}$$

where: Q0 is steel mass flow through the cell of movement in t / s;
ρ_0 - density of liquid steel in t / m^3;
L - cell length in meters.

3). With this data, during a complete pass through cell movement steel (t) is:

$$\tau = M / Q_o, \quad \text{in (s)} \tag{5}$$

where M is the mass of liquid steel tons.

4.2. The calculation formulas obtained through experiments on large models, made using dimensional analysis. In these experiments water can be used as a liquid for forming the liquid steel at the temperature of 1580-1600°C.Using models with water at the appropriate scale, so the model size to scientifically obtained based on dimensional analysis, but large, so that flow processes are directly observable and recordable measurements were made that led to establishing relationships which enable real outcomes scale processes taking place in the ladle. These relationships are:

1). Speed upward axial gas suspension - liquid in the wedge

$$u_0 = 1{,}43\, p^{-0{,}21} \cdot W_1^{1/3} \cdot X^{-1/3} = 3{,}37\, Q_1^{0{,}25} \cdot X^{-0{,}12} \text{ (m/ s)} \tag{6}$$

2). The diameter of the ascending wedge area, which is considered the area extending from the central axis to the region where upward velocity decreases the value u_o / e (e = 2.30258, based on logarithms neperieni) is given by:

$$d = 0{,}45\, p^{0{,}375} \cdot X = 0{,}38\, Q_1^{0{,}25} \cdot X^{0{,}62} \text{ (m)} \tag{7}$$

3). The volumetric capacity of transport ascending wedge area:

$$V = 0{,}91 p^{0{,}54} \cdot W_1^{1/3} \cdot X^{5/3} = 1{,}52 Q_1^{0{,}55} \cdot X^{1{,}13} \text{ (m}^3\text{/s)} \tag{8}$$

In relations (6), (7), (8), meaning notation is:
g - acceleration due to gravity, 9.81 m / s^2;
X - vertical coordinate, measured from the bottom of the pot model in m;
Q_1 - volumetric flow rate of inert gas blown from the model, in Nm^3 / s;
$W_1 = g\,.Q_1$, dimensional group, called consistent size;
$p = g^{1/5} \cdot Q_1^{2/5} \cdot X^{-1}$, another group dimensional (size consistent).
To translate data from models with water at natural scale, are determined after substitutions dimensional analysis.

4.3. The liquid flow based on the Navier - Stokes, with boundary conditions.
In models in this category, to establish equations describing the flow of steel, the following simplifying assumptions:
a) - failure zone region is equated with the observable, that is visually detected turbulence region;
b) - the region of the zone until it is homogeneous and is the density $\rho = \alpha \rho_g + (1 - \alpha) \rho_1$, where α is the fraction of gas as bubbles in the steel, in the wedge, and ρg are the density ρ_1 of the inert gas and and that steel;
c) - is supported continuity speed and the amount of movement arching wedge section.

Accordingly, Navier - Stokes, for turbulent two-dimensional k-ε model with, are used to represent the flow of liquid steel areas, this process is considered to be due to the difference in density areas by region.

5. CONCLUSIONS

Knowledge of research models underlying steel refining processes based on mass transfer are most commonly derived from models describing similar processes in other areas. Their use in steel refining involves adjustments and simplifications, more or less conventional and acceptable as observations and measurements posed validation operations are not always possible and accessible directly.

The results obtained with different models are complementary as each class of models ensures correct or satisfactory resolution of a matter or class of problems specific to developing metallic materials with special destination.

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