COMPUTER AIDED FOR STEEL MANUFACTURING IN EAF

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Abstract: *The optimization management of steel elaboration in the electric arc furnace (EAF) is about the optimization of the functional and technological performances of this complex process. This optimization management is based on many principles. The most important are: the principle of analogy – consists in observing and analyzing competently the modelated reality, using both analogy with other fields of research and logical homology; the principle of concepts – is based on the sistems' theory, including feed-back concept; the principle of hierarchisation – consists of making hierarchical models systems, for structuring the decision and coordinating the interactive subsystems. This paper shows an original variant for optimization of the functional and technological performances of the electric arc furnace (EAF), using management elements by mathematic modeling of respective processes. The main results presented in the papers are based on the modeling flow chart of the EAF technological process, which is thoroughly described in the paper.*

Keywords: *Computer Aided, Steel Manufacturing, EAF*

1. General Introduction

Mathematical modelling of the electric arc furnace's processes for the optimization of the functional and technological performances of this complex unit is based on the next principles [1,2,3]:

A. The principle of analogy – consists in observing and analysing competently the modelated reality, using both analogy with other fields of research and logical homology. According to this principle, for mathematical models making were used the following steps:

- ***The modelated subject definition*** – represents the first phase of the modelation analysis. This step must satisfy both the purpose and the simultaneous system's aims, assuring their compatibility
- ***The effiency criterias definition*** – is a step imposed on the correct definition of the system's aims and allows the optimization of the modelling solutions
- ***Making the options*** – basing on accessing some realistically, *original and efficient solutions*
- *Choices evaluating* – related to the established efficiency criterias
- ***Choosing the final solution*** – based on the analysis between the different solutions of the modelling.

B. The principle of concepts – is based on the sistems'theory, including *feed-back* concept.

C. The principle of hierarchisation – consists of making hierarchical models systems, for structuring the decision and coordinating the interactive subsystems.

2. The Concept of the Block Diagram for the Modelling Sistem

It was conceived, based on these modelling principles, the block diagram for the modelling system of the electric arc furnace's respective processes, presented in figure 1.

The modelling system's central element of the EAF processes conceived consists of the system's *criteria function*. Knowing that the technological processes study for EAF is subordinated to high quality steel obtaining, the modelling system's criteria function (CF) is the ratio between *quality and price* [2, 4, 5]:

$$\mathbf{CF} = \left(\frac{\mathbf{QUALITY}}{\mathbf{PRICE}} \right)_{\mathbf{max}} \quad (1)$$

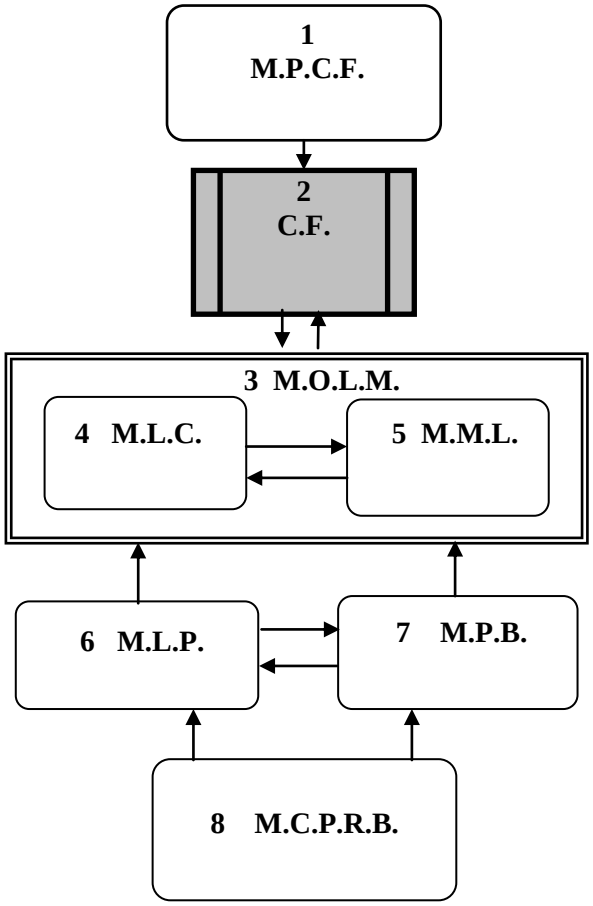

Figure 1: *The block diagram for the modelling system*

M.P.C.F. – Model Prescribing of Criteria Function; C.F. – Criteria Function; 3 – M.O.L.M.; M.L.C. – Model of Loading's Calculation; M.M.L. – Model of the Melting's Leading; M.L.P. – Model of Loading's Preheating; M.P.B. – Model of Reactive Powders' Blowing; M.C.P.R.B. – Model Designing Calculation for the Preheating's Recuperative Burners

The maximum of the criteria function (CF) is assured by its prescribing mathematical model (M.P.C.F.) [6, 7, 8].

The modelling system conceived for the EAF processes is composed of six subsystems, represented by the following mathematical models:

- The mathematical model of prescribing the criteria function (M.P.C.F.)
- The mathematical model of loading's calculation (M.L.C.)
- The mathematical model of the melting's effective leading (M.M.L.)
- The mathematical model of loading's preheating (M.L.P.)
- The mathematical model of reactive powders' blowing (M.P.B.)
- The mathematical model designing calculation for the preheating's recuperative burners (M.C.P.R.B.)

3. Results and Conclusions

The mathematical model of prescribing the criteria function concept consists of transforming the criteria function (CF) in quality-economical matrices M_{QE}, as in the scheme presented in figure 2.

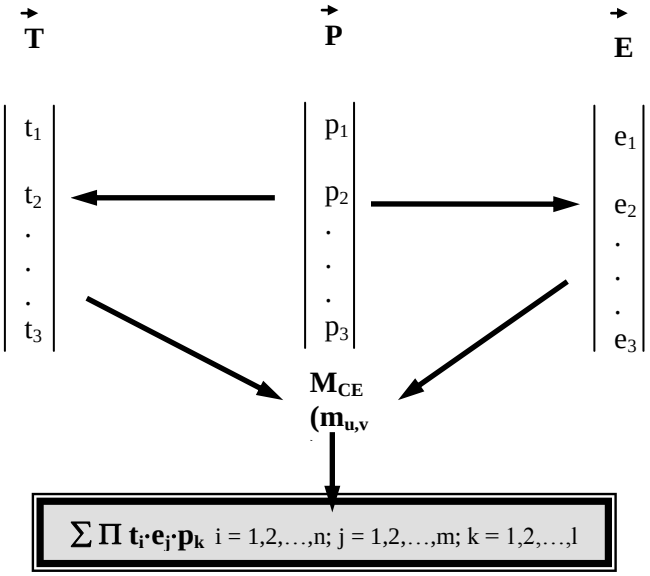

Figure 2: *The modelling system's criteria function's evaluation*

$\overline{T}$ *vector – technical parameters' vector* (t_i); $\overline{E}$ *vector – economical parameters' vector* (e_j); $\overline{P}$ *vector – weight vector* (p_1)

The levels of prescribing the criteria function can be obtained by using a composition algorithm for three vectors:

- $\overline{T}$ vector – technical parameters' vector (t_i);
- $\overline{E}$ vector – economical parameters' vector (e_j);
- $\overline{P}$ vector – weight vector (p_1)

The components of two vectors $\overline{T}$ and $\overline{E}$ witch are considered to have important weight in the criteria function's evaluation are:

- t_1 – the steels chemical composition;
- t_2 – the steels purity (in gases);
- t_3 – the steels purity (inclusions);
- e_1 – the specific consumption of basic material and materials;
- e_2 – the specific consumption of energy;
- e_3 – the elaboration process's productivity in EAF.

The values for the components of the 2 vectors were attributed on a relative scale, witch had a saw reference level a best level, as in the followings:

- NO = value 10
- NO ± 10 % = value 9
- NO ± 20 % = value 8
- NO ± 30 % = value 7

...

- NO ± 100 % = value 0.

The best level (NO) for each component of the 2 vectors is:

- for t_1 – the prescribed variation limits of the elaborated steel quality composition arithmetical mean;
- for t_2 – the minimum prescription of the gas content;
- for t_3 - the minimum prescription of the inclusion content;
- for e_1 - the minimum content specific consumption prescribed of basic materials;
- for e_2 - the minimum prescribed specific energy consumption;
- for e_3 – the maximum prescribed productivity of the elaboration process;

The correlation between the criteria function's (C.F.) prescribed levels and T vector's components' variation (figure no. 3) and respective the E vector's components' variation (fig. no. 4) are presented in figure no. 3 and 4.

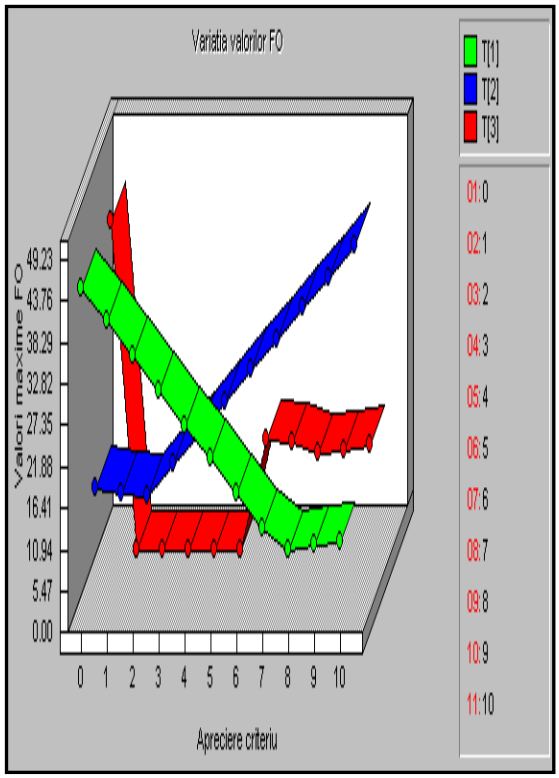

Figure 3: *The correlation between the criteria function 's (CF) prescribed levels and the T vector's components' variation (t_1, t_2, t_3)*

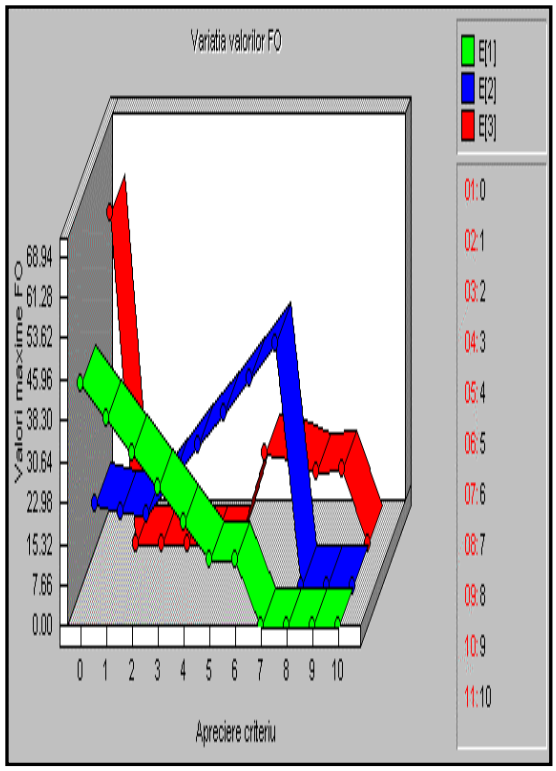

Figure 4: The correlation between the criteria function's (CF) prescribed levels and the E vector's

The cumulated correlation between the criteria function's (C.F.) prescribed levels and T and E vectors' variation is presented in figure no. 5.

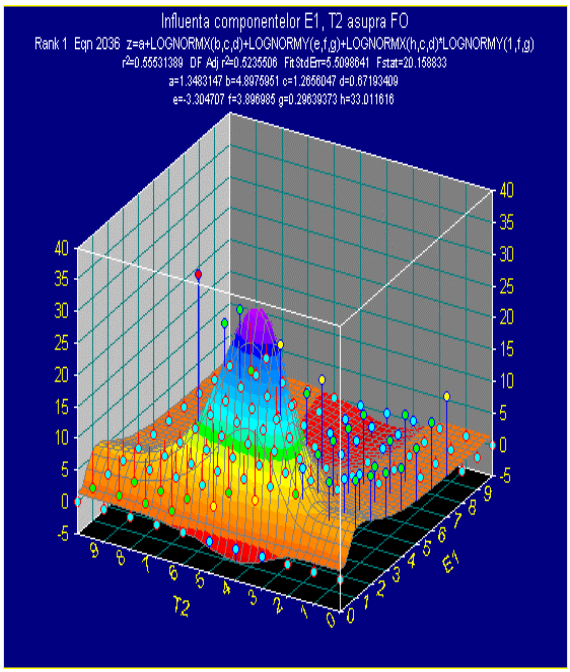

Figure 5: *The cumulated correlation between the criteria function's (CF) prescribed levels and T and E vectors' variation.*

You can notice the obtaining of:

- The criteria function's maximum level $FO_{T,max}$ = 43,76 for the T vector's variation (t_1 component - the prescribed variaton limits of the elaborated steel quality composition arithmetical mean);
- The criteria function's maximum level $FO_{E,max}$ = 55,31 for the E vectors' variation (e_3 component - the maximum prescribed productivity of the elaboration process);
- And respective the criteria function's maximum level $FO_{CUM,max}$ = 19,85 for the T and E vectors' cumulated variation.

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