ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VII (XVII), 2008

ELECTRIC ARC FURNACE'S TECHNOLOGICAL PROCESSES MANAGEMENT

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ABSTRACT

The paper presents the main principles for the optimization of the functional and technological performances by mathematical modelling of the electric arc furnace's processes (EAFP).

These principles are based on the classification of the functional and constructive options for the electric arc furnace's charge preheating plants.

The classification's most important criterion is the proceeding's technical-economical efficiency.

The main scope of the paper is to validate an original mathematical model for the electric arc furnace (EAF) functioning optimization.

KEYWORDS: Management, EAF, Mathematical Modelling.

1. TEORETICAL GROUNDS

The original optimization mathematical model [1] of the electric arc furnace's charge preheating process mainly takes into consideration two thermo-technological aspects:

- The heat transfer between fluids and particles and
- The heat transfer between the fizz layer and an exchange surface.

According to the energetic balance at the gaseous environment level, the conductive transfer model is also analysed through the finished elements method.

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

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

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

B. ***The principle of concepts*** is based on the systems' theory, including the ***feedback concept***.

C. The principle of hierarchisation consists of making a hierarchical models system, for ***structuring the decision and coordinating the interactive subsystems***.

2. THE CONCEPT OF THE BLOCK DIAGRAM FOR THE MODELLING SYSTEM

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 [4], the modelling system's criteria function (CF) is the ratio between ***quality and price***:

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

The maximum of the criteria function is assured by the mathematical model of prescribing the criteria function (M.P.C.F.)

The mathematical model of prescribing the criteria function concept consists of transforming the criteria function (CF) in a ***quality-economical matrix M_{QE}***, as in the scheme presented in figure 1.

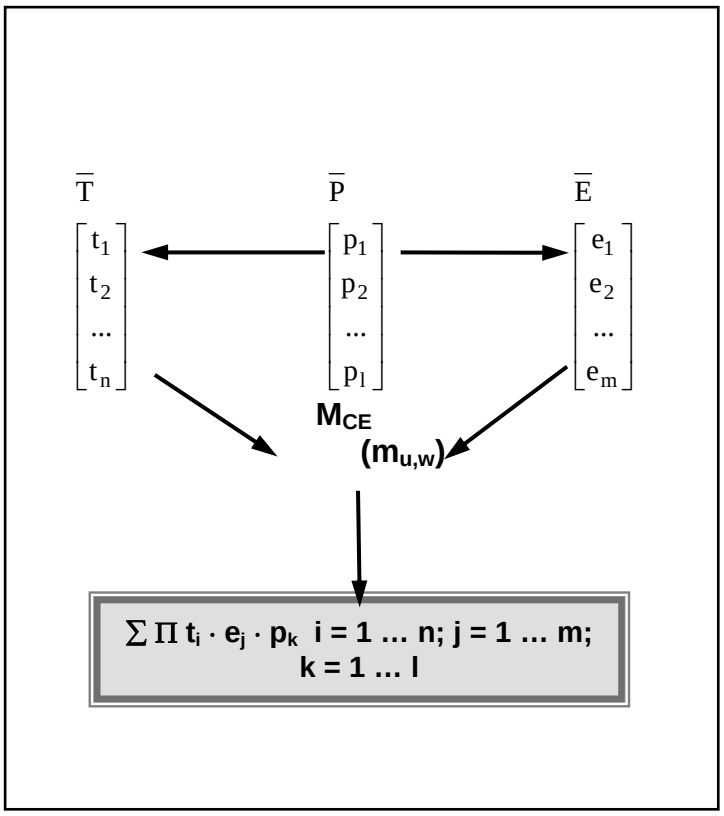

Figure 1. The modelling system's criteria function's evaluation

The levels of prescribing the criteria function could be obtained by using a composition algorithm for three vectors [5]:

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

In figure 2 there is presented the general logical scheme used for the EAF's charge preheating.

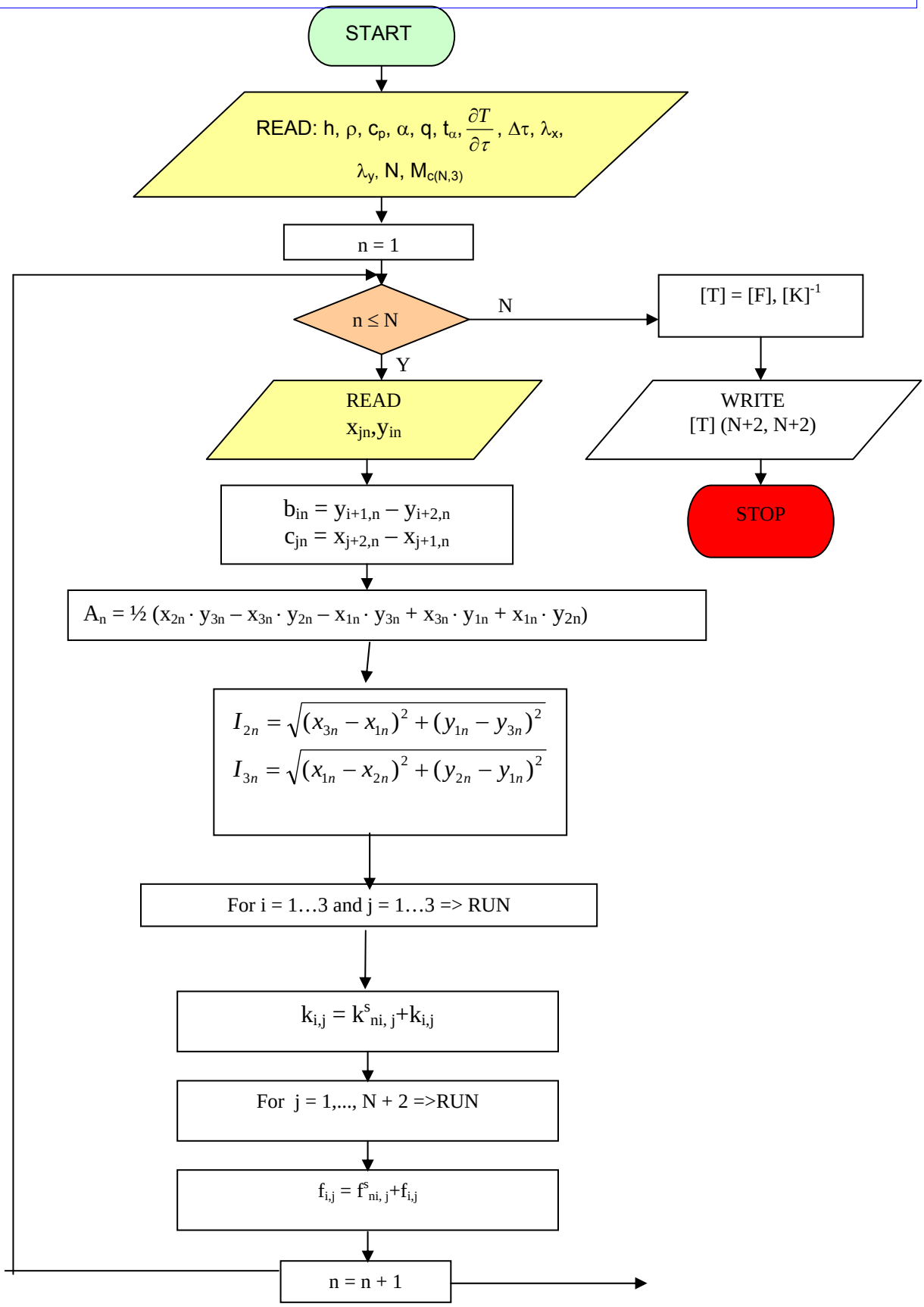

Figure 2. The general logical scheme

3. RESULTS AND CONCLUSIONS

The correlation between the criteria function's (C.F.) prescribed levels and the $\overline{T}$ vector's components' variation is presented in figure 3.

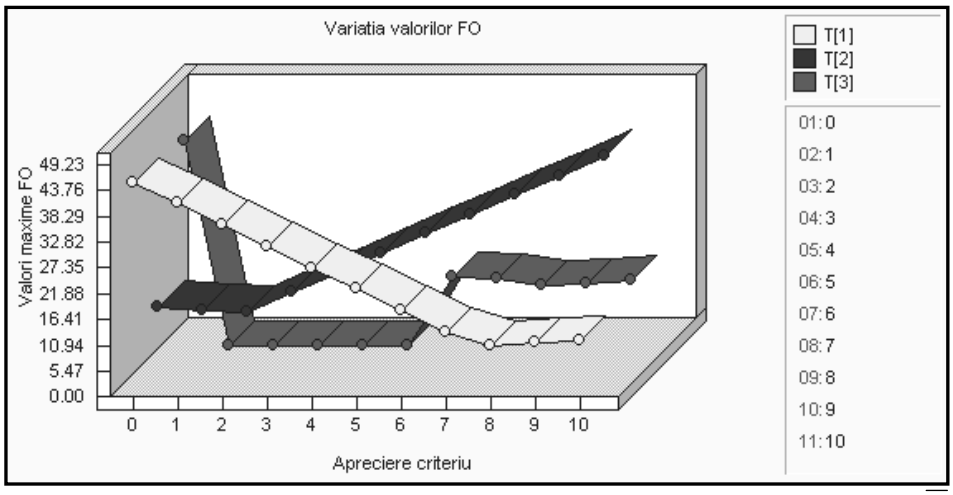

Figure 3. The correlation between the criteria function's (CF) prescribed levels and the $\overline{T}$ vector's components' variation ($\overline{T}_1$, $\overline{T}_2$, $\overline{T}_3$)

In figure 4 there is presented the scheme of the grid used for the EAF's charge preheating modelling.

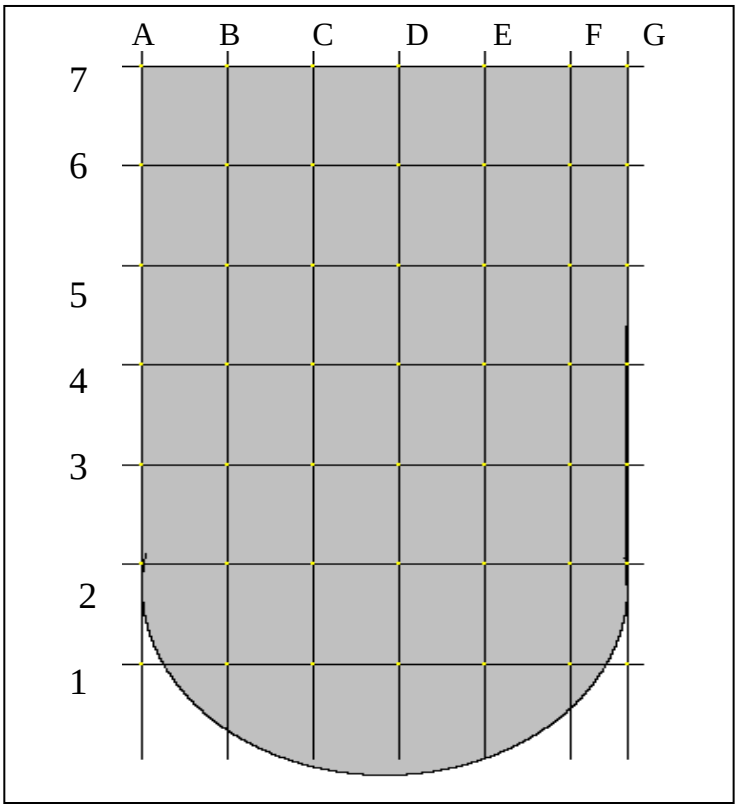

Figure 4. The grid scheme

The executions of the EAF's charge preheating modelling (CPM) were made both for a 10t EAF (figure 5 a, b, c) and for a 50t EAF (figure 5d). It was considered to be a load with medium permeability ε = 0.45.

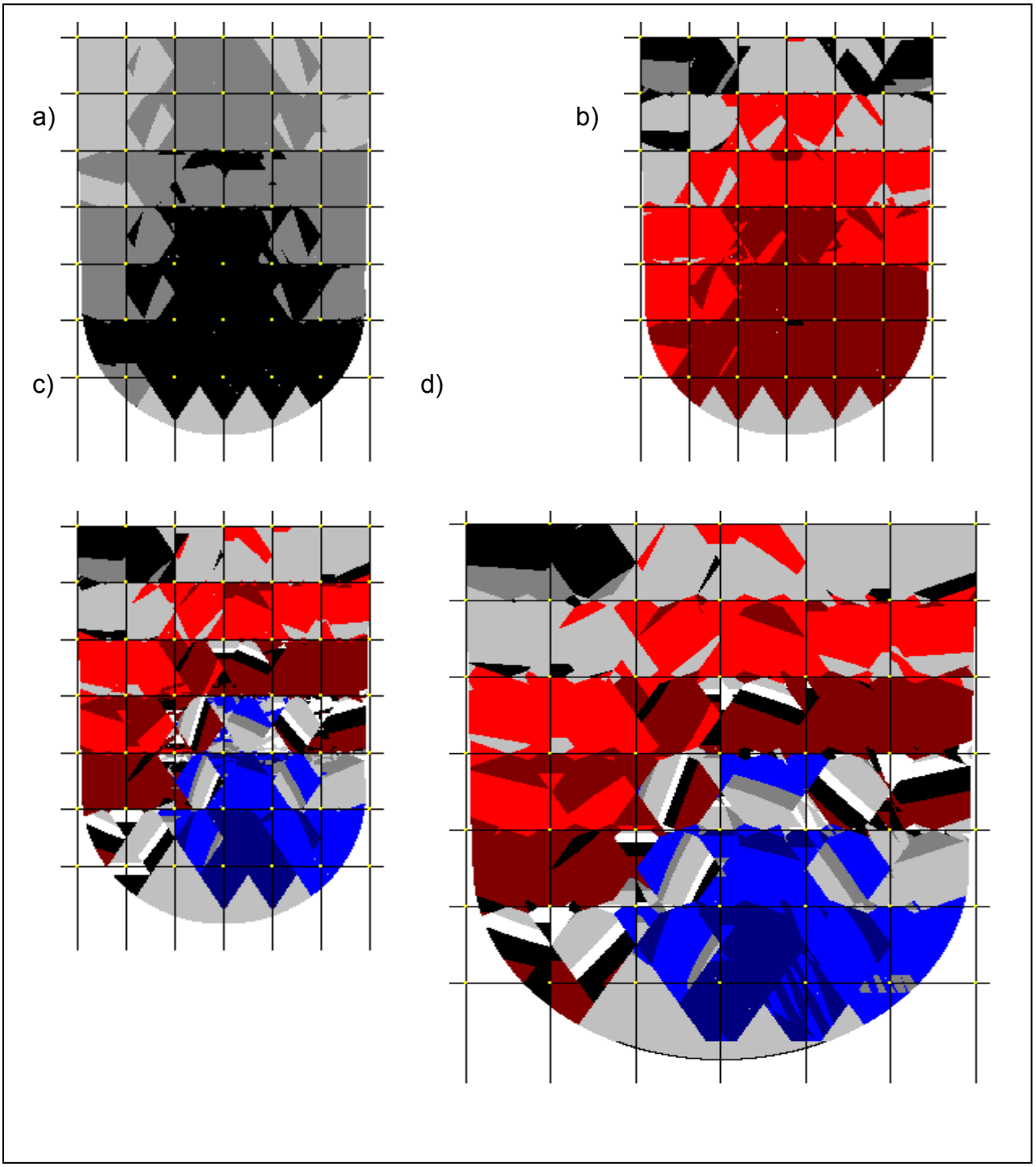

Figure 5. The main CPM's results

The thoroughly analysed preheating (including from the descriptive point of view) process's steps were established at the moments: t_1 = 15 min; t_2 = 30 min; t_3 = 45 min; reported to the process's start (t_0 = 0).

At the moment t_1 = 15 min, the CPM execution's results show the load's

temperature gradient minimum – maximum of 145^0C – 330^0C, which corresponds to a preheating speed between the 580^0C/h-1320^0C/h limits. The temperature's distribution in the longitudinal section shows a superior temperature zone.

ACKNOWLEDGEMENTS

The author are grateful to the managers and the technical specialists of "THE SPECIAL STEEL COMPLEX" Târgoviste (C.O.S.T) for their collaboration in the experimental measurements.

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