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Lenuţa Suciu, Iancu Tătucu, Vasile Suciu

Numerical Model with Finite Elements of the Steels` Thermal Transfer which are Submissive to the Warm Thermal Treatments

This paper presents the numerical model with finite elements applied to the thermic transfer`s study, to improve the technological properties of the steels submissived to the thermic treatments in industrial furnaces.

Keywords: *finite element, steels, thermal transfer, treatments*

1. Introduction

Among the physical, mechanical and technological phenomena's which participates to obtain some products through plastic deformation of high quality is also the way in which the initial semi-products, also the steels which were warmed in the furnaces which are used in the respective departments.

The improvement of the semi-products warming process is tightly hold with the knowledge of the complicated phenomena of the thermal transfer which takes place in the working space of the furnaces. The warm flux control broadcast to the piece can be made in conditions in which can be obtained the necessary and exactly information regarding the temperatures camp evolution inside the furnace.

Actually this information is taken from directly measures of the temperature with the help of the thermocouples in the precise points of the working spaces. Generally, these measures are proved to be insufficient for the thermal transfer improvement to the piece. The previous considerations gave the idea of the study of the thermal transfer at the steels` warming, from another point, from the research techniques - the simulation of the thermal process.

2. The thermal transfer's fundamentals in the industrial furnaces

According to the followed aim in this study, we will refer to the warm transfer inside the working space of one's furnace to the piece submissive to warm. This thermal transfer can take place through conduction, through convection with

forced or natural circulation through radiation from warm surfaces or from gas, or more than that, from more of this ways in the same time.

We are talking about a thermal transfer through conduction when we refer to the transfer inside the material or when the piece is warmed, directly supported on the furnace's hearth. The convective transfer is present in every furnace. Really, the product which is going to be warmed is always rounded by a specific gas (air, burnt gases, protector gas, reactive gas) without the furnaces which works with vacuum, at which the thermal process take place in a empty space

3. Numerical methods to treat the thermal transfer's problems

The method of the finite element is a method used a lot of times in the engineer study, because it says and estimates the properties of one product from the deformations` point of view, of the tensions which appear during the thermal treatments. After making the mathematic model which describes a certain process sit appears the problem of the way in which that model can be solved. There are two methods of solve:

- Analytical
- Numerical

From analytical methods we understand those methods which show the solutions through algebraic relations, powers series, transcendent functions and others. These solutions are obtained through mathematic relations as: variables separation, co-ordinates changes, solutions` superpositions, improvement in series, etc. the analytical solution are expressed as usual in general form, their particularization is made through the initial and the frontier conditions.

The obtained analytical solutions for many thermodynamic gas processes ask a exactly bounder like the differential equations` straight; for example the material's properties are supposed to be independent from the temperature. Also these solutions supposed as usual a regular geometry.

Not like the analytical solutions, the numerical solutions are obtained through arithmetical calculations, as numerical values, for each application in part.

Because the differential equations which describe thermodynamic gas processes are not straight, are preferred the numerical solutions. It has improved a lot of numerical methods for solve of the differential equations. The essence of these methods is to obtain a system of algebraically equations, usually straight, which estimates the solution of the initial differential equations.

The unknowns of the given system are the values of the searched function in the one discreet net-knots, which estimates the integration domain.

The differential equation system can be solved with two methods:

a) obtain a equation with finite difference, This can be made through:
   - using an improvement in Taylor series;
   - integrate on a finite control volume;
   - apply a variation principle.

b) the method of the finite elements which are based on a complete model of the studied phenomenon.

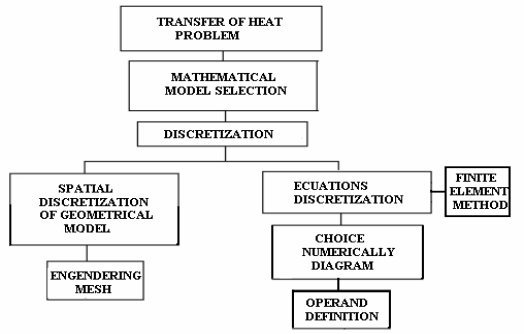

Figure 1. The structure of a numerical simulation

In the engineering, the applications of the finite elements` method can be classified in three problems classes:

- *The stability and stationary regime problems,* in which the unknown function or functions are independent of time. Here can be, for example, the study of elastically behavior of the elements which are in a static regime, problems of warm transfer in stationary regime, the study of stationary regimes of fluids` running, etc;
- *The own values problems,* in which the parameters are also independent of time and in which can be determined some critical values of the parameters as long as the equilibrium configuration is respected;
- *The propagate and transitory regime problems,* in which the unknown functions are dependent on time. An example can be the warm transfer in a transitory regime.

Considering the particular case of the warm transfer problems and taking into account a thermal system made by one or more solid elements, which are in energetically interaction with an ambient environment, we can synthesize the following problems which can appear:

- *The estate problems.* Are known information about the structure and physical properties of the analyzed elements, but also the way of interacting of the system with the ambient environment. It is followed to determine the temperature distribution, so the estate of the certain thermal system;
- *The interaction problems.* Are known information about the structure, physical properties of the analyzed elements and the temperature distribution in the system. It is followed to determine the energetically; interaction of the system with the ambient environment, also the warm transfer from/ to the previous one;

If we do not have the necessary information for the problem's reformulation, these are going to be supposed after a previous experience. With the help of the obtained solu-

tions can be examinated the information initially supposed, and if it is necessary the calculation will be taken again with new information.

The most of the times, the type of the finite elements which are going to be used appear from the type the problem which should be solved and the analyses domain structure of it in a large sense; the finite element appears as an estimate model with physical, geometrical land functional properties. From the geometrical point of view, the finite element reproduces in an idealized form the parts of a real element submissive to analyze. It has dimensions and can be attached to it physical properties as: density, viscosity, elasticity, thermal conductivity, etc taking into account the followed purpose.

4. Conclusion

The study of the warm transfer in all three known forms : conduction, convection and radiation purpose to emphasize the physical effects associated to heat and to improve the scientific analysis methods which, not every time exactly, gives information bounded on the performance or projection of one system or process.

The engineer objectives about the heat transfer can be said as:

- Determine and assure the quantity of heat transfer in the time unity between two systems at the specified temperature;
- Determine and assure the distribution of the temperature which might be compatible with the surety norms in exploitation and work protection;
- Choose the methods and proceedings of intensification or brake of the energy transfer as a heat form.

References

[1] Frunzăverde, D. – *Tratamente termice,* Editura Intergraf, Reşiţa, 1993.

[2] Suciu, L, - Modelarea şi simularea proceselor tehnologice, Referat nr.3, Teza de doctorat, Timişoara, 2006

[3] Tatucu, I., - Modelarea câmpului electromagnetic şi a câmpului termic – Editura Eftimie Murgu, Reşiţa, 2002

Addresses:

- Assist. Dr. Eng. Lenuţa Suciu, "Eftimie Murgu" University of Resita, Piaţa Traian Vuia, nr. 1- 4, Reşiţa, ilesuciu@yahoo.com
- Assoc. Prof. Dr. Eng. Iancu Tătucu "Eftimie Murgu" University of Resita, Piaţa Traian Vuia, nr. 1- 4, Reşiţa, i.tatucu@uem.ro
- Eng. Vasile Suciu "Eftimie Murgu" University of Resita, Piaţa Traian Vuia, nr. 1- 4, Reşiţa, vasisuciu@yahoo.com