PHASE TRANSITION OF FIRST ORDER AND CONTAT HEAT TRANSFER IN CASTING

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Abstract: *Based on the finite element method, the Stefan-Schwartz problem in micron size is solved in the estimation of contact heat exchange in the foundry. The dimensions of the contact spots are minimal, but using a good computing network it has proved possible to consider contact heat transfer processes. A temperature field in the area of complex geometry of the contact surface was obtained. A casting / mold temperature jump with perfect contact was also obtained.*

Keywords*: STEFAN-SCHWARTZ TASK, CONTACT HEAT EXCHENGE, SMOOTHNESS OF THE SURFACE*

1. Introduction

The boundary condition at the working surface of the casting mold is:

$$\lambda_C \nabla T_C(x,y,z,t) = \alpha_{C|M}(t)(T_C - T_M) = \lambda_M \nabla T_M(x,y,z,t), \quad (1)$$

where λ_C, λ_M are the coefficients of thermal conductivity of the cast material and that of the mold; T_C, T_M are the non-stationary temperature of the 3D cast/mold system; $\alpha c|m$ is the coefficient of contact heat exchange; $T_C - T_M$ is the temperature difference on both sides of the ideal contact surface. On Figure 1 is geometry of the our 3D system cast/mold:

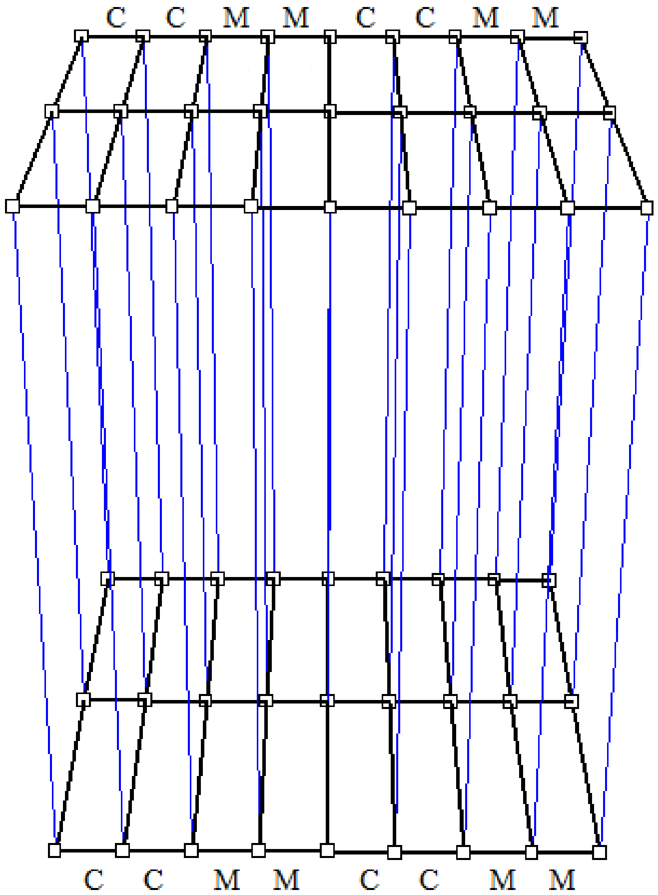

Fig. 1 *Geometrical idea for modeling: C are finite elements of the cast; M are finite elements of the mold.*

Figure 2 illustrates the intricate contact surface between the cast and the mold:

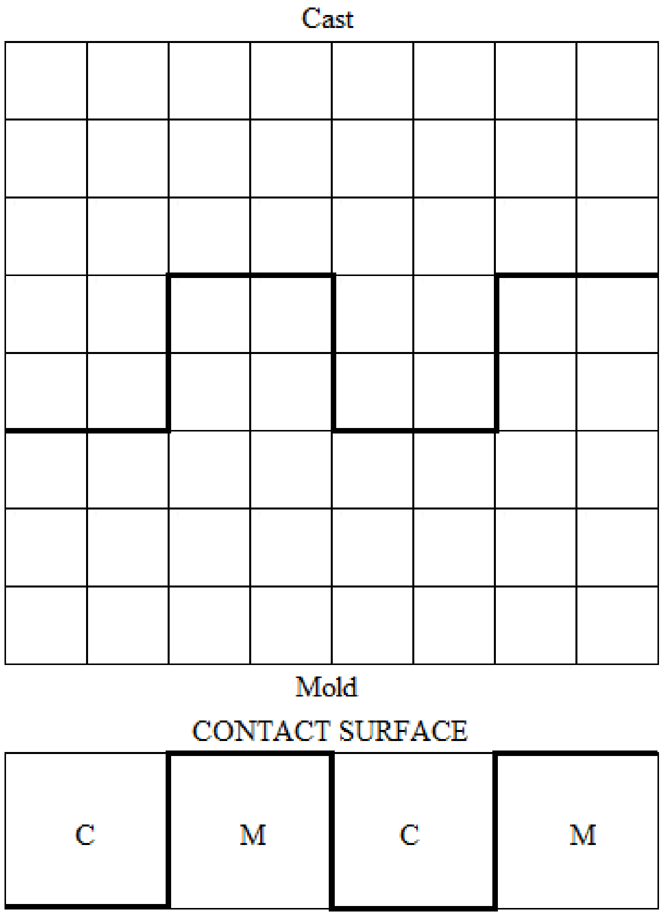

Fig. 2 *Idea for contact surface between cast and mold*

The numerical experiments for the Stefan-Schwartz problem are presented on a fragment of the 3D system considered to be a cast mold. The overall dimensions of the system 8x8x18 in μm. The dimensions of a finite element is microns.

A continuation of Figure 2 is Figure 3 where are shows the dimensions for demonstrating the numerical results by temperature field of the finite elements at the contact surface (see Figure 2):

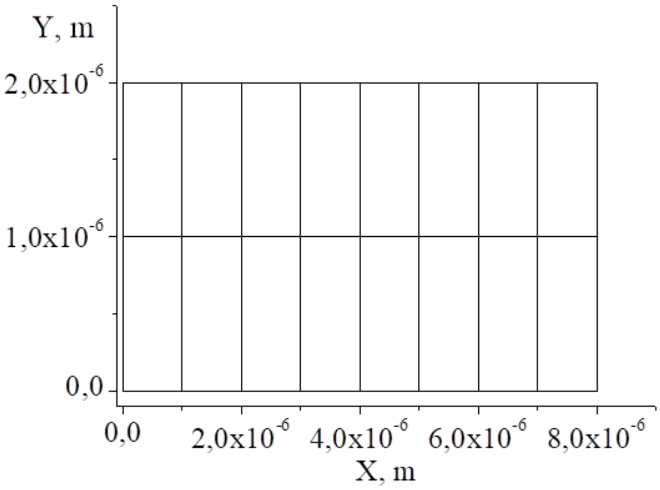

Fig. 3 *Finite elements at contact surface between cast and mold (see Fig. 2).*

The figure 4 shows the numbers of each point of the every finite elements in contact:

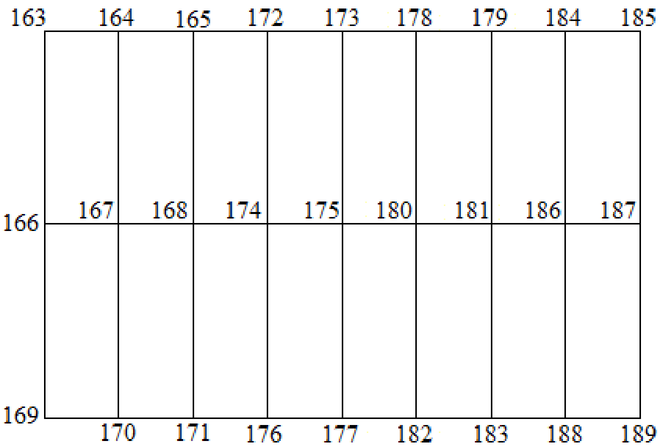

Fig. 4 *The numbers of the each point of the every finite elements.*

The purpose of this work is to represent the temperature field at a complex contact surface [1, 2, 3] and theory [4, 5] and [6, 7].

2. Numerical results of the Stefan-Schwartz problem in contact heat exchange

A temperature field is represented by two temperature curves in each finite element on the figure 5:

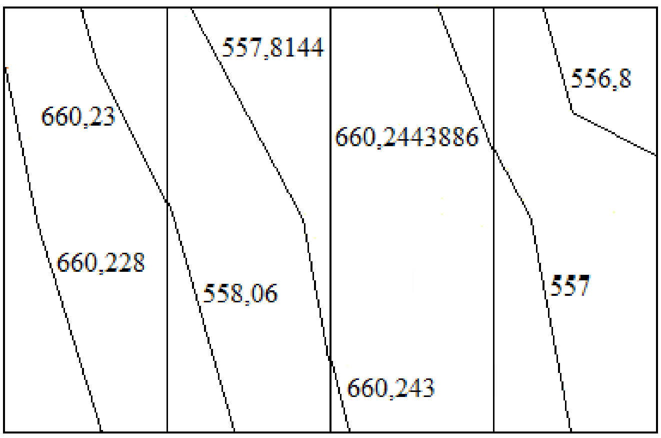

Fig. 5 *The numbers of the each point of the every finite elements.*

The temperature field indicates the temperature gradient; and the temperature jump at any point of contact.

The follow figure 6 present the calculated temperatures at each point of the demonstrated system the most important basic information:

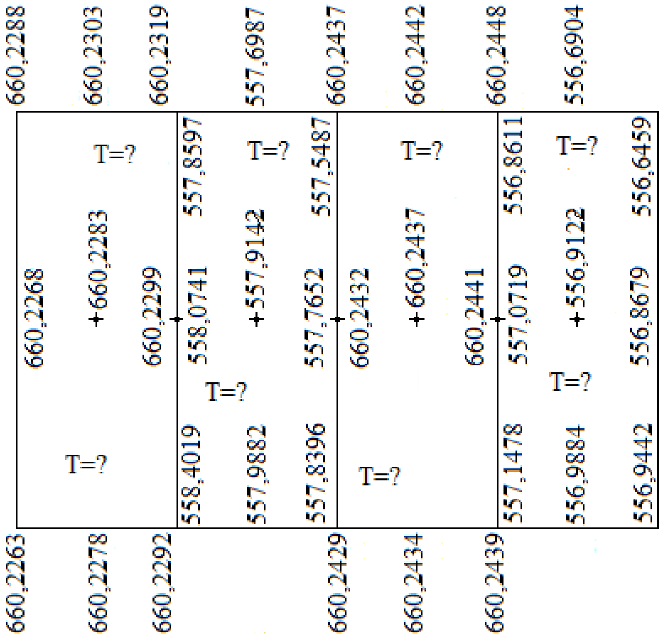

Fig. 6 *Temperatures of the each point of the every finite elements – the most important basic information. The notation T =? are the temperatures obtained for the corresponding curves (see Figure 5).*

The last figure 7 shows the temperature field in the area of the contact surface:

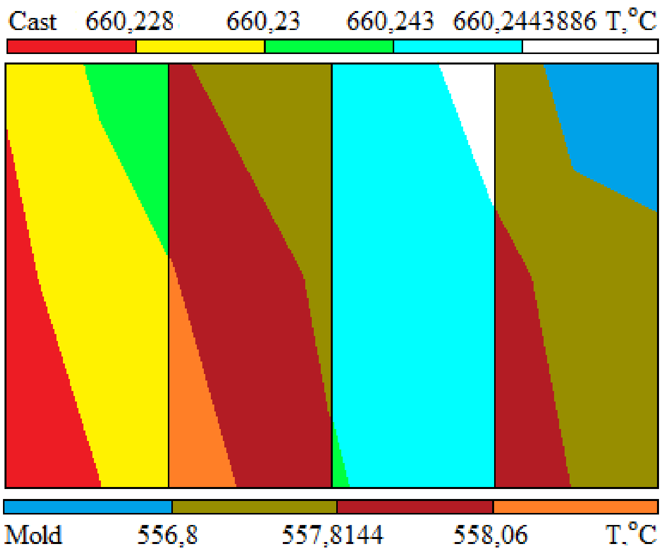

Fig. 7 *Numerical results of the Stefan-Schwartz problem in contact heat exchange.*

These results demonstrate the ability, through various identification assessments or from technological experiments, to determine the thermal resistance in the real case.

3. Contact Resistance in Real Case

The actual contact surfaces have a specific roughness reported in the smoothness class. Real contact is made in contact spots whose total area is up to several percent of the actual geometric area. In the process of casting, the contact surface of the mold is changed and if these changes are not known, it is operated intuitively.

The development of machine casting methods based on [1, 2, 3] has created an important casting branch in mechanical engineering [4] and pressure metallurgy [5]. The problem of the evaluation of contact heat exchange is always present. The experimental and theoretical evaluations performed [6, 7] provided a good opportunity to analyze real casting processes by creating a theoretical one.

The numerical results obtained allow us to investigate the complex thermal resistance in the contact spots. One micron on the side of one finite element makes it possible to do numerical studies even for 3D printer technology. Using databases and numerical experiments and advanced experimental techniques, we can work for contact heat exchange between different materials.

4. Conclusions

Results for the study of heat exchange in contact spots are presented. The minimum size of each finite element is a micron, which is the lower limit of the macro scale.

These results can be applied to modern technologies.

5. Reference

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