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USE OF PROCAST COMPUTER SYSTEM IN FOUNDRY PROCESSES OF INVESTMENT CASTING

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ВИКОРИСТАННЯ КОМП’ЮТЕРНОЇ СИСТЕМИ PROCAST В ПРОЦЕСАХ ЛИТВА ПО ВИПЛАВЛЕНИМ МОДЕЛЯМ

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Today in the world there are a large number of programs for computer simulation of foundry processes. In world practice, the programs presented in Table 1 have received the main distribution. Currently, in the USA, England, and Europe, the most common are two modeling systems: ProCast and MagmaSoft. In addition, a certain market segment in Europe is occupied by WinCast, SolidCast, and Nova-Solid/Flow systems. In Eastern Europe and the countries of the former CIS, the most popular software systems are Polygon and LVMFlow.

Modern programs for casting processes simulation are based on physical theories of thermal, diffusion, hydrodynamic, and deformation phenomena. They can adequately simulate many processes occurring during the filling of a mold with liquid metal, crystallization of a multi-component alloy, and further cooling of the casting. Possibilities of the programs include hydrodynamic calculation of filling molds, analysis of temperature fields during crystallization and formation of shrinkage defects, calculation of stresses and residual deformations in castings and optimization of gating systems [1].

The experience of the practical application of automated systems for modeling simulation of foundry processes shows that software products of foreign manufacturers are successfully used in the national industry. Neither the high price of the programs, nor the absence in most cases of an interface and national database on materials and alloys stops consumers. Foreign programs for simulation of foundry processes used today are mainly characterized by the degree of completeness of the factors taken into account in the modeling.

The ProCast program uses the finite element method as a mathematical method. The finite element method is based on heat and mass transfer equations in integral form. The area in which the equations are solved is divided into elements, within which function approximants are built based on the system of basis functions defined on the element. By projecting the integral equations onto these bases, a system of difference equations is obtained. The system is complex, its solution requires large memory resources and considerable time. One of the main advantages of the finite element method is a good approximation of the boundary, and the main disadvantages are the need for a high-quality finite-element generator, the complexity of the equations, and the impossibility of factorization. This method has a fundamentally more complex and adequate mathematical apparatus and more accurately describes the processes occurring in the considered geometric model [1].

The basis of ProCast is a single graphical interface (Visual Environment) with an integrated finite element mesh generator, preprocessor, databases, postprocessor and two solvers: hydrodynamic (Flow solver) and thermal (Thermal solver). As additional options, a large list of modules is offered that expands the basic capabilities of the program.

Consider the design of the investment casting process in the ProCast program using the example of the “center shaft” part model.

The following boundary and initial conditions are required for the calculation: the material of the part is 10X18N9БЛ; solidus, liquidus temperature and pouring temperature of the alloy – T_{liq} = 1441.07 °C, T_{sol} = 1419.07 °C, $T_{melting}$ = 1540 °C ±10 °C; 3D model of the assembled gating-feeding system, created in the program IX 8.5 (Fig. 1).

Let's take a closer look at the results of porosity and shrinkage readings, which are among the most significant results of the calculation. Shrinkage is one of the most important casting properties of alloys. As is known, shrinkage processes in castings occur from the moment the molten metal is poured into the mold up to the complete cooling of the casting and directly affect the quality of the casting.

Fig. 2 shows that the percentage of porosity and shrinkage of the metal is 0%, which indicates the receipt of a suitable casting without defects in the metal microstructure and the absence of porosity and shrinkage. Based on the calculations carried out, it can be judged that when pouring, 100% spillage of the part comes out; with this pouring, according to the calculation results, no shrinkage and porosity of the metal is observed.

This gating-feeding system is suitable for casting the "socket" part.

Such calculations must be carried out to eliminate shrinkage defects in time even at the stage of developing a mathematical model [2]. This makes it possible to significantly reduce the production time of castings by making timely changes to the design of gating-feeding systems, which provides: improved quality of castings; a reduction in the price of the product. Therefore, when solving issues related to foundry production, the ProCast automated casting process simulation system is an indispensable tool for a foundry technologist. The program has ample opportunities, efficiency in obtaining the necessary results and low cost.

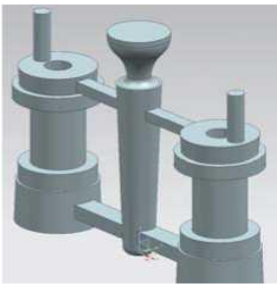

Figure 1 – 3D model of the gating-feeding system

Figure 2 – Determination of shrinkage and porosity when pouring metal molds

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