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Computer aided modeling of foundry processes at Motor Sich PJSC

Casting, computer aided analysis, MAGMA5, cast, feeding system.

There are several drawbacks in modern foundry which are caused by variety and complexity of design and production process:

– material capasity of a casting;

– high labor intensity of a practically "blind" process;

iterative search for an acceptable result;

– extremely long cycle of casting technology development;

– high power consumption of the casting process;

– a high percentage of defects in the details of the foundry group, especially for details of the 4-6 complexity groups;

– high prime cost and, therefore, price.

Thus computer-aided design and modeling of foundry processes are becoming increasingly important. This ensures the development of the optimal and most cost-effective casting technology. At present time for foundry processes Motor Sich JSC uses MAGMA5 computer simulation system .

This system makes it possible to estimate the quality of the sprue and feed system (LPS) and the temperature and time parameters of the casting processes on the basis of the simulation of the casting and solidification process of the casting, not on a real casting, but on its computer model.

When modeling in MAGMA5, it is possible to:

Calculate the thermal processes during solidification;

calculate the formation of shrinkage shells and macroporosity;

calculate the formation of microporosity;

to see hydrodynamic processes during pouring;

Take into account the gas permeability and gas capacity of rods and shapes and, in particular, to assess the effect of air permeability of the earth form, calculate the air pressure in the form and estimate its effect on the process

Estimate the erosion of the shape and rods

This system makes it possible to estimate the quality of the sprue and feed system as well as and the temperature and time parameters of the casting processes on the basis of the simulation of the casting and solidification process.

With MAGMA5 it is possible to:

– calculate the thermal processes during solidification;

– calculate the formation of shrinkage shells and macroporosity;

– calculate the formation of microporosity;

– consider hydrodynamic processes during pouring;

– take into account the gas permeability and gas capacity of rods and shapes assess the effect of air permeability of the form, calculate the air pressure in the form and estimate its influence on the process:

– estimate the erosion of the shape and rods:

– determine the pattern of residual stresses in the casting and in the mold, which affect the load-bearing capacity of the part obtained from the casting:

– determine variation of the level of mechanical stress and the parts geometry after machining

– predict hot cracks in the casting

– predict the variations of the dimensions of the casting and the distortion of its geometric shape – deformations, as well as deformations in earthen form and in the chill mold

– forecast the microstructure of the material in the casting, which determines its mechanical properties after heat treatment.

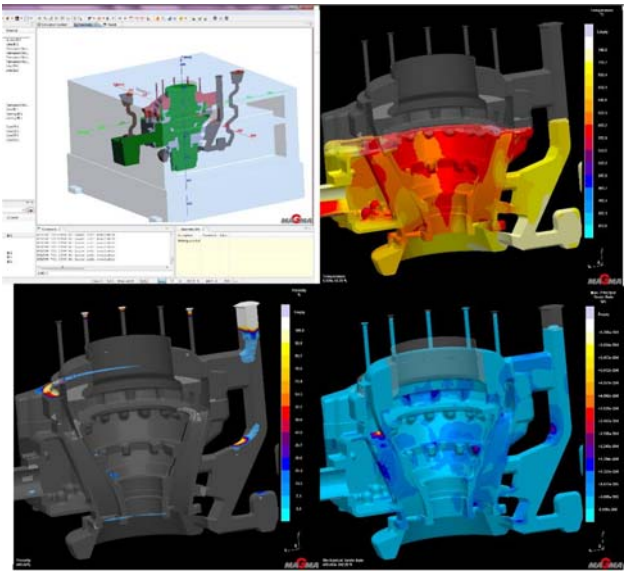

Fig. 1. MAGMA5 features

Based on the experience of the foundry of Motor Sich JSC, two tasks can be distinguished, the solution of which requires the use of software:

The first one is improving the technology and increasing the yield of suitable castings in production. It requires an in-depth consideration of the real conditions of process in order to identify the causes of defects and the correct definition of ways to eliminate them.

The second task is the development of a sprue – feeding system (SFS) at the stage of rigging design. In this case, the calculation of SFS is conducted for standard temperature and time parameters and an electronic model of the cast is developed. Also it is not necessary to make castings and tooling at intermediate stages of the

virtual casting process. And there is an opportunity to find several blunders at once and fix them simultaneously in the modeling process.

In the serial production of the analysis using simulation in a number of cases, it was possible to obtain high-quality castings and develop recommendations for reducing the level of rejection for shrinkage defects. As an example, we can mention the stages of finishing the technological process of the "Heat exchanger body" (Fig. 2):

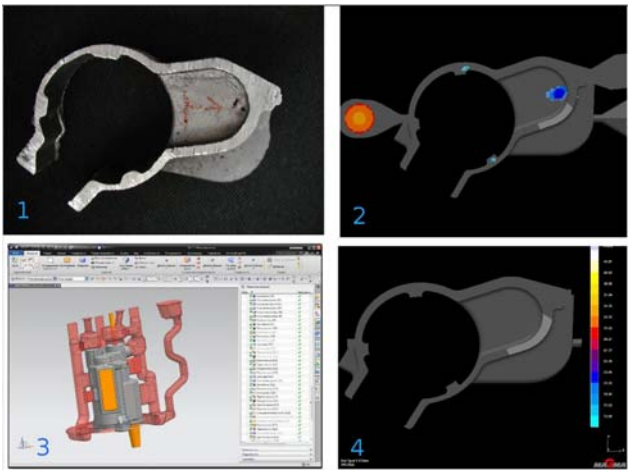

Fig. 2. Stages of finishing the process of the "Heat exchanger body" part

– at the first stage, the type of defect and the possible reasons for its occurrence are determined;

– in the second stage, simulation in MAGMA 5, refinement of the input parameters to obtain the most approximate result;

– at the third stage, the options for modifying the tooling are considered and changes are made to the tooling and casting model;

– at the fourth stage, the casting process is simulated taking into account changes in the tooling and casting model.

The use of MAGMA 5 allowed several variants to be worked out in a short time, without intermediate rigging adaptation and trial fills. This allowed to choose the most suitable option that allows to obtain a suitable part.

Conclusions.

As the results of MAGMA5 use at Motor Sich JSC, the following conclusions can be drawn:

– MAGMA5 can be used to optimize the design of SFS, as well as temperature and time parameters of the process for casting into shell molds, sand molds and chill molds in air for parts of almost any complexity;

– MAGMA5 makes it possible to evaluate the efficiency of SFS at the stage of technological process development and choose the optimal option for obtaining high-quality casting without expensive experimental fusions. The use of MAGMA5 makes it possible to significantly reduce the SFS design time, to improve its quality with significant reducing of costs for the experimental testing of casting technology.