

Mould Design and Process Simulation in Casting

WHY CASTING SIMULATION?

Modelling reduces development time

The application of modelling and simulation in the casting industry is more and more accepted. The widened use originates in the high reliability numerical methods have gained, the constant increase in performance of modern computers as well as the higher demands from the casting industry. Lightweight construction forces casters to build big, yet thin-walled components, or complex components with high functional integrity at a maximum casting quality in a minimum amount of time.

The necessary time needed for developing a cast part can be significantly shortened by computer aided development methods. Optimising the mould by means of modelling avoids costly mould changes and reduces post processing operations and finishing. The manufacturing process can also be optimised by simulation and the quality of the cast parts is increased. Casting simulation is thus a vital factor for cost reduction and competitiveness

HOW DOES CASTING SIMULATION WORK?

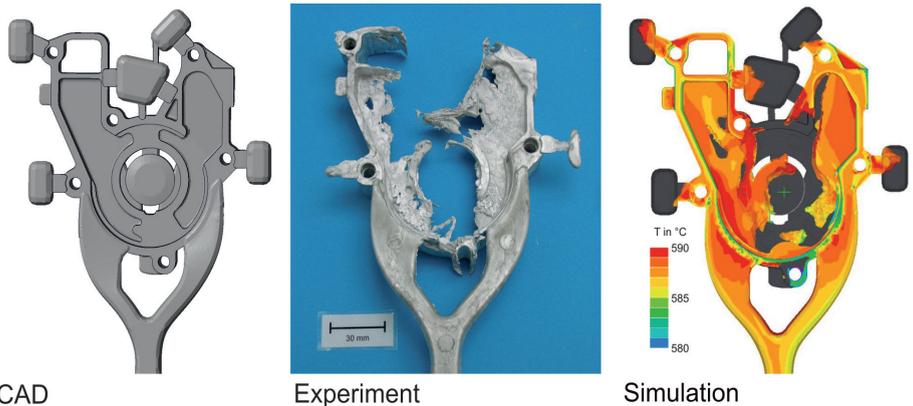
Numerical description of physical processes

The basis for the modelling is the description of the physical processes which occur during casting. Numerical calculations are carried out to determine

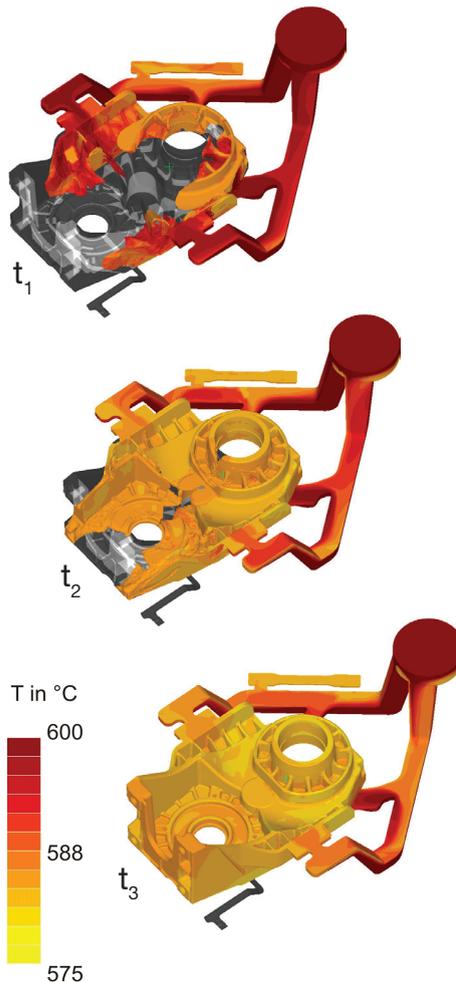
- temperature distribution,
- mould filling,
- solidification,
- residual stresses and deformations.

The development of the temperature distribution and the heat balance in permanent moulds is worked out in a

- cycle calculation.



Comparing experiment with simulation: fractional fillings show a good compliance with the calculation in the mould filling during Thixomolding® of an oil pump housing (courtesy of BMW AG, München).



Calculated mould filling of a high-pressure die-cast component (courtesy of ABM Greiffenberger Antriebstechnik GmbH, Marktrechwitz).

NMF uses multiple systems for the modelling of casting processes: ProCAST and Flow-3D®, two of the major commercial simulation platforms regarding casting.. Temperature dependent material properties, process data and boundary conditions form the basis of the calculation.

HOW MUCH CAN SIMULATION ACHIEVE?

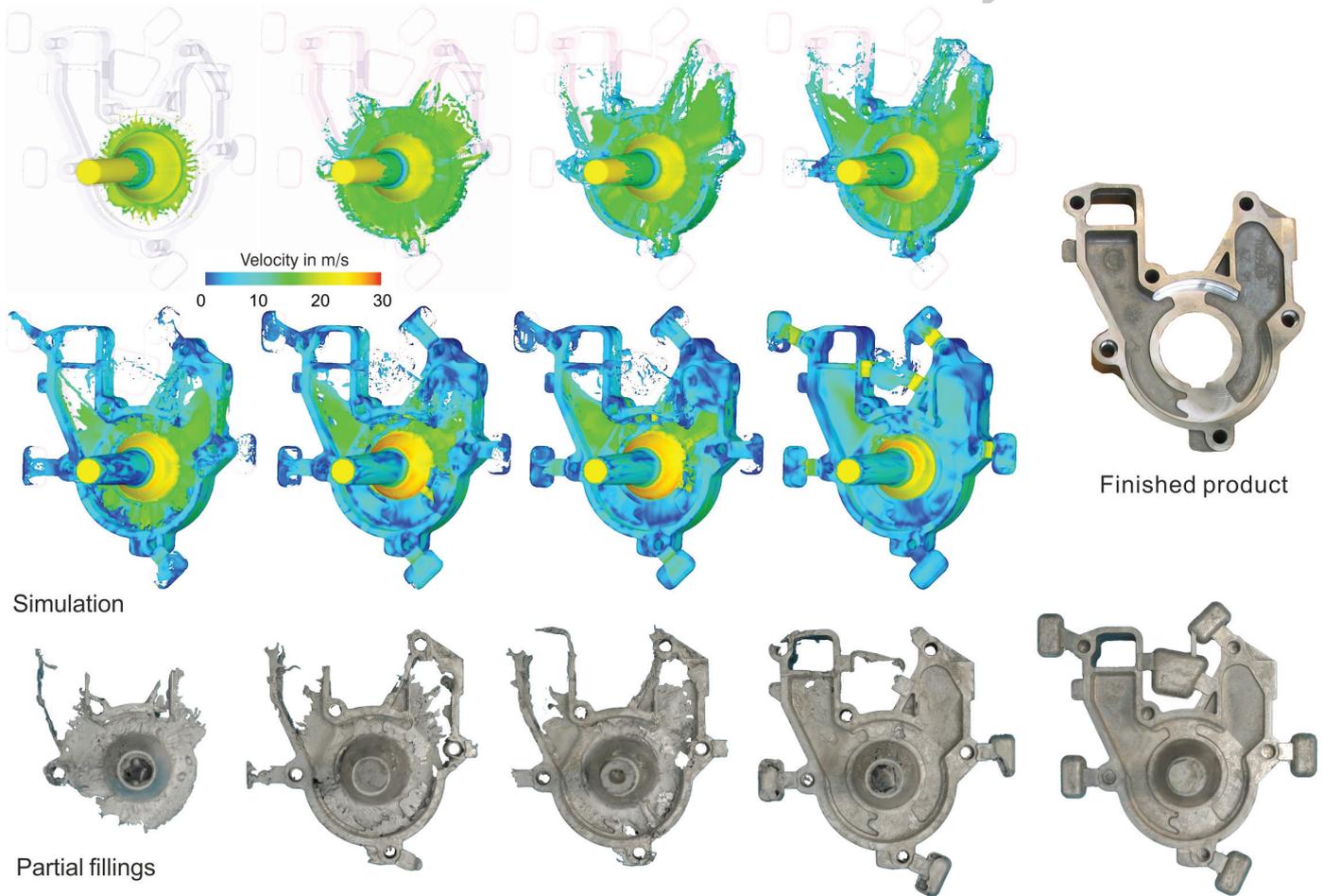
Virtual testing during the planning stage

For all common casting methods, a number of questions can be answered. Already in the planning stage, the

- design of the cast system and
- the heat balance and the maintenance of the temperature in the mould

can be checked and investigated, before the casting mould is actually built. By determining those parts of the mould which are filled last, the appropriate dimensioning and set-up of the ingate, the overflows and the ventilation can be deduced.

The description of the solidification provides information about casting defects and component properties. For example, those areas which solidify last in a solidification calculation give information about the formation of shrinkage porosity in the component.



Investigating the filling pattern of a cast oil pump housing (with central gating): the simulation results show good accordance with experimentally obtained partial fillings (courtesy of BMW AG, München)

Thus appropriate strategies for

- avoiding casting defects can be applied. The ideal process configuration, e.g. the choice of the casting temperature or the planning of the first casting phase in pressure casting can be tested virtually and the minimum cycle time can be deduced. By determining the residual stresses and deformations, the dimensional accuracy of the component after ejection can be judged and post processing can be minimized by an ideal cycle design. Modelling is especially useful when new products are developed or when new methods or materials are introduced.

HOW CAN CASTING SIMULATION BE APPLIED IN THE DEVELOPMENT STAGE?

Modelling accompanies innovation

NMF works on the innovative application of simulation technology in the casting industry. Currently, investigations and development on the following topics are

carried out:

- Further development of criteria for a better evaluation of how casting defects form and finding strategies to avoid those
- Reduction of mould wear and increase of mould lifetime
- Description of the rheology of thixotropic metal melts and modelling of Thixomolding®
- Automatic optimisation of casting moulds

WHAT CAN WE DO FOR YOU?

You design – we do the virtual testing!

We at NMF carry out casting simulations for optimising processes and components and offer you our wide range of services:

- Consultancy and information about the possibilities and application of modelling methods
- Calculations for mould filling, solidification and cycles for low and high pressure die casting as well as permanent

mould casting of both aluminium and magnesium. Further casting methods and materials on request.

- Calculation of the residual stresses and deformations in cast parts
- Virtual trials of casting processes and components to assure ideal design
- Special evaluations on demand of the customer

NMF is fully equipped with all necessary tools (multiple simulation platforms, thermophysical databases, CAD) which are constantly expanded by the development of special software tools, e.g. FlowViz. CAD files of all standard systems can be processed.

Contact

www.nmfgmbh.de

Neue Materialien Fürth GmbH
Dr.-Mack-Straße 81
90762 Fürth
E-Mail: simulation@nmfgmbh.de

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