Comparison of Results of Numerical Simulations of Castings with X-Ray Computed Tomography Reconstructions

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Abstract. For more than 10 years, it is possible to numerically simulate the solidification process in castings. Since then this technique has rapidly progressed with increasing available computing power permitting more accurate and complex algorithms to be implemented. Hence the foundry industry is able to continuously advance their production processes.
An important aspect of casting simulation is the prediction of areas that are prone to porosity. Such areas are identified only according to their probability of porosity occurrence. No information of morphology and distribution of pores can be obtained.
X-ray computed tomography (CT) opens the possibility to visualise the three-dimensional structure of castings and their imperfections. This permits the detection of porosities and their distribution in the entire casting.
By comparing the data obtained by numerical simulation and CT, the simulation data can be validated for the whole casting. This is normally done by sectioning the cast part at regions of interest, which can give only limited information about the three-dimensional distribution of porosities. The more exact data of the CT regarding distribution and type of pores together with the solidification parameters from the numerical simulations permit more accurate relations to be derived between the process parameters and the casting. In that way the casting process can be further advanced.
Numerical simulations of different castings were performed using FLOW-3D, a general computational fluid dynamics (CFD) software, as well as MAGMASOFT, a specialised software for casting processes. For CT a v|tome|x c - system by phoenix|x-ray with a 240 kV microfocus tube and 16 bit detector with 1024x512 pixel resolution has been used. Further x-ray investigations have been accomplished using a phoenix|x-ray x|argos – system with a 320 kV x-ray tube and a 32 bit line-detector. The reconstruction was accomplished using Volume Graphics Studio Max including a module for pore calculation. Different parts of industrial production produced by high pressure die-casting were investigated.