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Martin Liepe, M.Sc.; RüdigerBähr Prof. Dr.-Ing. habil.
(Institute of Manufacturing Technology and Quality Management, Otto- von-Guericke-University Magdeburg, Germany)

A HOLISTIC CONSIDERATION OF WORK-ROLL CENTRIFUGAL CASTING IN NUMERICAL SIMULATION

E-Mail: martin.liepe@ovgu.de

Forming tools as rolls and roll-rings need to fulfill increasing requirements in the future. That is caused by the rising percentage of high strength steels for forming of pipes, wires and circular profiles. Simultaneously the roll-producing foundries are obligated to comply the demands of energy and resource efficiency, long lifetimes of tools as well as low material charges. Additional conditions are an ensured hardness of roll surface as well as high roll productivities and qualities. Currently rolls for forming are manufactured as monolithic parts by gravity casting, but a substitution of that manufacturing process by centrifugal casting connected with composite materials optimizes the castings concerning their mechanical properties and the reducing of cost-intensive materials. However, the percentage of iron- based rolls in Germany produced by centrifugal casting in 2014, was only 14,6 %. That low fraction is owed to the difficult process control, in spite of the obvious technical advantages as higher strengths and wearing properties as well as reduction of porosity and inhomogeneity. In opposition of conventional gravity casting in lost molds, centrifugal casting in dies is relatively insecure because a negligible process instability affects the casting properties in a negative way. Motivated by that, the necessity occurs to configure a manufacturing process which is robust, controllable and increasingly predictable. At this point the numerical simula- tion of that casting process sets, which has demand to develop a complete reproduction of mold filling, solidification and cooling of the casting rolls in order to generate appropriate manufacturingparameters.

In the course of last decades, the simulation of casting processes has evolved to a useful tool in process and part optimization in foundries considering nearly all casting processes and materials. However, modeling of centrifugal casting of thick-walled parts is very complex in view of the specific flow characteristics, the extensive heat balance as well as the long- lasting process duration compared with conventional casting operations. In the framework of a government-funded research project the centrifugal casting process of cast iron rolls is holistically highlighted. Therefor considerably preliminary assessments concerning the influ- ence of die coating on heat transfer between die and melt are necessary. In addition to this a correlation between cooling conditions of melt and the subsequently linked microstructure as well as the mechanical properties will be implemented in the simulation software. Theappliedsimulation software FLOW-3D for these investigations offers appropriate calculation and visualization methods especially concerning high melt dynamics and the resulting turbulent flows during casting process. Furthermore, by implementation of subroutines and criteria functions, the possibility exists to create demand-conforming simulation modeling and evaluation. That is suitable especially for centrifugal casting viewing the aspired aim to describe the very important hardness at the border area of work rolls already in the simulation. The consideration of cooling rate, which is necessary for these calculations, can be realized in the simulation based on local cooling-down of the melt via the following pouring and centrifugation interval.