Chair of Metal Forming and Casting
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Development of a material model for gas generation in inorganic foundry sands

Motivation

In the foundry industry, for lost molds and cores usually organically bonded sand is used. In regard to the increasing importance of the environmental friendliness of manufacturing processes, inorganically bonded molding materials are being used increasingly. While toxic waste gases are released during the casting process when organic binders are used, casting with inorganic water-glass binder largely produces water vapor. Although this makes the inorganic binders much more environmentally compatible than their organic counterparts, the two types of binder also differ in the physical principles of gas formation. In this context, it is important in what time course the gases are released from the molding material and how much gas is present in the core at any point in time. If the pressure in the core exceeds the counter pressure of the melt, the gas escapes not only via the core bearings or via designated vents, but also through the melt, which leads to porosity in the cast part.

Approach

A fundamental understanding of the relationship between the material parameters of inorganic molding materials and the gas release during casting is established in this research project. First, various material parameters of inorganic molding materials were determined. For this purpose, test stands for the determination of the temperature-dependent gas evolution (see Fig. 1) and the temperature profile in inorganic molding materials during casting (see Fig. 2) were designed and built.

The measured data is then used to develop a model that can be used to simulate heat transport in the molding material, taking convection into account without explicitly representing it. Based on the temperature distribution calculated in this way, a metamodel is developed which allows the gas release to be predicted.

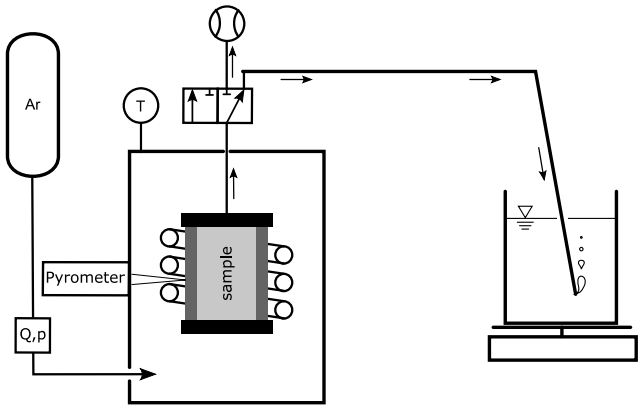

Fig. 1: Principle sketch of the setup for determining the temperature-dependent gas evolution of inorganic molding materials

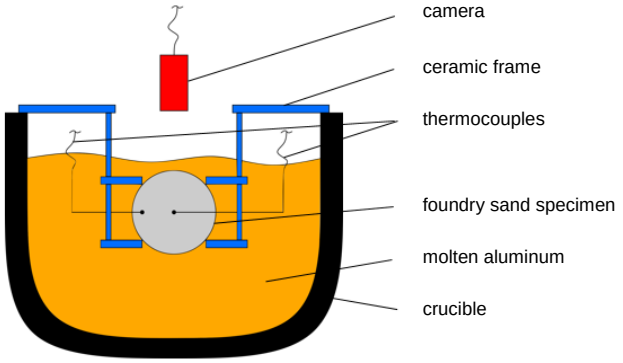

Fig. 2: Principle sketch of the setup for determining the temperature profile in inorganic molding material during casting.

Outlook

The simplified calculation of water accumulation in cold areas of the core and the resulting gas release significantly reduces the computing time. This makes it possible to integrate the simulation into the design loops and to react to critical configurations at an early stage.

In order to support the use of inorganically bonded molding materials in higher-temperature melts, it is necessary to consider the gas release e.g. in copper melts.

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