Cast Iron in Motion with

HIGHLIGHTS OF MAGMAIron 5.5

Quantitative prediction of shrinkage related defects with a new powerful feeding model taking into account

- **Convective heat transport** during solidification
- The **metallurgical state** of the melt
- **Inoculation** effects on precipitated eutectic graphite
- **Atmospheric** and local **metallostatic pressure** on feeding flow
- **Graphite expansion** and **austenite shrinkage**
- **Flow resistance** in mushy zones during solidification
- Impact of **mold stability** on porosity

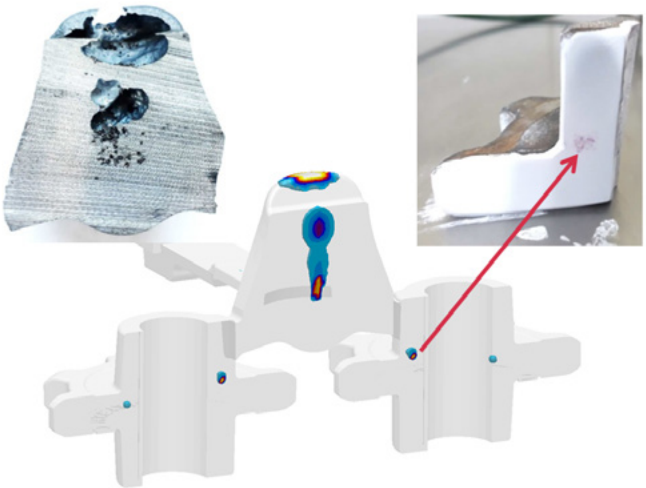
MAIN BENEFITS

MAGMAiron quantitatively predicts microstructure and porosity for cast iron as a function of alloy composition, metallurgical state of the melt and inoculation effects and offers

- Increased **safety** by accurately predicting porosities
- **Robust** and **optimized** gating and feeding designs
- **Reduced cost** by avoiding scrap through optimized process parameters
- **Availability** by addressing metallurgical and material specifics for grey, ductile and compacted cast iron grades

MAGMAiron has been further developed with respect to heat transfer, solidification as well as the feeding models. Completely new capabilities for cast iron support foundrymen to consider the effects of metallurgy and metal treatment on solidification and feeding behavior for cast iron.

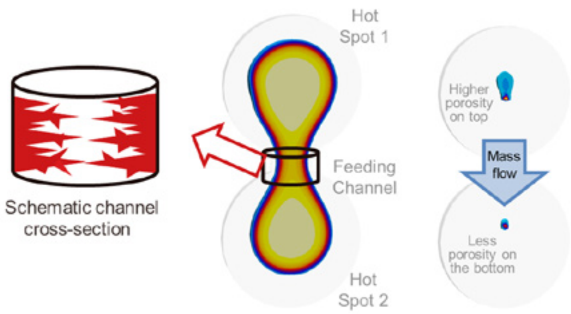
Feeding in cast irons depends on a multitude of parameters. Cast iron feeding and porosity formation is strongly controlled by the metallurgy of the melt and process conditions. MAGMAiron considers density changes based on local precipitation of graphite and austenite. The balance between expansion and shrinkage of these phases, combined with the feeding of the melt, indicates the risk of forming shrinkage porosity.



Accurate porosity prediction with MAGMAiron

SMAFEE – SMART FEEDING

The "heart" of the optimized MAGMAiron module is the new SMAFEE smart feeding algorithm. SMAFEE accurately predicts shrinkage porosity formation. The software calculates local metal transport in partially solidified regions of the casting and the resulting ability to feed the solidifying iron. Both metal quality and inoculation state influence feeding and porosity formation in the casting.



SMAFEE considers flow through partially solidified feeding channels

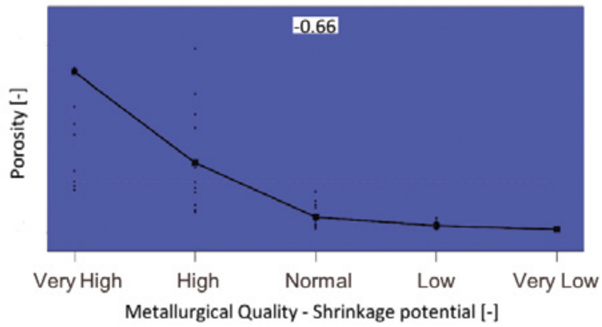
PRESSURE DRIVEN FEEDING

Pressure differences in the metal are created through the combination of metallostatic pressure, local austenite shrinkage and graphite precipitation, and the rigidity of the mold.

MAGMAiron considers the density changes based on local precipitation of graphite and austenite.

- Different feeding zones stay in contact; mass exchange is possible depending on the pressure difference.
- The permeability in the partially solidified feeding zone is a function of the solidification progress.

With the innovative SMAFEE feeding algorithm, you can take even better account of the influence of melt quality, inoculation practice, and local pressure distributions on porosity development.



Effect of melt quality on amount of porosity

METALLURGICAL QUALITY

The graphite precipitation during solidification is strongly influenced by the melting practice of cast iron, raw materials and additives being used. MAGMAiron settings open the possibility to consider different foundry practices influencing the melt quality. The new parameter

- modifies the amount of precipitated graphite
- affects position and size of porosity.

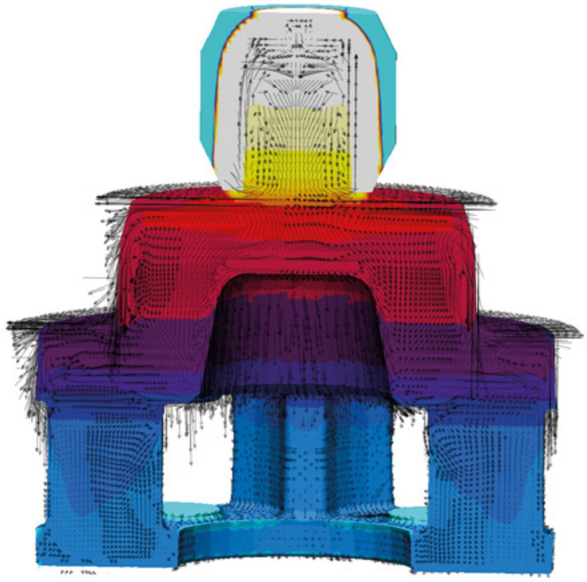
IMPACT OF INOCULATION

The quality of inoculation is strongly influencing the local microstructure. Beyond this MAGMAiron considers the impact of the predicted eutectic cell size or nodule count on the local feeding behavior.

THERMAL CONVECTION DURING SOLIDIFICATION

Solidification simulation is considering the conductive heat transport between the mold, the solidifying casting and the melt.

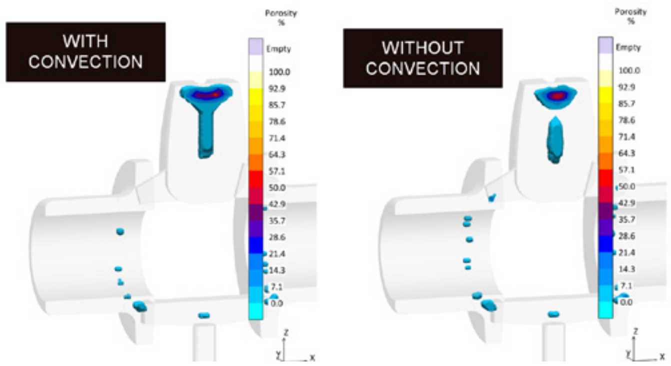
Different inoculation levels change the extent of predicted porosity



Currents due to thermal convection influence the feeding behavior

Due to density differences occurring in the melt, convective currents develop and change the temperature distribution in the casting. Thermal convection during solidification is now calculated as a standard for iron castings. The impact of the flow on the temperature distribution during solidification influences the feeding behavior in large castings as well as in series production.

- Consideration of conduction and convection on the resulting thermal fields
- Considering flow resistance in mushy zones
- Impact on solidification times, feeding flows and resulting porosity
- Only moderate increase in calculation times



Porosity prediction with and without consideration of convection

MOLD STABILITY

MAGMAiron considers the impact of the mold stability on the feeding performance during solidification.

- Pressure interaction between graphite expansion and mold rigidity is calculated and considered for local feeding.
- Different mold types can be considered.

THE NEW STANDARD

- SMAFEE substitutes standard and extended feeding algorithms for all cast iron grades, as long as microstructure simulation is considered.
- Thermal convection modeling is active as a new standard, it can be deactivated by the user.