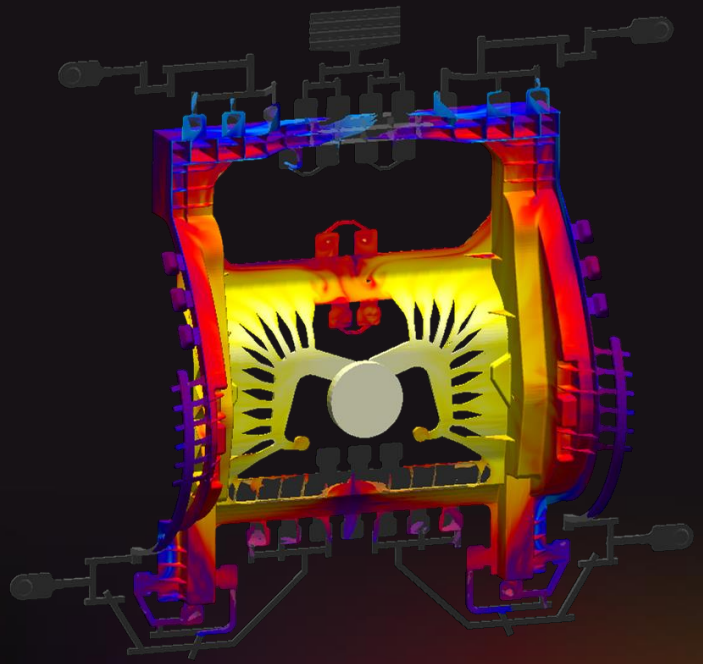

International MAGMA User Meeting 2024
October 9-11, 2024
RADISSON BLU – Frankfurt
BE PART OF IT
MAGMA
Radisson BLU

Simulation of GIGA-Castings with MAGMASOFT®

Tips and Tricks

Guido Dietrich

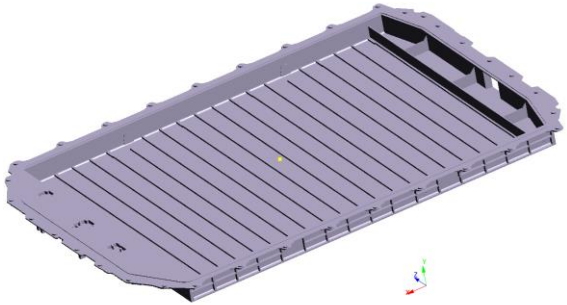


GIGA Castings

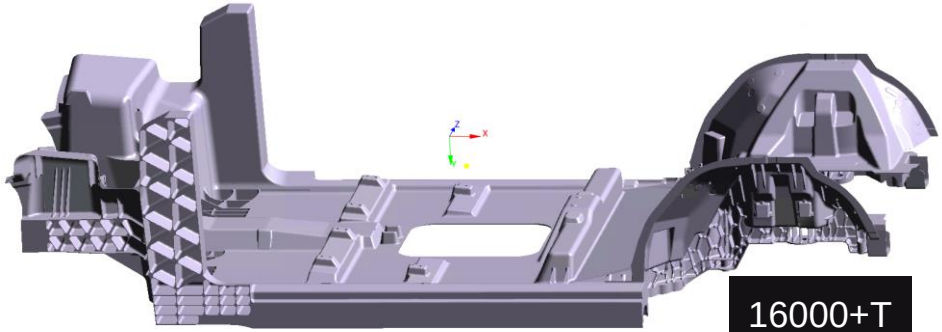
What is a Giga casting?

6000T – 9000T

6000T – 9000T



9000T – 12000T



16000+T

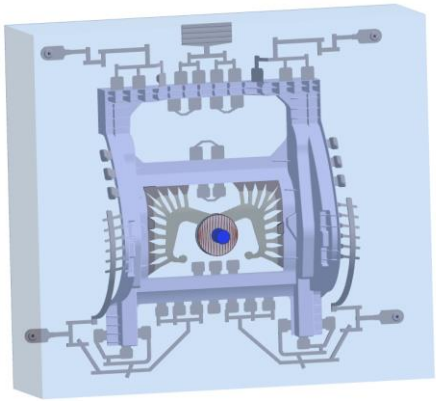
GIGA/MEGA CASTINGS

Challenges

- Very large geometries
- Huge number of mesh elements
- High memory requirement
- Long calculation times
- High software and hardware performance required in all perspectives

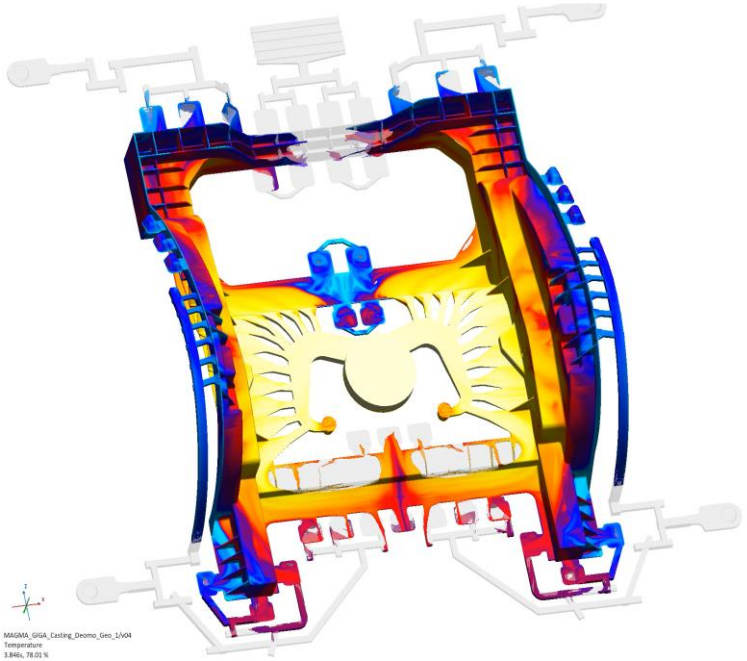
Example

- 1 heating cycle + 1 production cycle
- 9,5 Mio cast elements, 22 Mio die elements
- including result preparation for all results
- Running on 32 Cores → 23St 15min

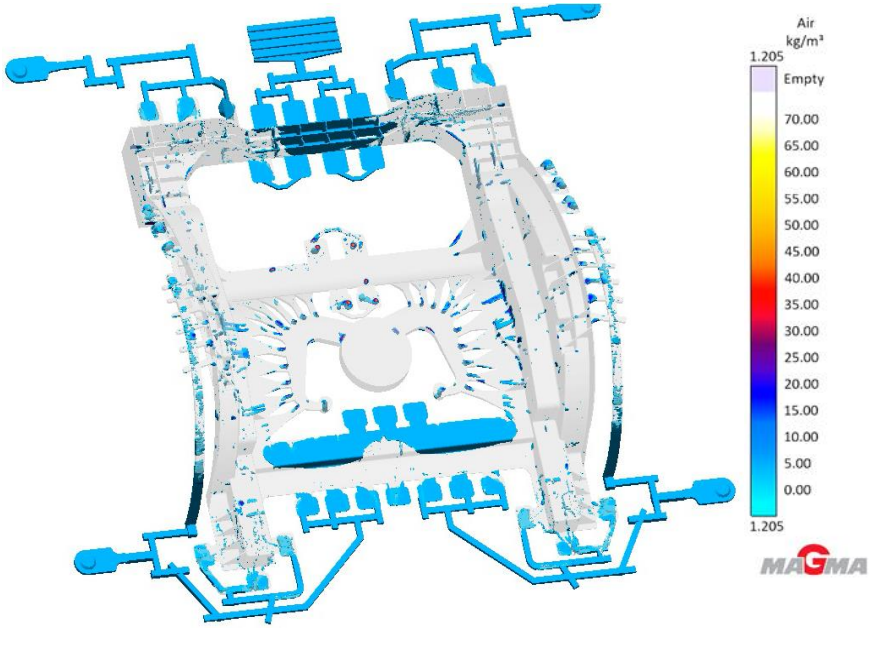


GIGA/MEGA CASTINGS

Filling Temperature



Air Inclusions



MAGMA APPROACH
From simple to efficient

MAGMA APPROACH

Efficient Simulation Model

- Use the "classic biscuit" simulation model for the first loops → it's ok to start without a shot chamber.
- Use the "classic spray" simulation model or simplified spray non-moving surfaces
- Do not consider mold data and tempering channels for the first loops – if it's reasonable.
- General mesh default is 3 elements over wallthickness – **BUT** try to use 2 elements wherever it's acceptable – divide the wall thickness just by 2 elements and keep the parameter for the equidistant meshing method marginally lower.

  Example: typical wall thickness 2.5mm, divide by 2 = 1.25mm → equidistant mesh by 1.2mm
- Reduce the number of results or adjust them specifically for your individual needs.
  (e.g. 15%-70% in 5% steps and 70%-100% in 1.5% steps)
- Order only results that you really use and evaluate - activate "Prepare fast Post" to speed up result assessment → your time is more valuable than the computation time.
- Use the new "Interact" software to animate 3D result sequences. These files can be very big, but if they are available, it save a lot of time to start a 3D animation. Inside the result perspective, it takes more time to run a 3D animation.

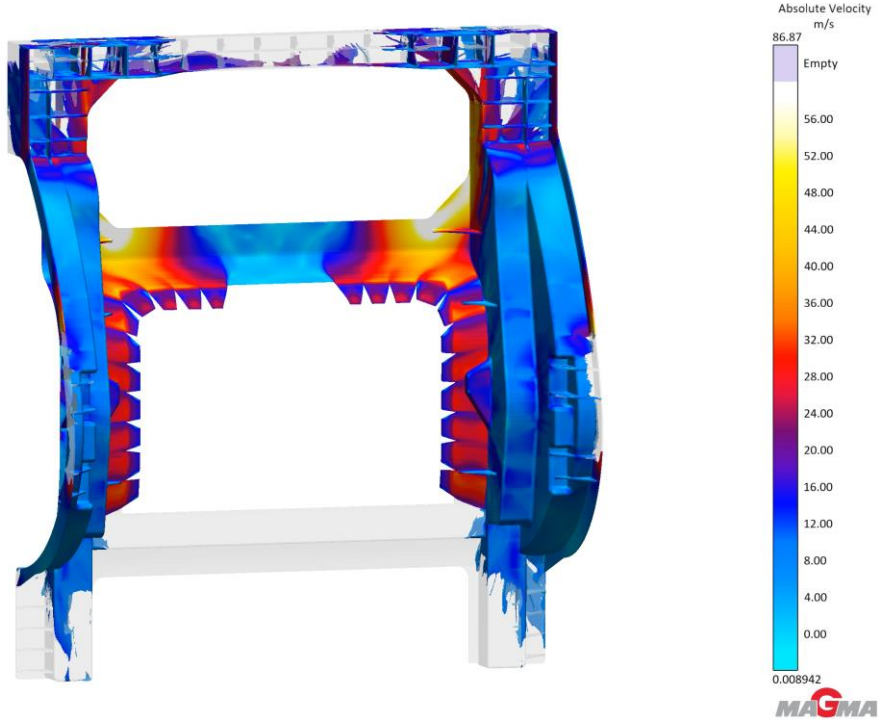
SIMPLIFIED “VIRTUAL” INGATES

Efficient Simulation Model

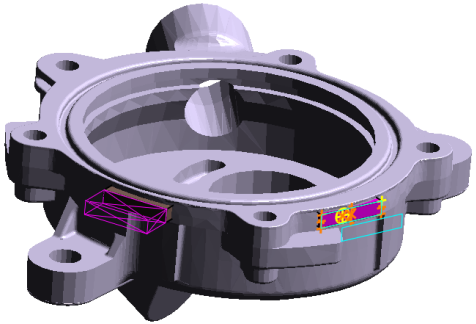
- With MAGMASOFT 6.1 it is possible to fill a part by using simple ingate geometries (Inlets). This can help to get a first rough idea about the fill situation without the necessity of a complex runner system.

  → significant reduction of calculation time!

- ADJUST initial casting temperature to your simulation model to account for temperature loss from holding furnace to
  - Dosing of Shot Chamber
  - Simulation start from Biscuit
  - Simulation from virtual ingates

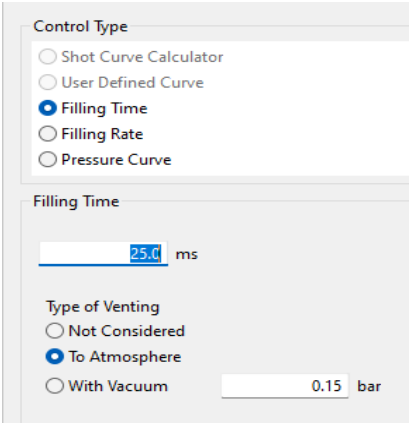


SIMPLIFIED “VIRTUAL” INGATES



Position multiple gates directly on the part to design the filling – get a quick impression of the fill pattern without a gating system .

- With the help of an extrusion, any component surface can be used as the basis for an “inlet”.
- The inlet geometry does not necessarily have to be a rectangle.
- Inlet/component contact area counts for the inflow behavior.
- Each created volume (inlet) must subsequently be assigned to an inlet ID, otherwise no different properties/flow directions can be calculated.



Combine “virtual ingate” with extended filling definitions in HPDC module

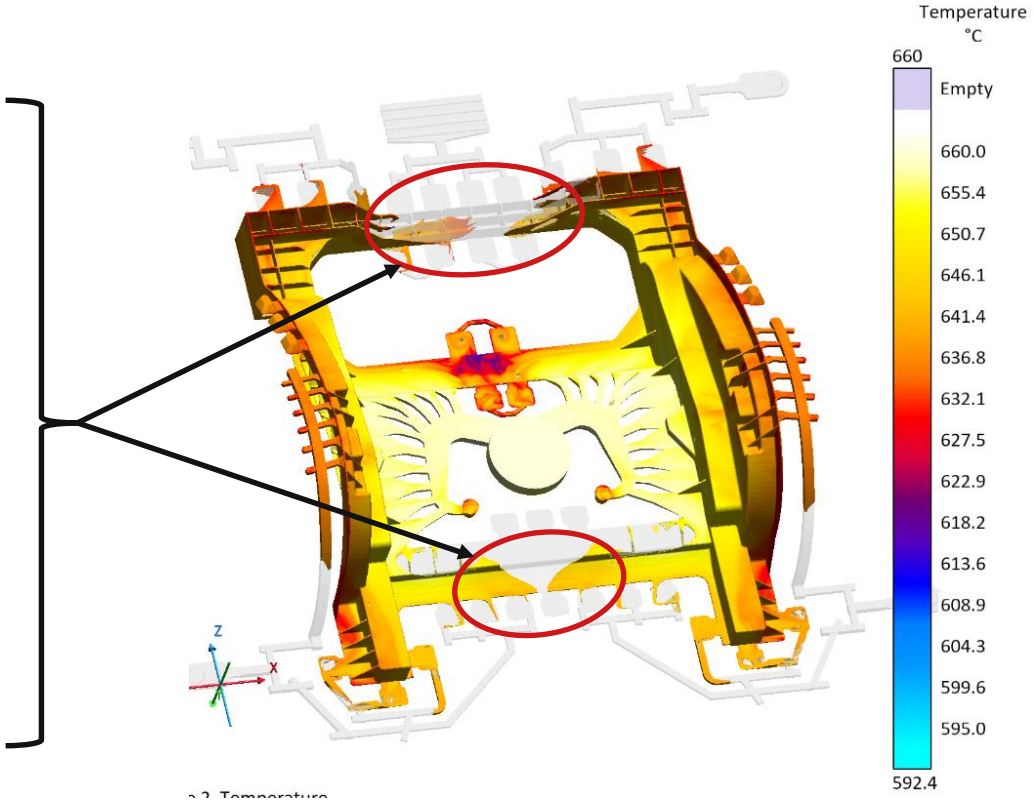
- Filling Time
- Filling Rate
- Pressure Curve

Process phase dependent HTCs
Why it can be helpful?

PROCESS PHASE DEPENDENT HTCs

Motivation

- Cold run/flow or misrun is a very critical defect, especially for GIGA Castings with very long flow length.
- The identification of cold run/flow in Simulation is challenging.
- Sometimes due to changes in the viscosity of the melt the flow behavior or flow pattern does not match well to reality.



PROCESS PHASE DEPENDENT HTCs

What are the main effects for each process phase?

Dosing

- Velocity range: 0 - 2 (m/s)
- Temperature : 630 – 710°C

HTC mainly driven by velocity and probably surface tension/condition

Filling

- Velocity range: 0 - 80 (m/s)
- Temperature: Tliq - Tinitial

HTC for thin-walled big structural parts mainly driven by velocity respectively pressure condition (kinetics of the melt)

HTC for small thick-walled parts are maybe stronger influenced by temperature.

Solidification

- Temperature: below Tliq

HTC is mainly driven by temperature as well as pressure and gap formation due to shrinkage

PROCESS PHASE DEPENDENT HTCs

How did we come to these HTCs?

- Since MAGMASOFT® 5.4 the HTC during dosing is automatically reduced to 20% of the default (defined) HTC.
- Due to the large volume and high injection speed, HTCs during filling is expected to be higher than the default one.
- Because of no movement in solidification, using a temperature dependent HTCs makes sense.

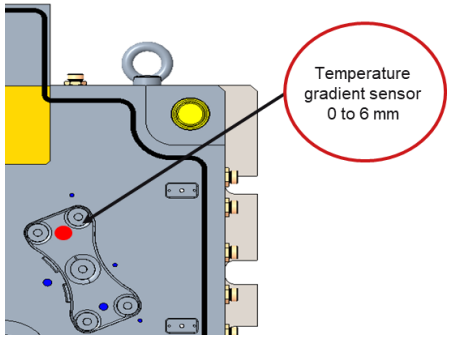
Temperature (°C)		HTC W/m² K	
		Std HTC	Mod HTC
0		3000	400
479	At solidus	3000	400
579		7000	17,000
600		7000	38,000
620	Above liquidus	7000	42,000
700		7000	42,000

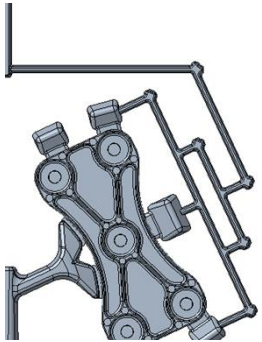
“PPD_HTC” File

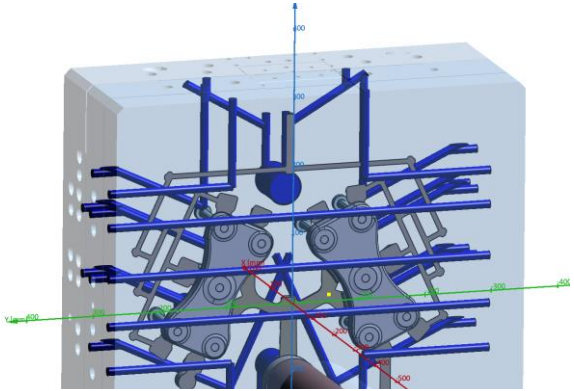
DOSING	
V	HTC
0.0	2000
2.0	2000
10.0	10000
END	
FILLING	
V	HTC
0.0	2000
2.0	2000
10.0	10000
20.0	30000
30.0	60000
40.0	100000
50.0	150000
END	
SOLID	
T	HTC
0.0	1500
479.0	1500
579.0	17000
600.0	38000
620.0	42000
700.0	42000
END	

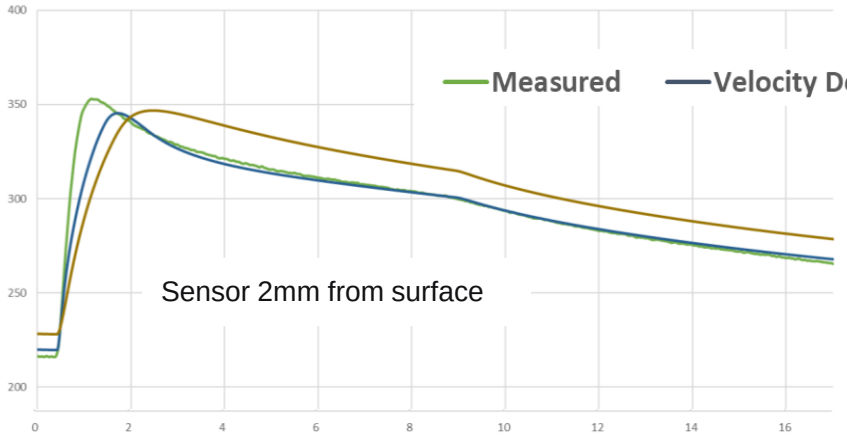
VELOCITY DEPENDENT HTC

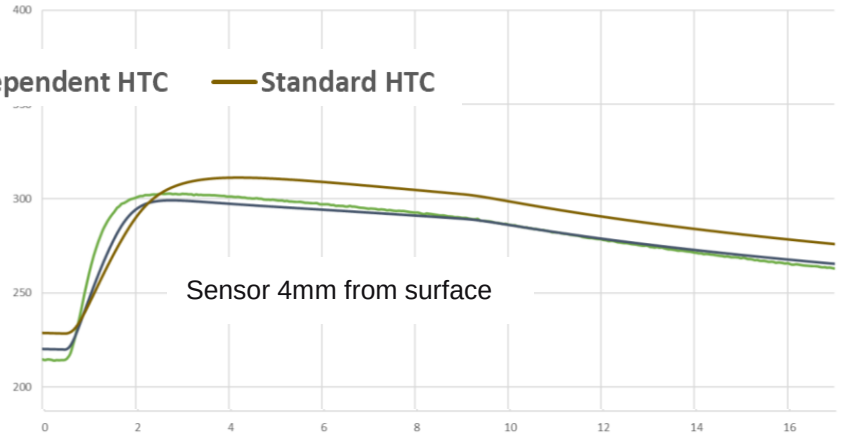
Results compared to the real measurements











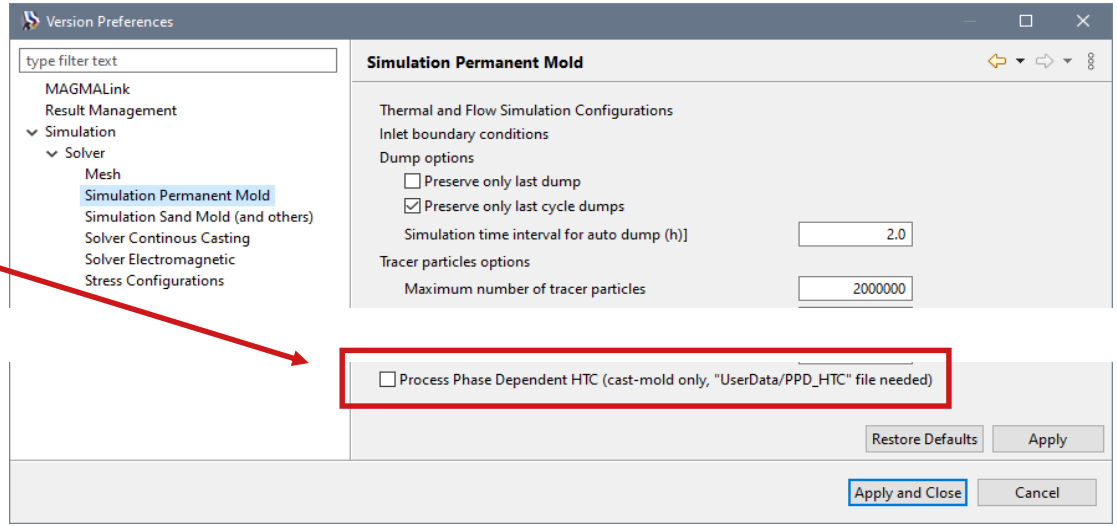
PROCESS PHASE DEPENDENT HTCs

How can I use it? (available with MS61)

Step 1: Asking MAGMA for a special License key. (Please contact me)

Step 2: Activate in “Version Preferences” dialog.

Step 3: Put the file “PPD_HTC” with all parameter sets in to this folder: Project/Version/UserData



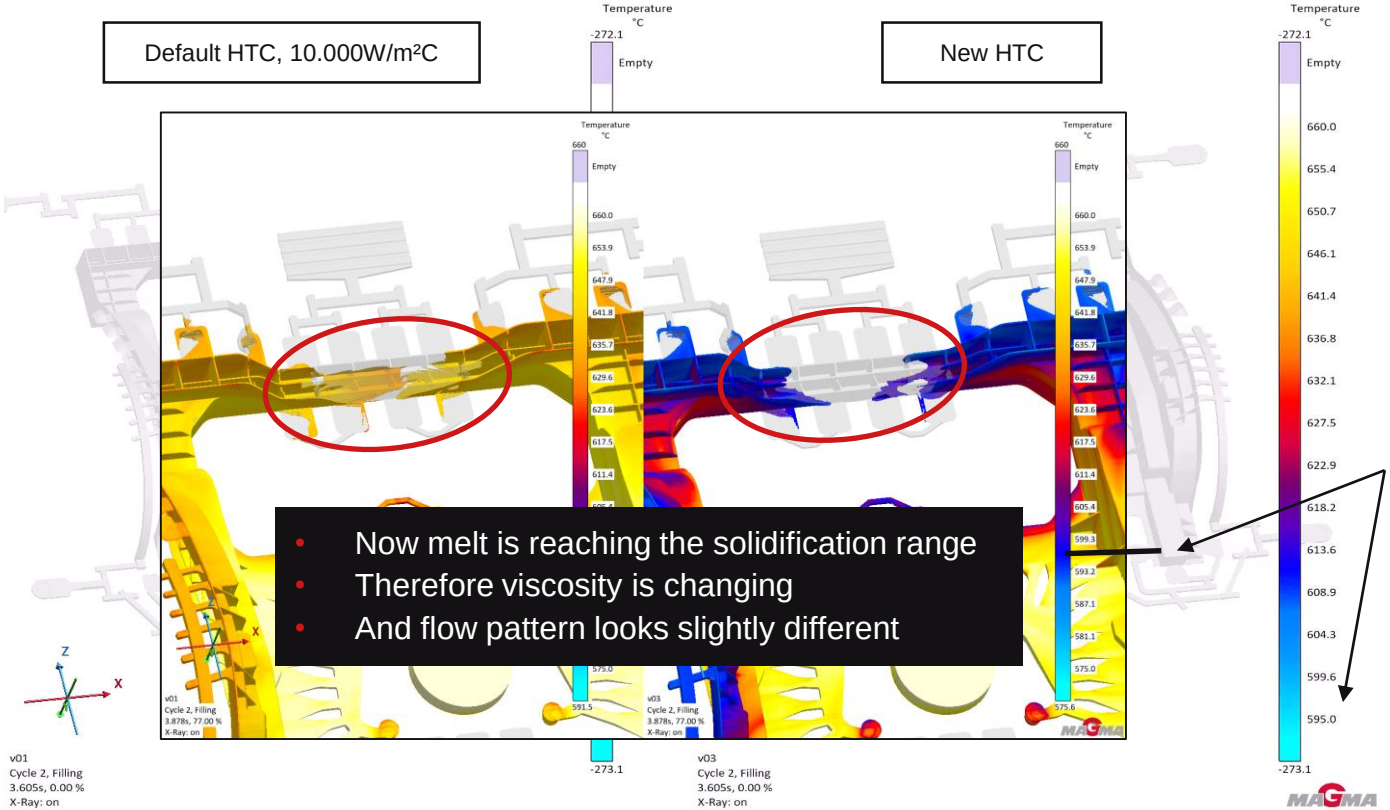
Now all HTC’s between melt and die, that you have defined in the definition perspective, are no longer active!

PROCESS PHASE DEPENDENT HTCs

Filling Temperature

Default HTC, 10.000W/m²C

New HTC

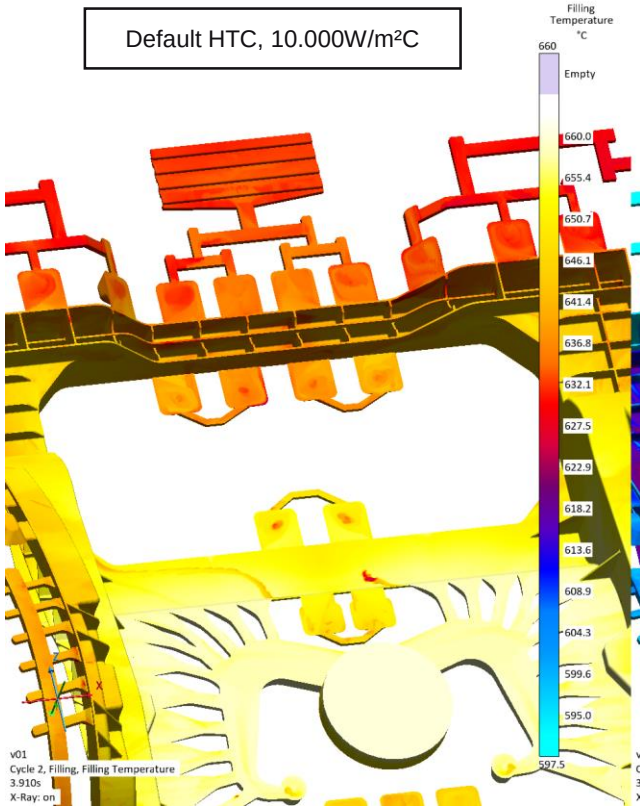


- Now melt is reaching the solidification range
- Therefore viscosity is changing
- And flow pattern looks slightly different

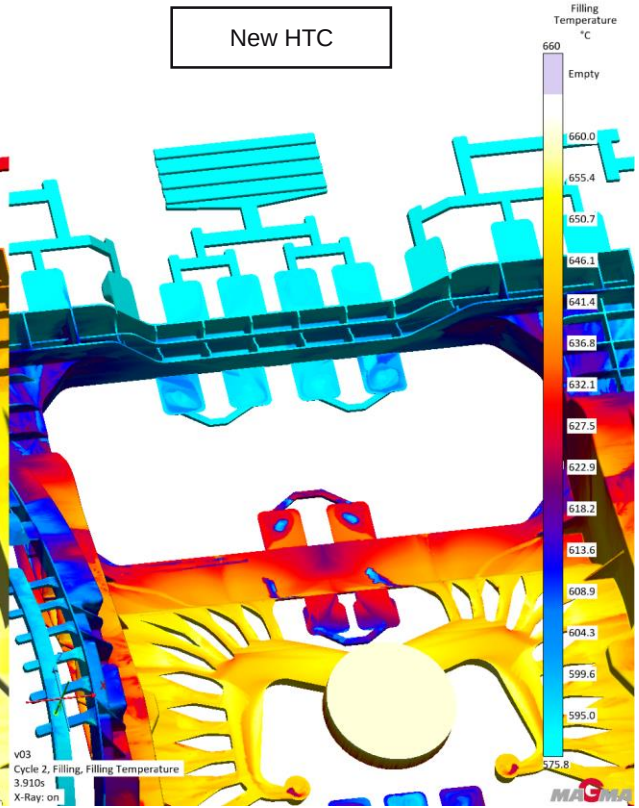
PROCESS PHASE DEPENDENT HTCs

Criterium Result Filling Temperature

Default HTC, 10.000W/m²C

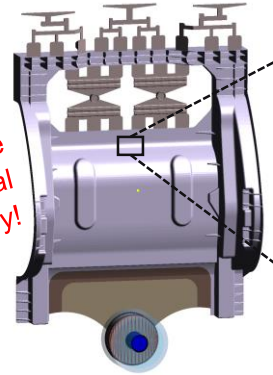


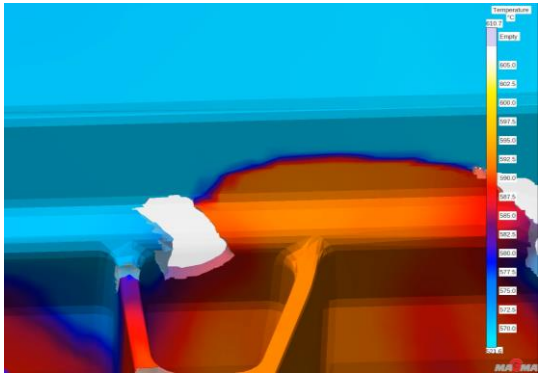
New HTC



PROCESS PHASE DEPENDENT HTCs

Real example

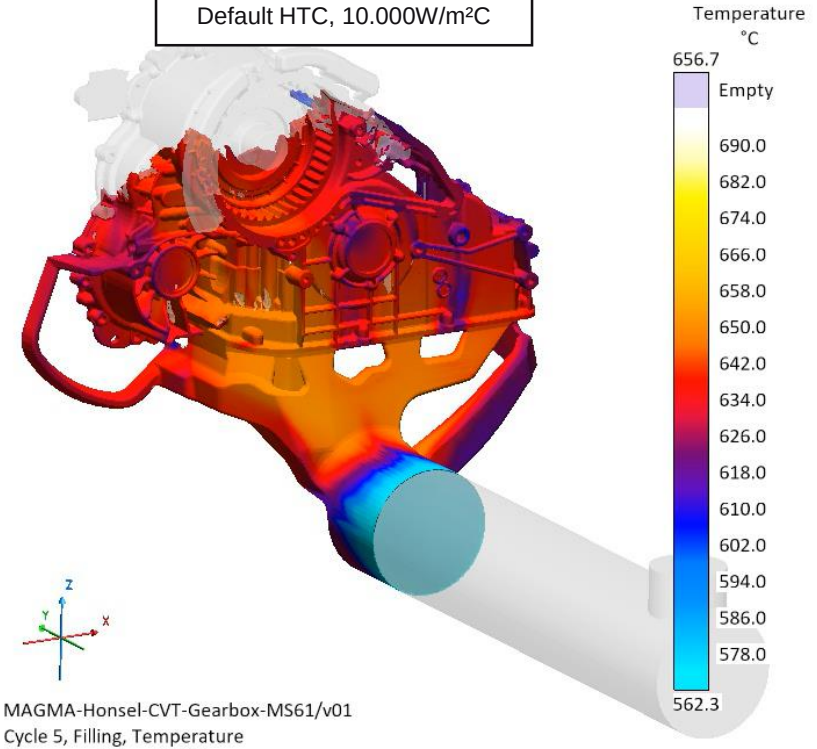




PROCESS PHASE DEPENDENT HTCs

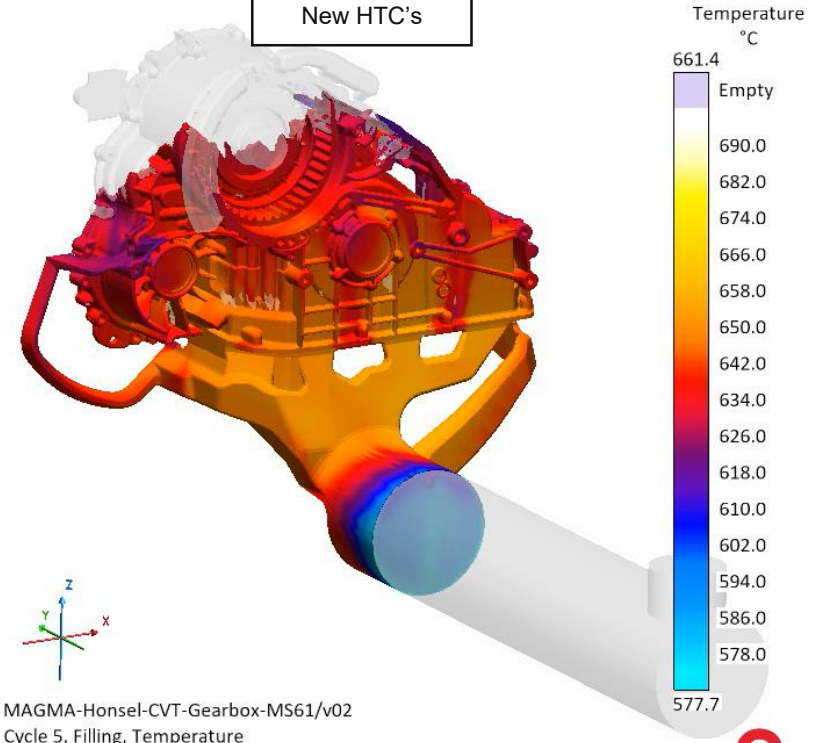
Filling temperature

Default HTC, 10.000W/m²C



MAGMA-Honsel-CVT-Gearbox-MS61/v01
Cycle 5, Filling, Temperature
Plunger position: 695.54 mm

New HTC's

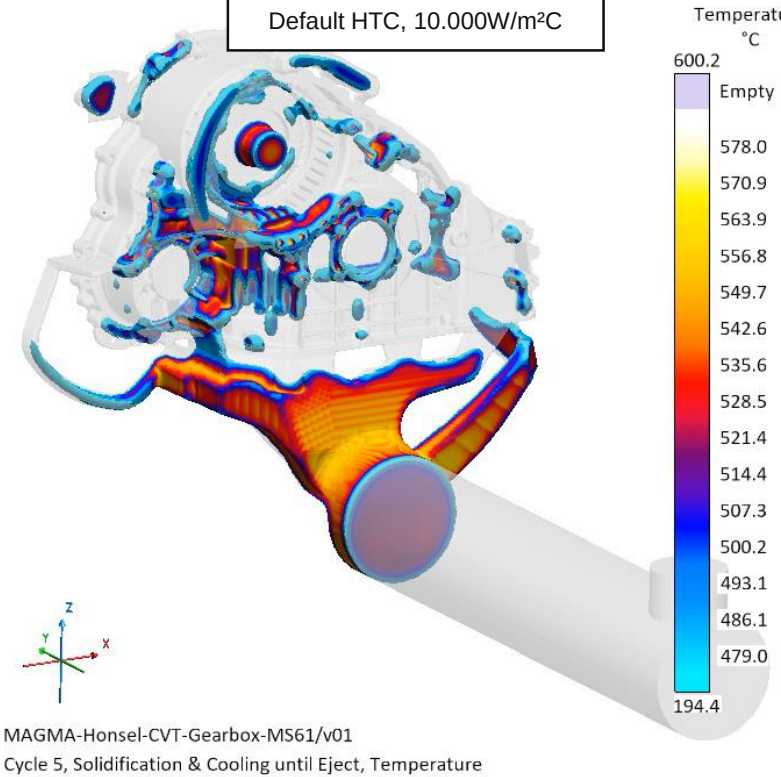


MAGMA-Honsel-CVT-Gearbox-MS61/v02
Cycle 5, Filling, Temperature
Plunger position: 695.47 mm

PROCESS PHASE DEPENDENT HTCs

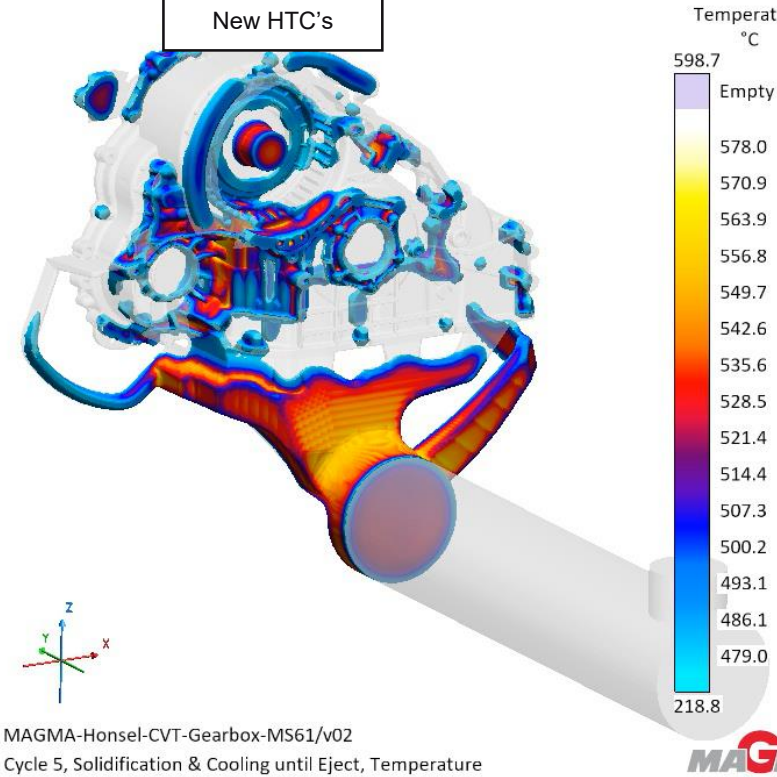
Solidification temperature

Default HTC, 10.000W/m²C



MAGMA-Honsel-CVT-Gearbox-MS61/v01
Cycle 5, Solidification & Cooling until Eject, Temperature

New HTC's

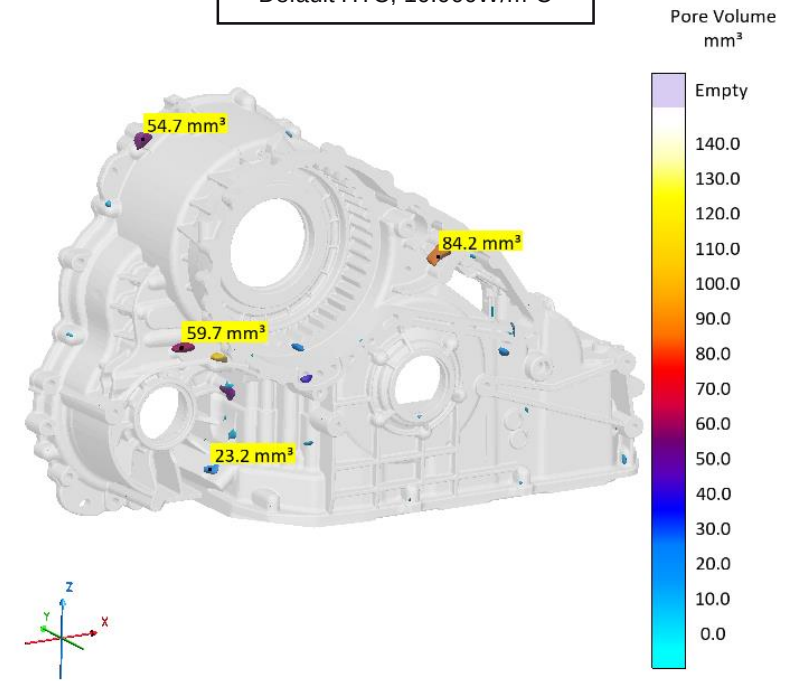


MAGMA-Honsel-CVT-Gearbox-MS61/v02
Cycle 5, Solidification & Cooling until Eject, Temperature

PROCESS PHASE DEPENDENT HTCs

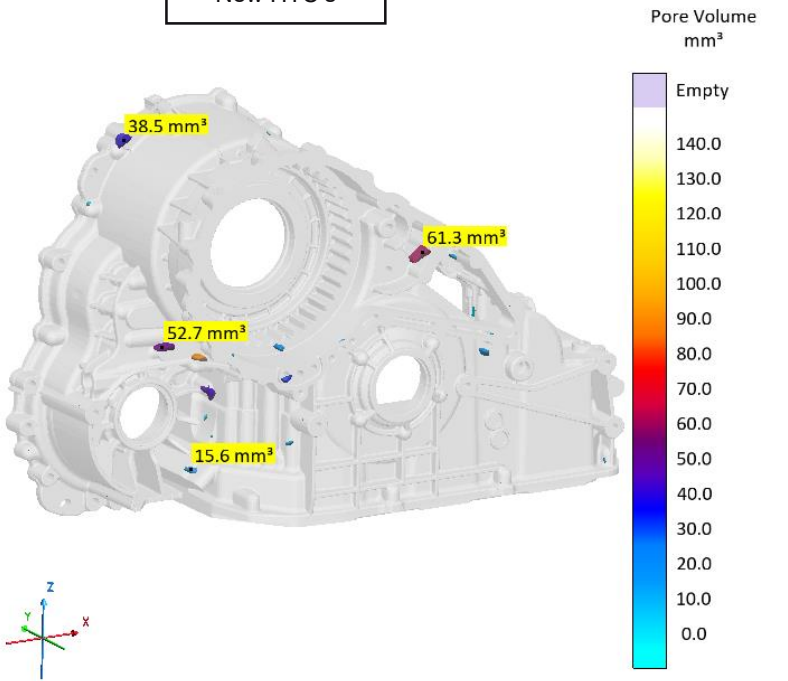
Porosity

Default HTC, 10.000W/m²C



MAGMA-Honsel-CVT-Gearbox-MS61/v01
Cycle 5, Solidification & Cooling until Eject, Pore Volume

New HTC's



MAGMA-Honsel-CVT-Gearbox-MS61/v02
Cycle 5, Solidification & Cooling until Eject, Pore Volume

PROCESS PHASE DEPENDENT HTCs

Summary

- First feedback from selected customers was positive. With this new HTC settings it was possible for them, to be closer to some real casting problems.
- The velocity dependent HTC is a first approach to improve the identification of filling related defects. Especially for big thin walled casting geometries it makes sense to use a process dependent HTC.
- For “normal” HPDC parts the default HTC of 10.000 W/m²C is still a good compromise for this complex physical question.
- The setup of process phase dependent HTCs is planned to be integrated into MAGMASOFT®
- It would be nice to get some additional measurements with according MAGMASOFT® projects as well as documentation of the real defects for further validation and development. If you are interesting in this topic, or you have additional ideas about it, please contact MAGMA GmbH!

Thank you for your attention.

Guido Dietrich

MAGMA Gießereitechnologie GmbH

G.Dietrich@magmasoft.de