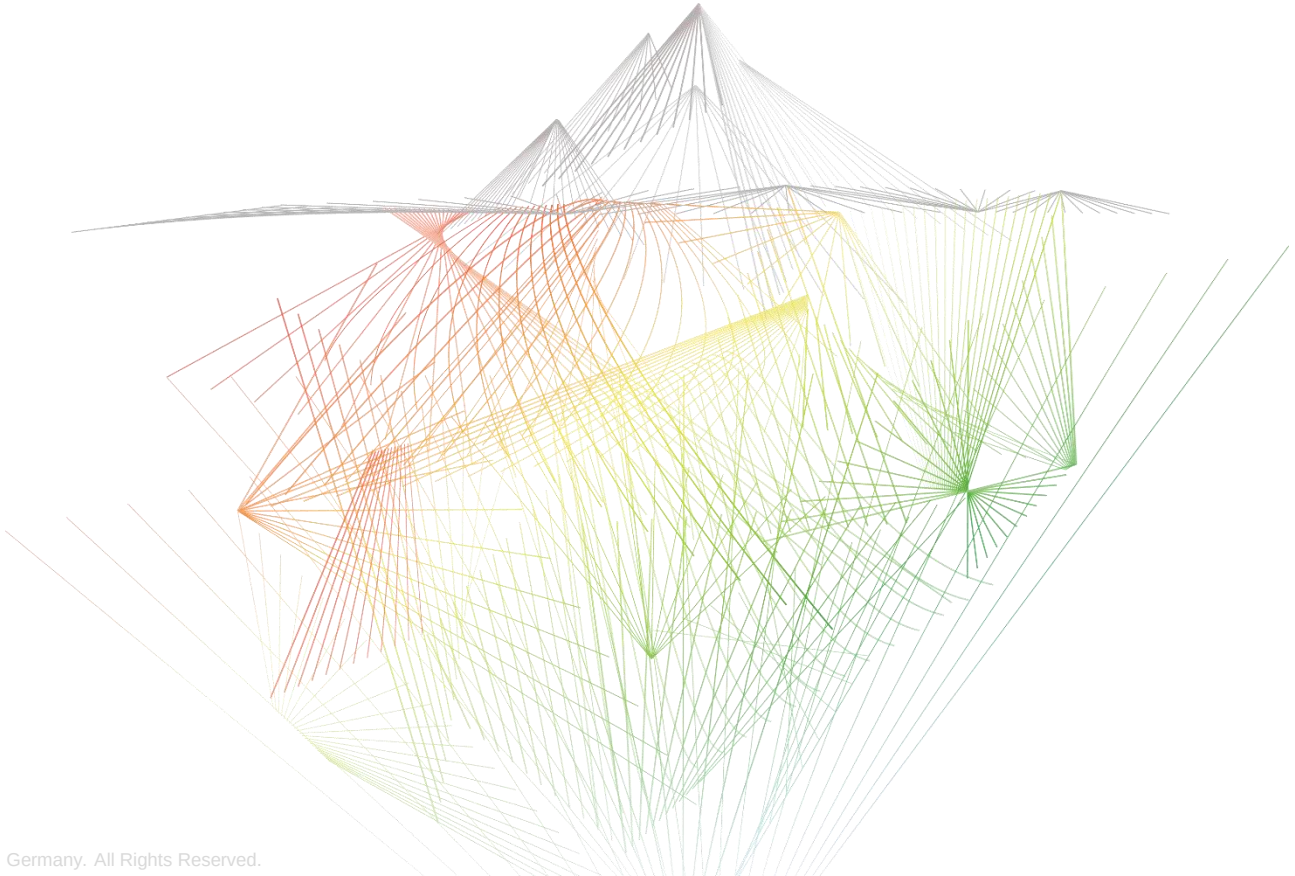
MAPP 2023 – Understanding Mold Stresses



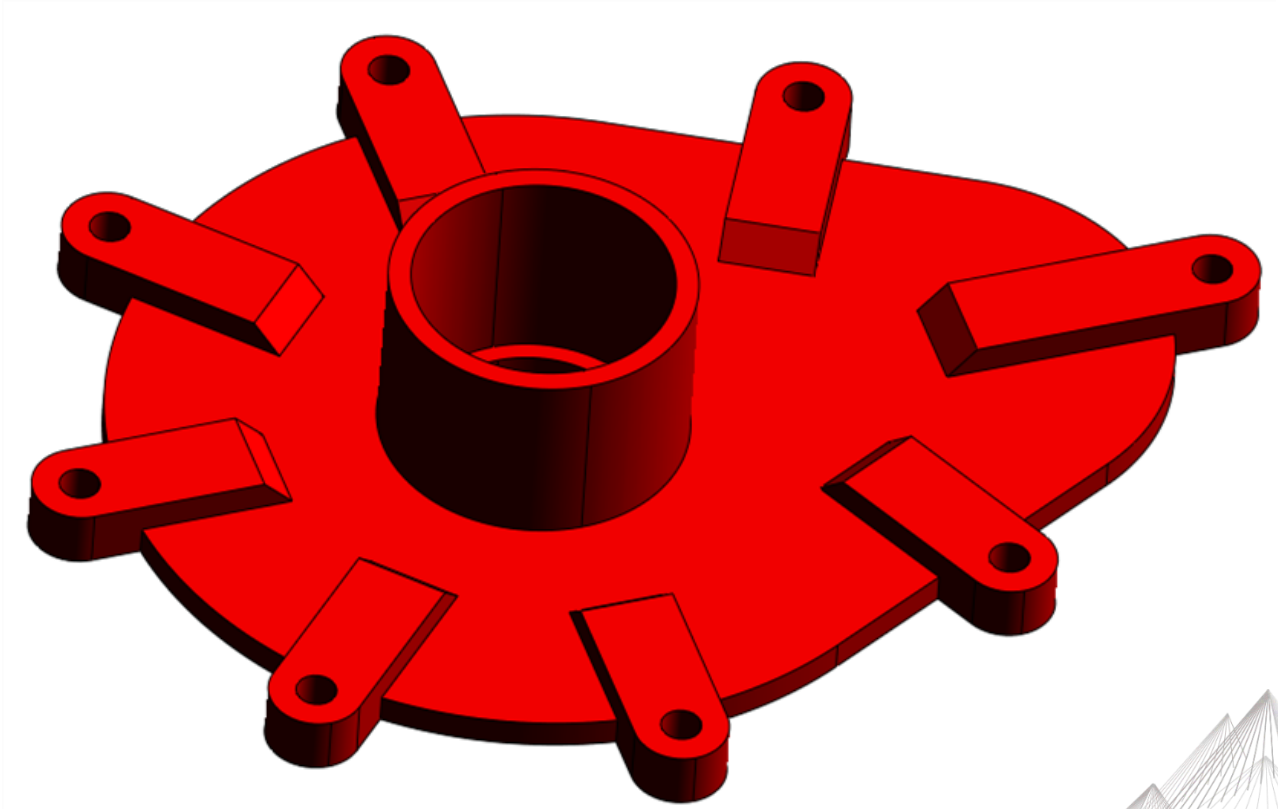
SIGMASOFT® Virtual Molding

Agenda

- Overview of the project and goals
- Process parameters and corresponding results
- Discuss Mold Design considerations
- Final Conclusions

MAPP 2023

Project Overview



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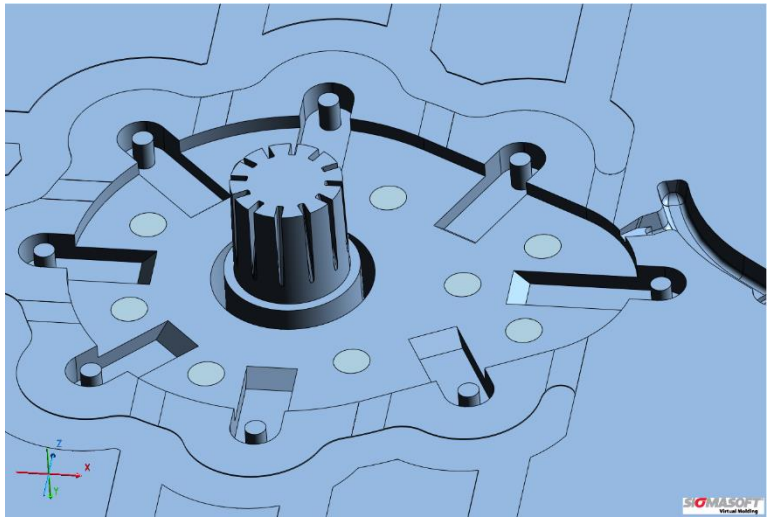
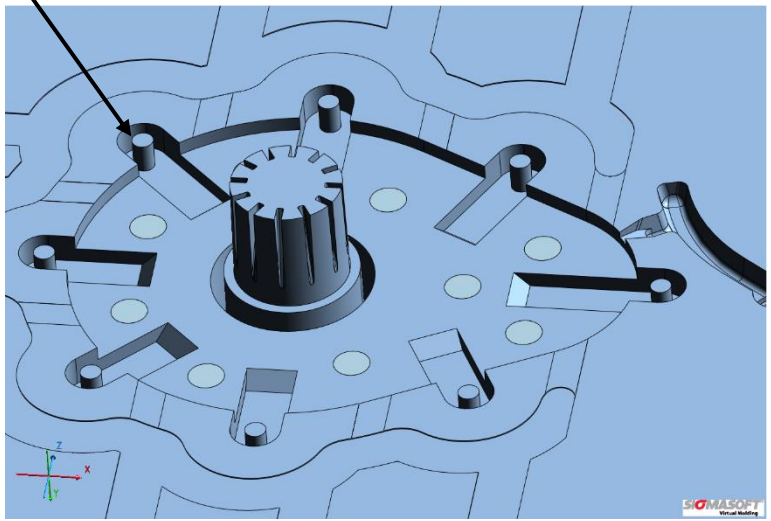
Project Overview

There are a couple of areas of concern within the mold design



Wear and Tear

Concerned that the core pins wear and tear over time



What could increase core pin bending and stress?

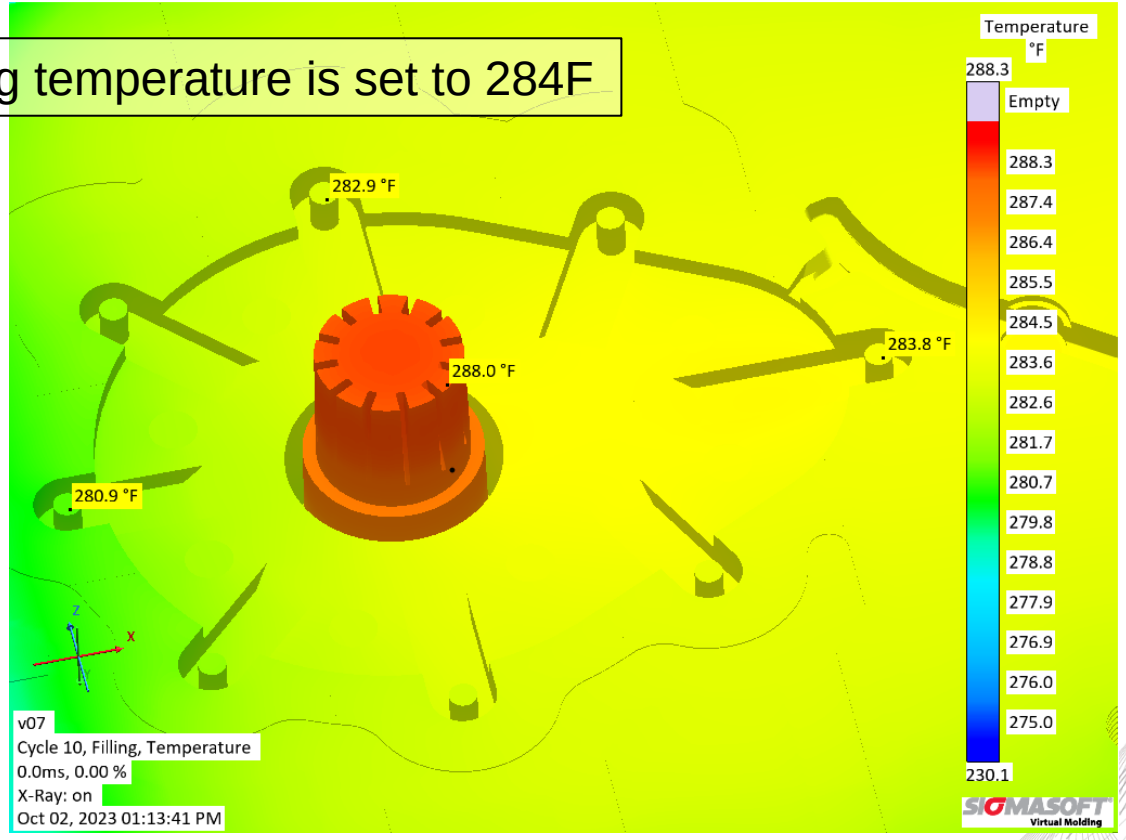
- Temperature of the core pins
- Pressure differential on the pins during filling and packing
- To a lesser extent, temperature of the part

Process Parameters

- PPA
- Polymer Temperature – 617F
- Mold Temperature – 284F
- Fill Time – 0.3 seconds
- Packing Pressure – 15,900 psi
- Cooling Time – 10 seconds

Mold Temperature

Operating temperature is set to 284F



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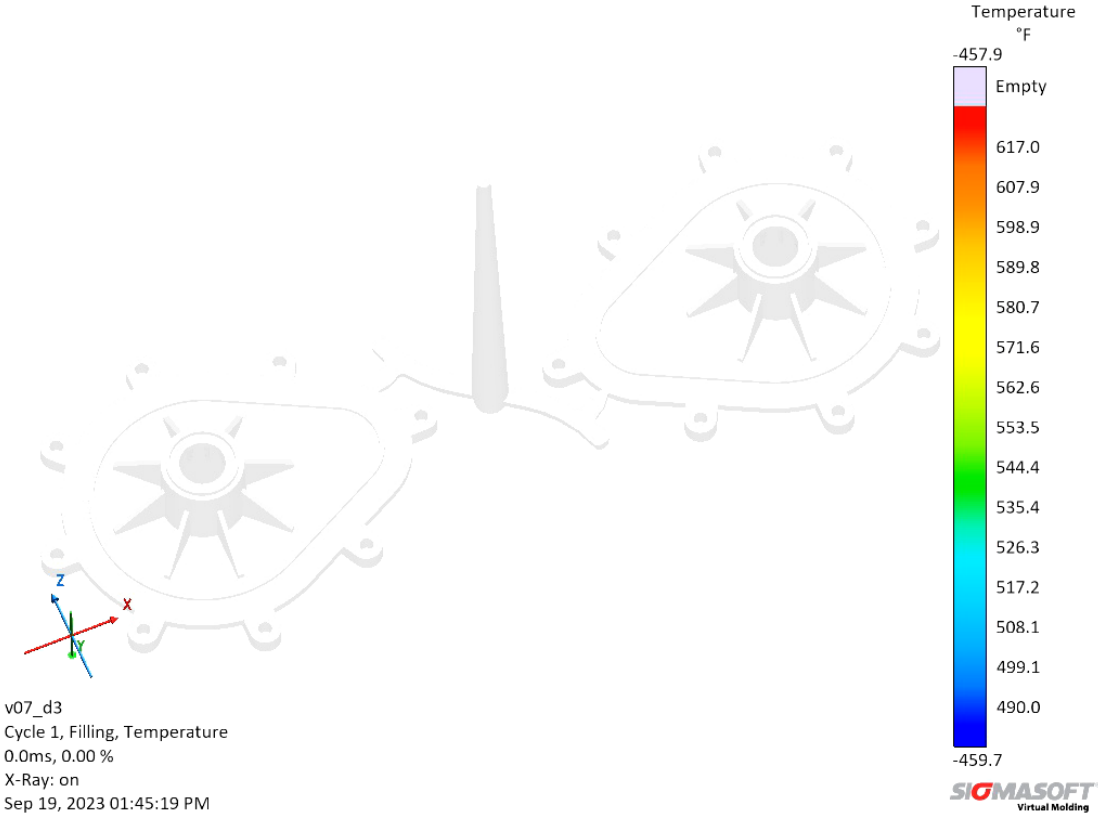
Filling Pattern



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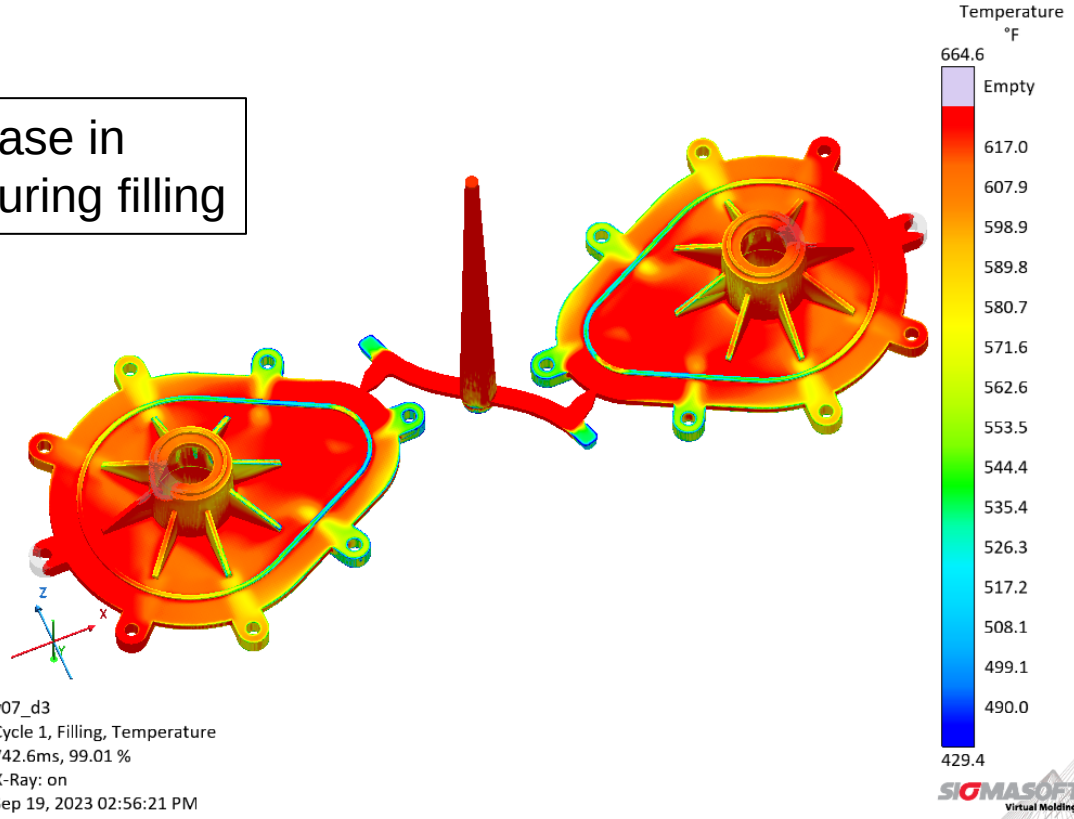
Filling Temperature

50F increase in temperature during filling



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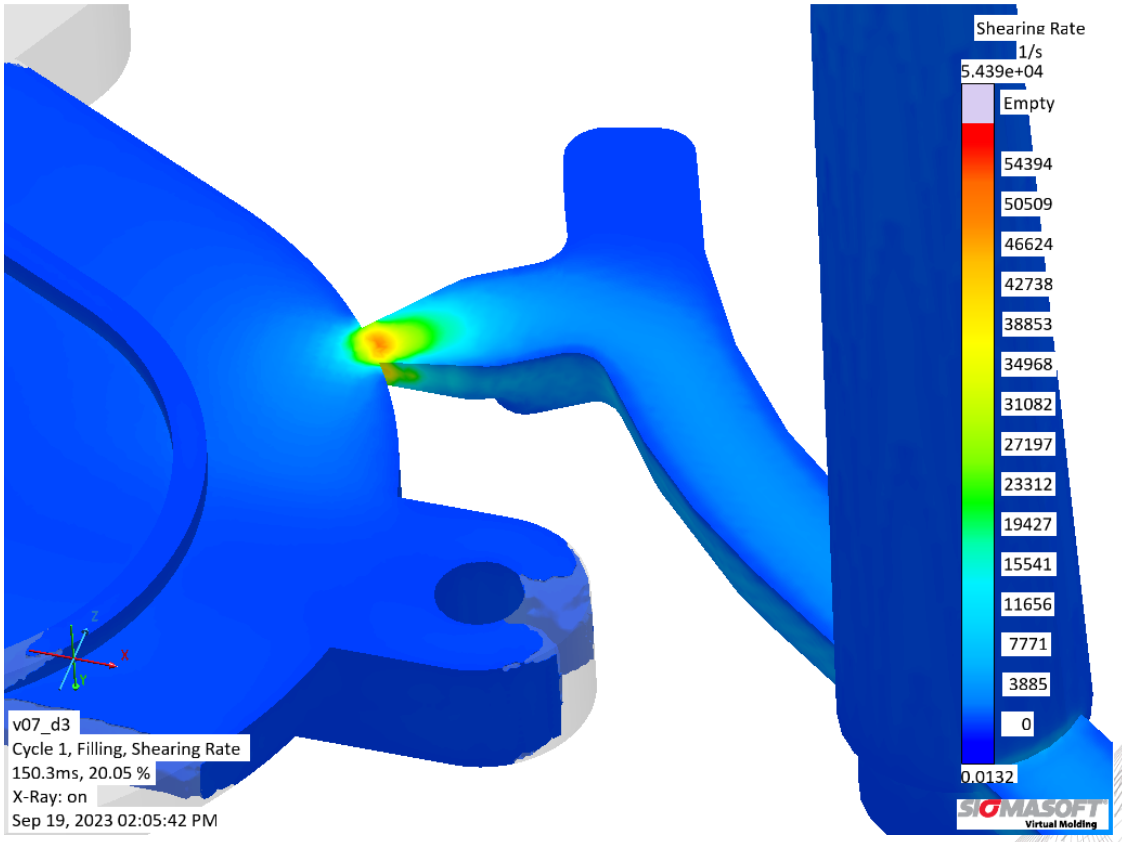
Shear Rate

The Shear Rate is 54,400 1/s

Shear rate value corresponds to the temperature increase



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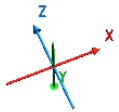
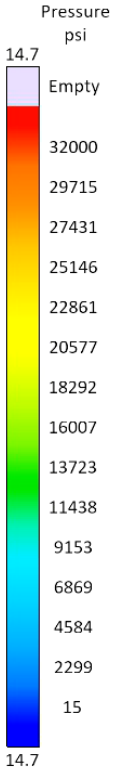
Filling Pattern



v02
Cycle 1, Filling, Pressure
0.0ms, 0.00 %
X-Ray: on
Sep 30, 2023 09:03:26 AM



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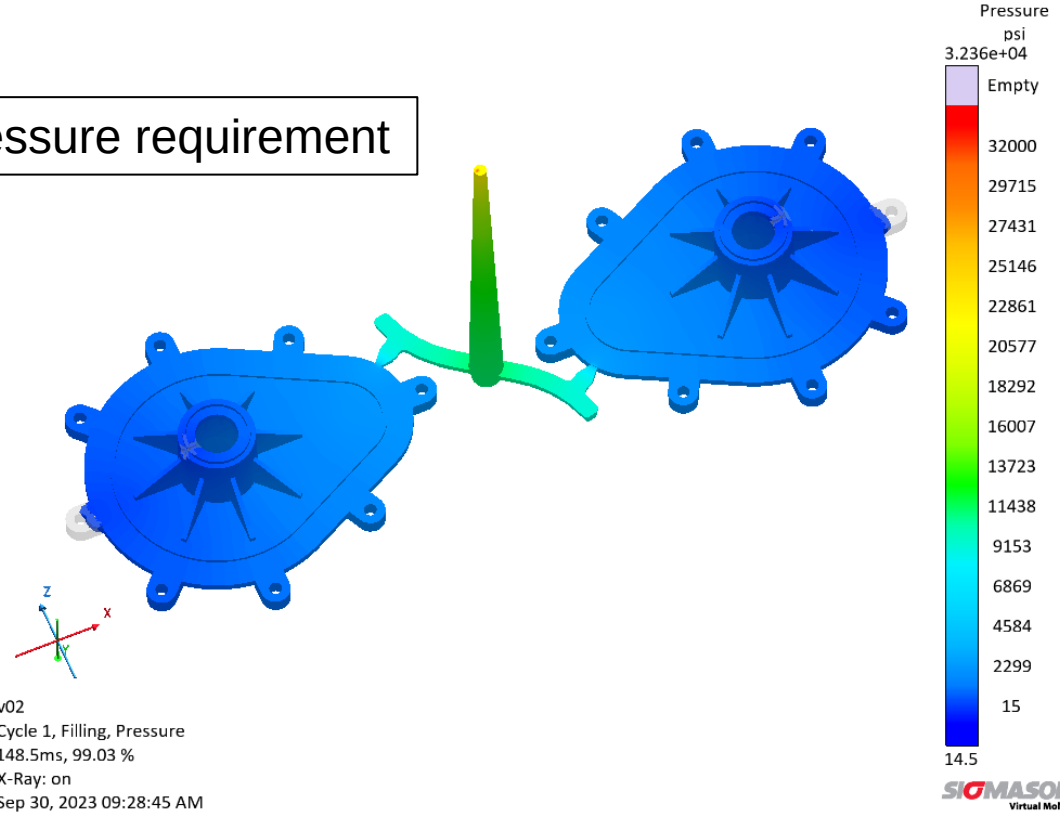
Filling Pressure

32,000 psi pressure requirement



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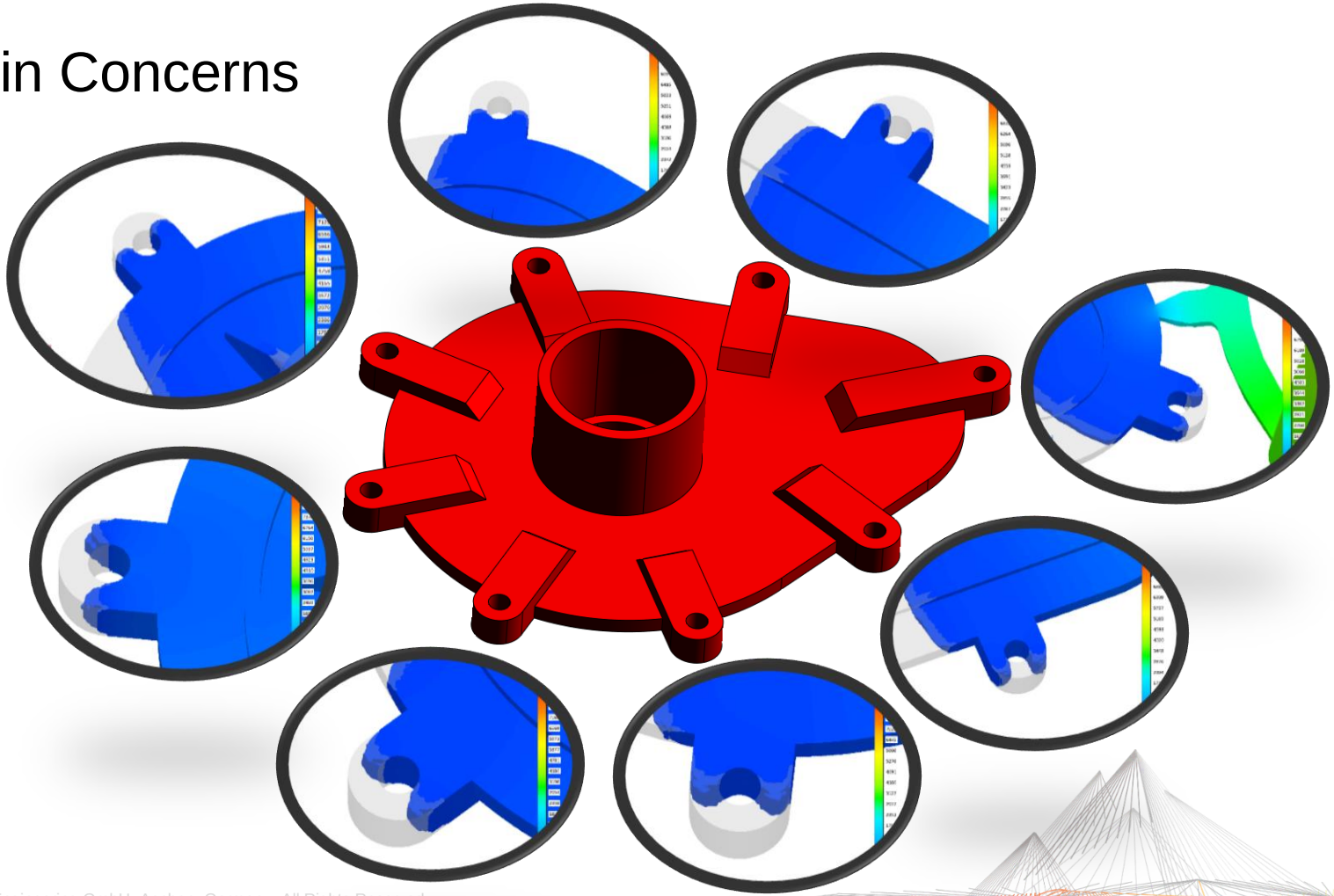
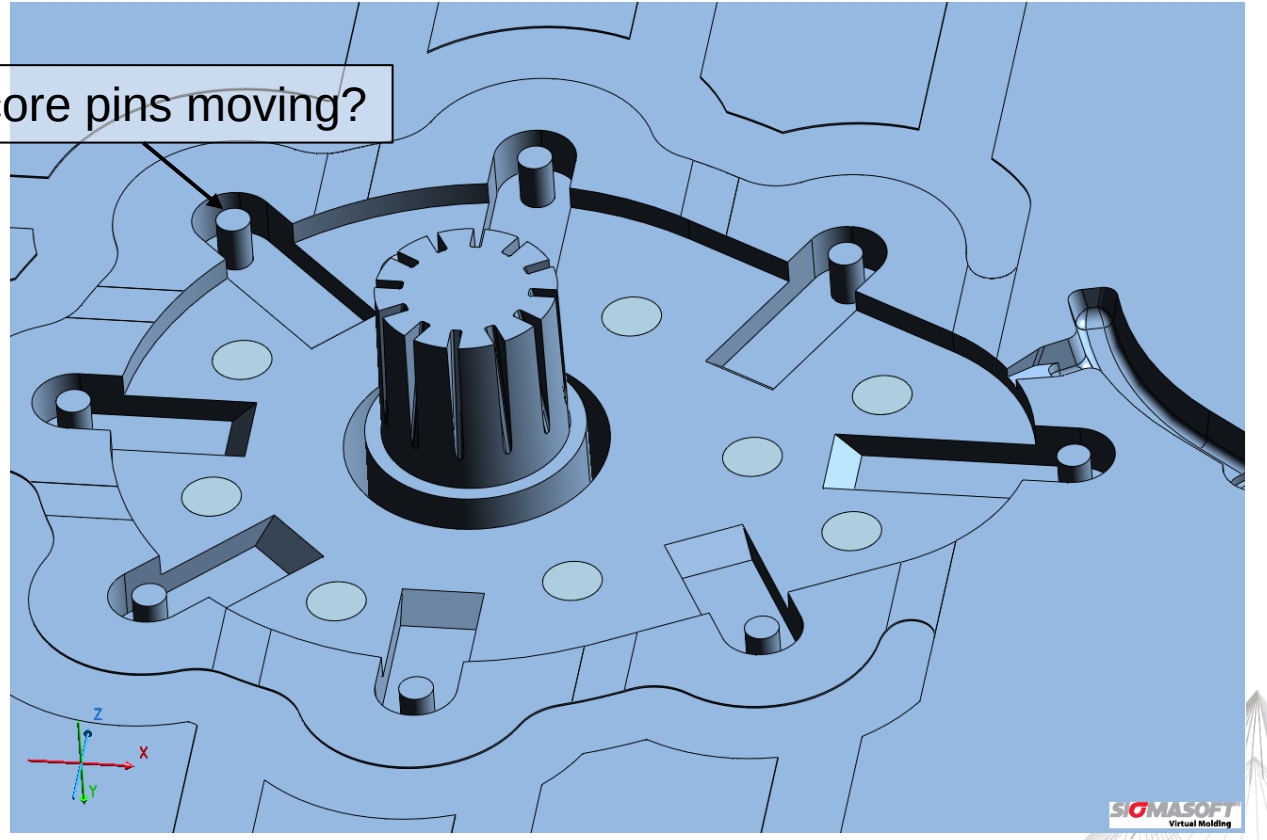
Core Pin Concerns

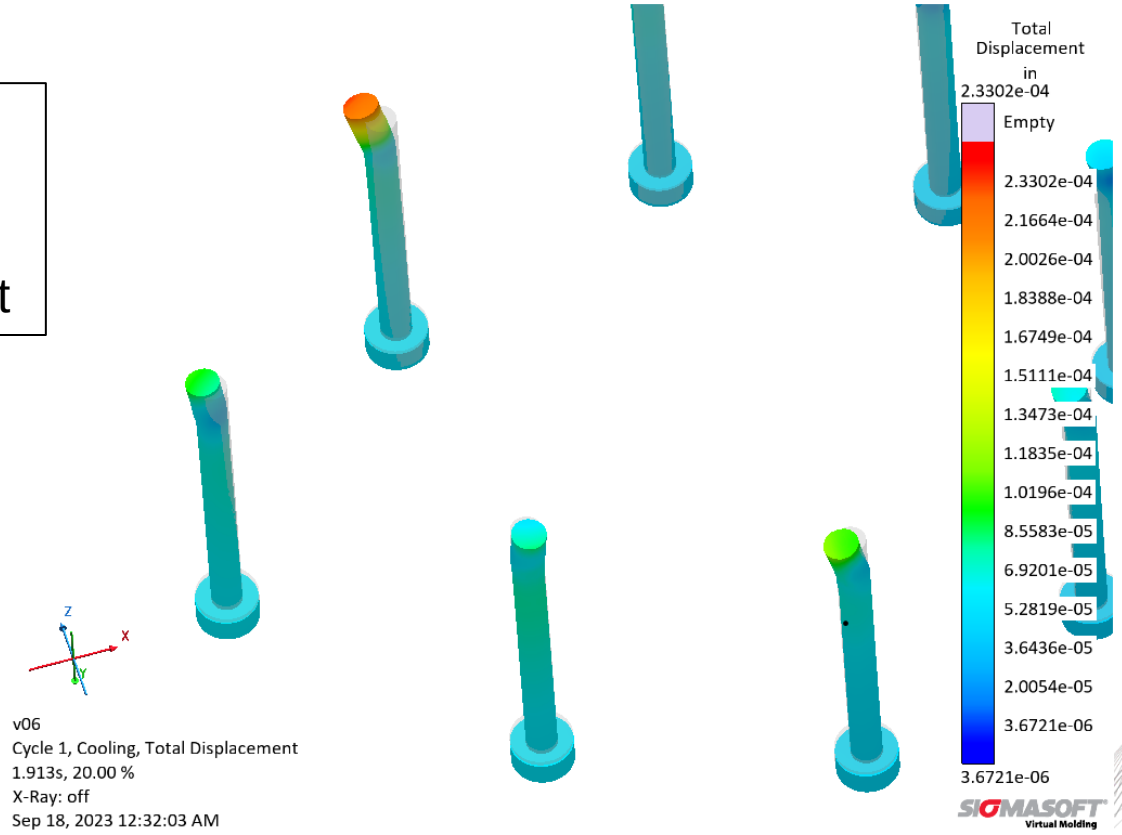


Stresses in the Core Pins



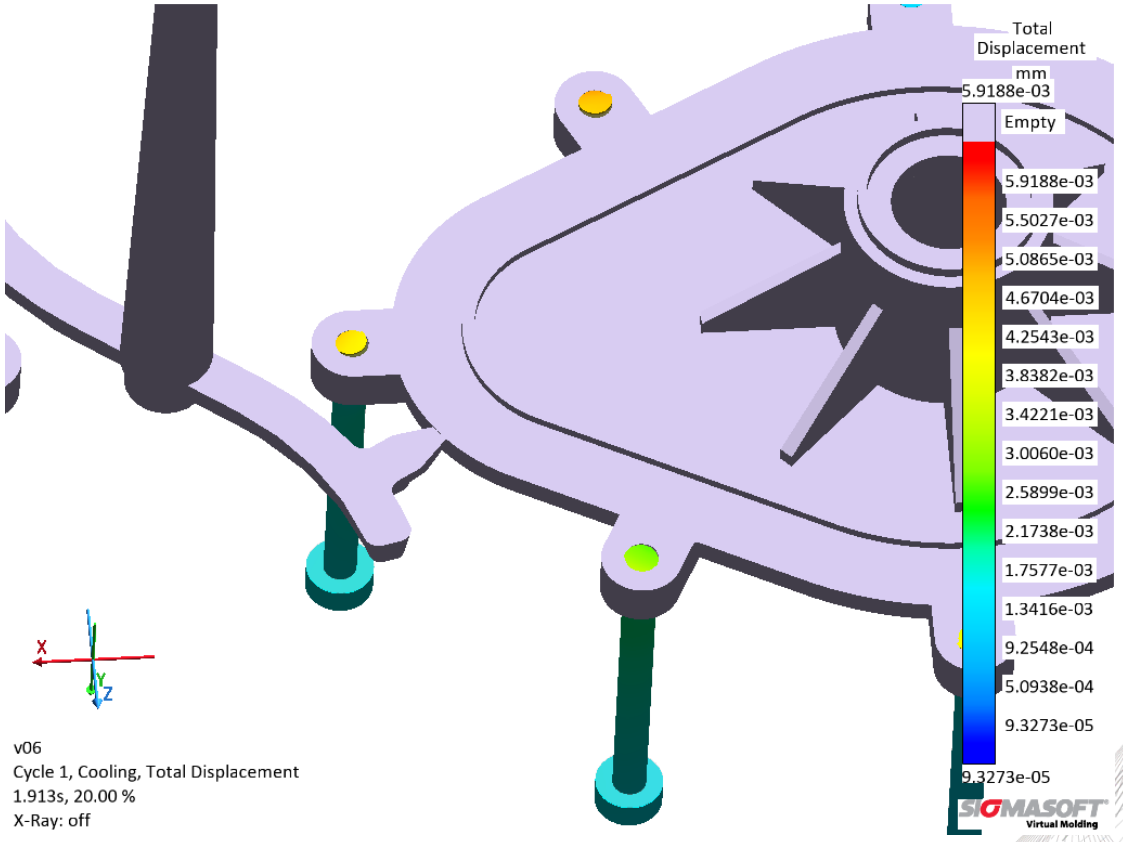
Deformation in the Core Pins

Core pins move in the direction that the flow hits it



How does this movement influence part quality?

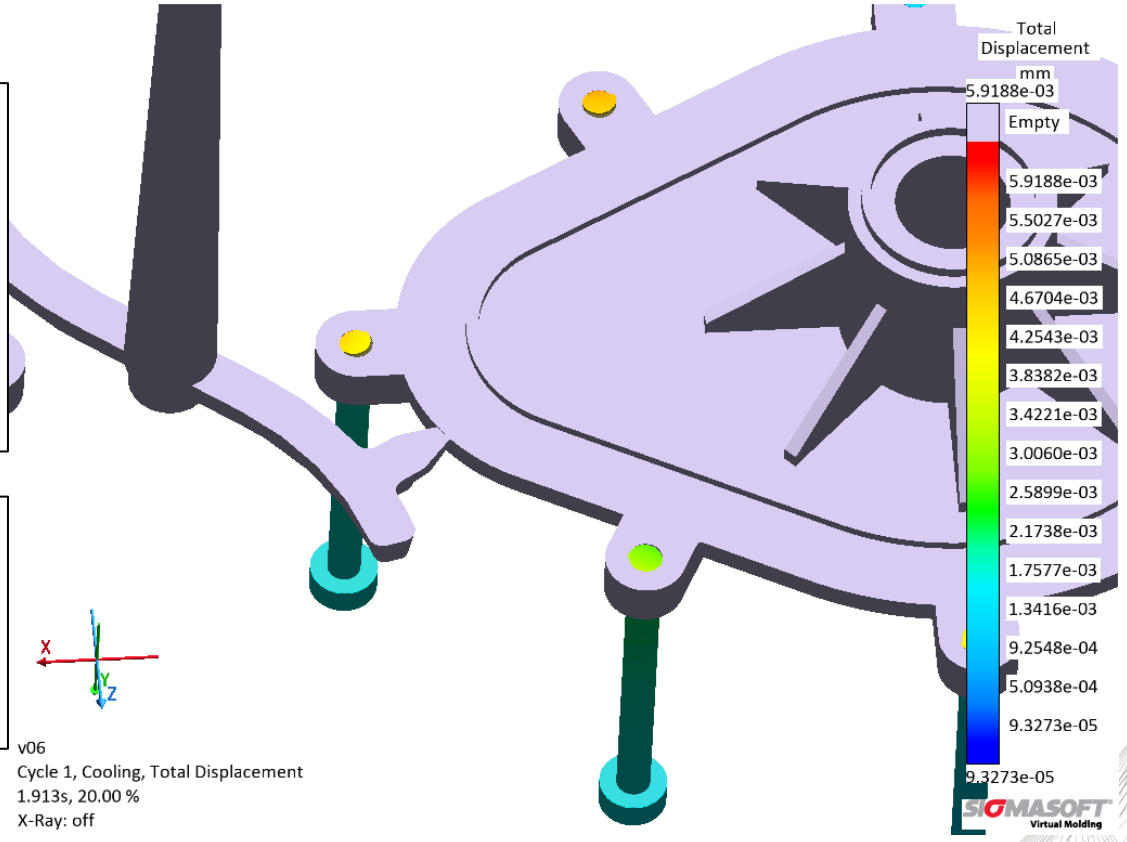
Shift the placement of the holes and cause assembly issues



How does this movement influence part quality?

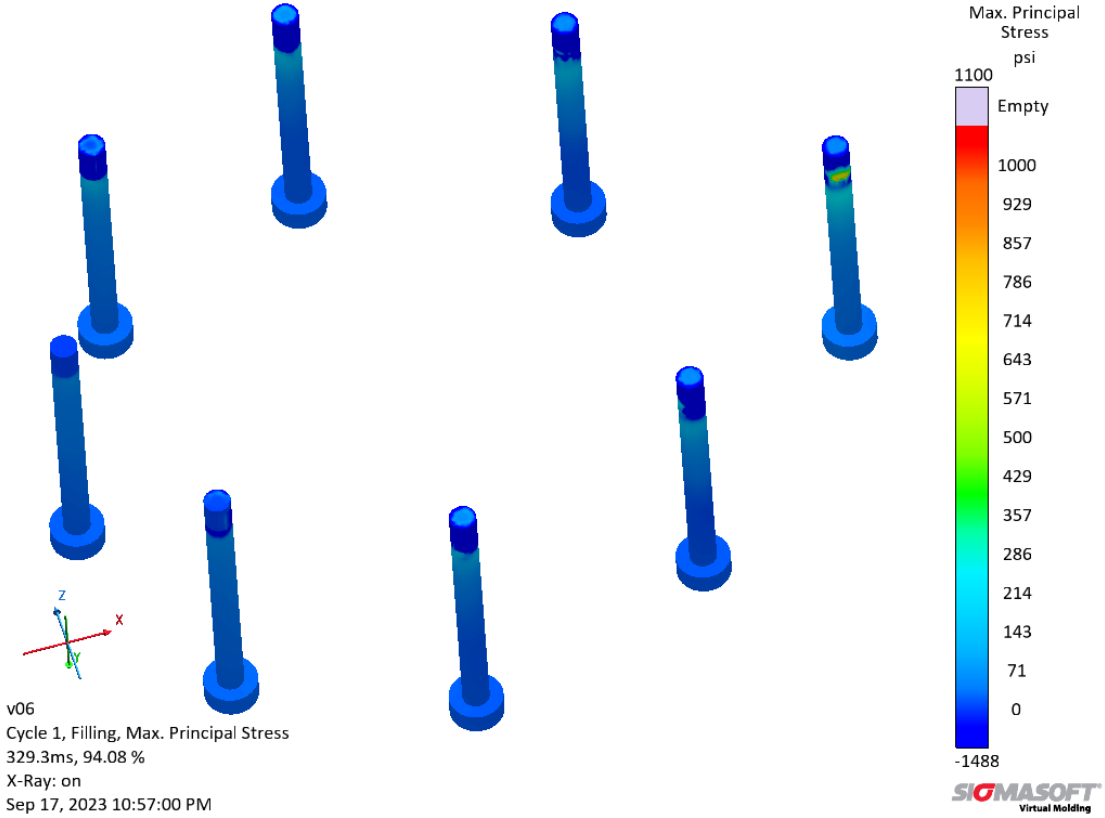
Create differences in wall thickness which can impact cooling time

Differences in cooling can lead to warpage



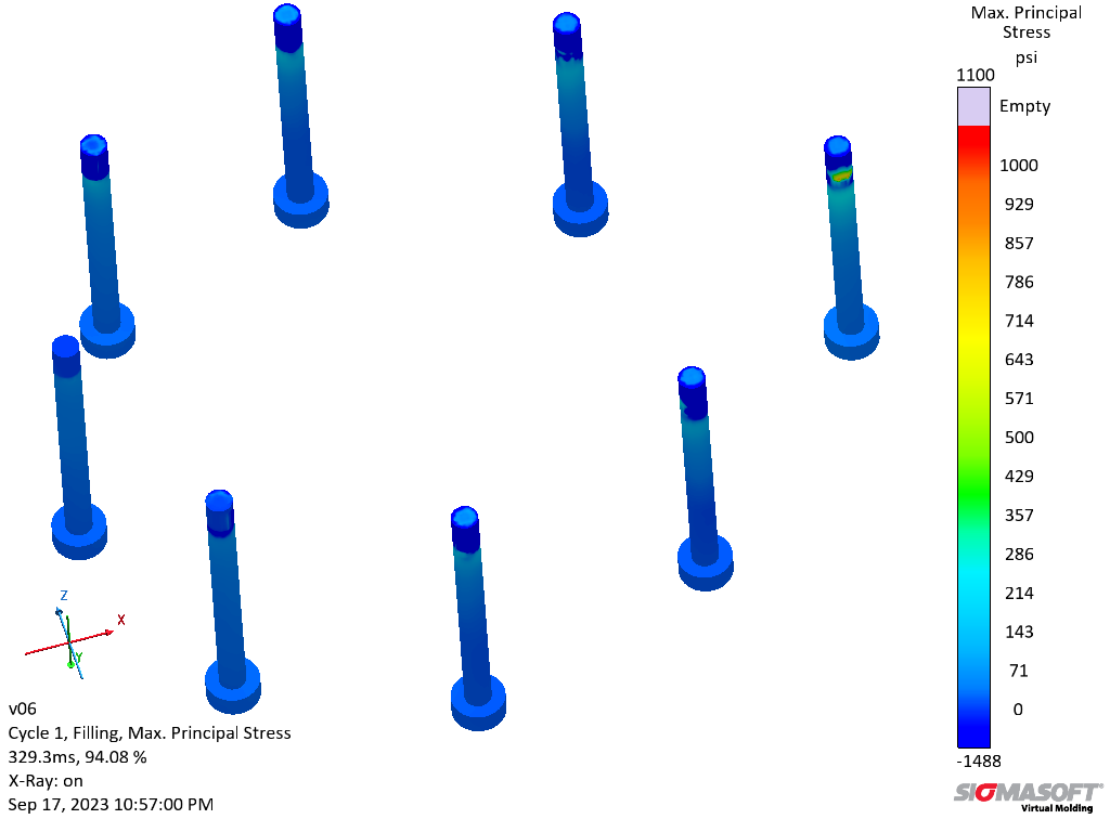
Stresses in the Core Pins during Filling

The highest stresses are located just above where the core pin touches the core block



Stresses in the Core Pins during Filling

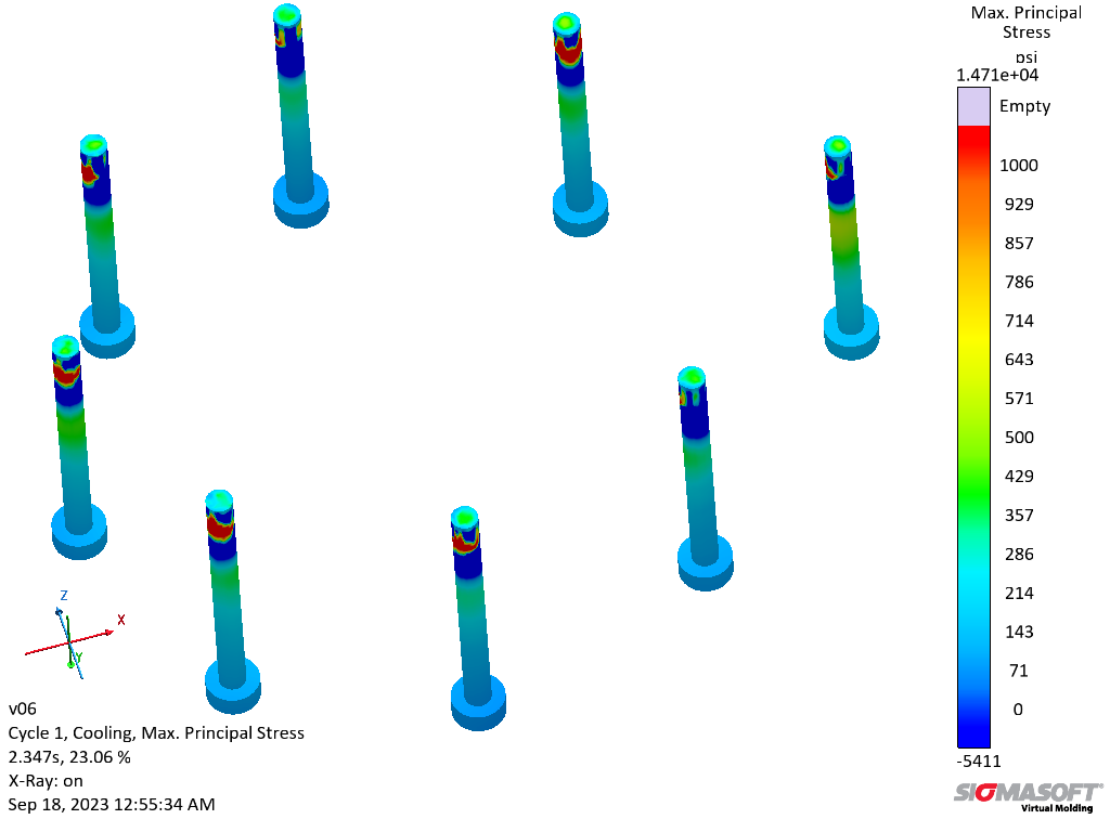
Stresses are not high enough to break the pins



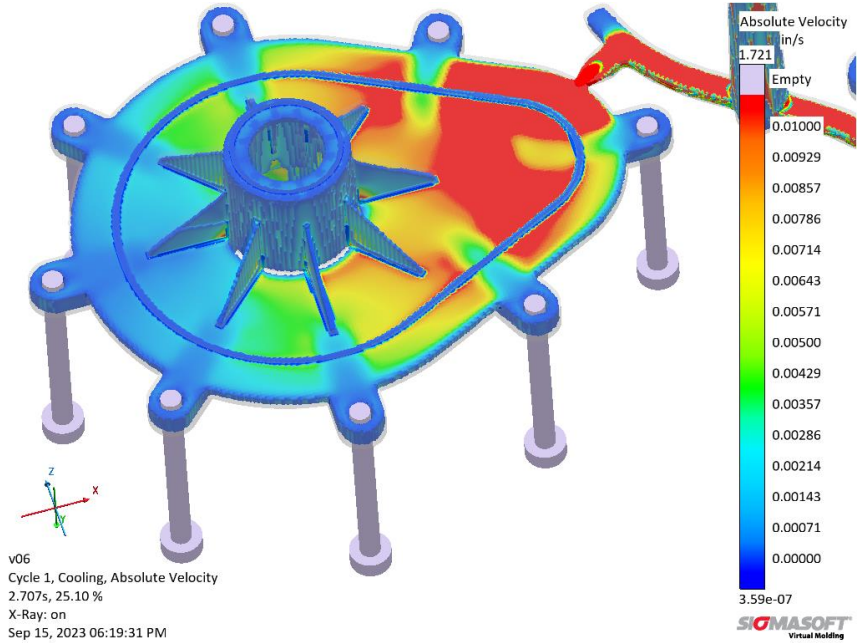
Stresses in the Core Pins during Packing

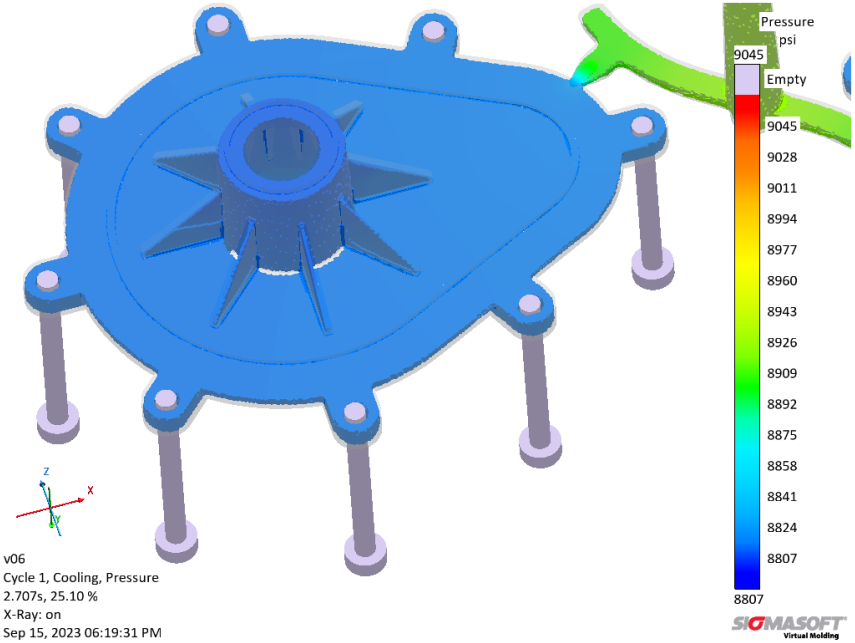
Stress increases during packing

Stresses are not high enough to break the pins



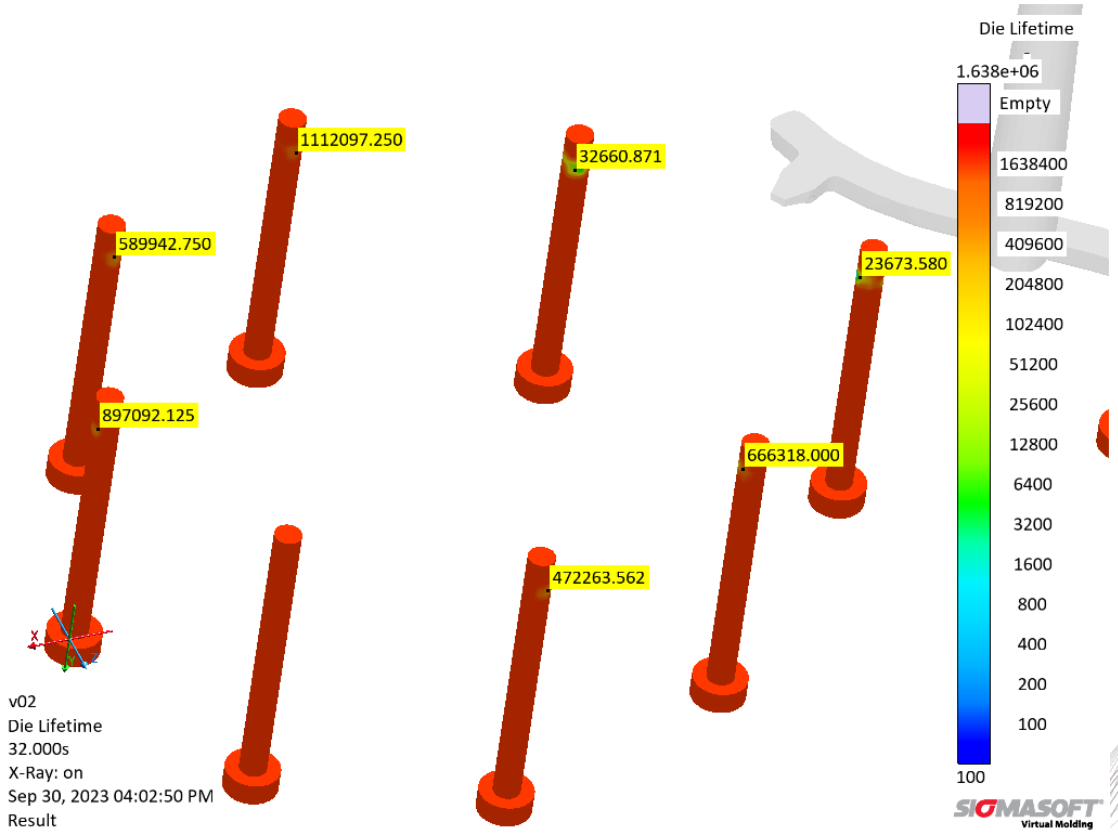
Why is the force higher during Packing?





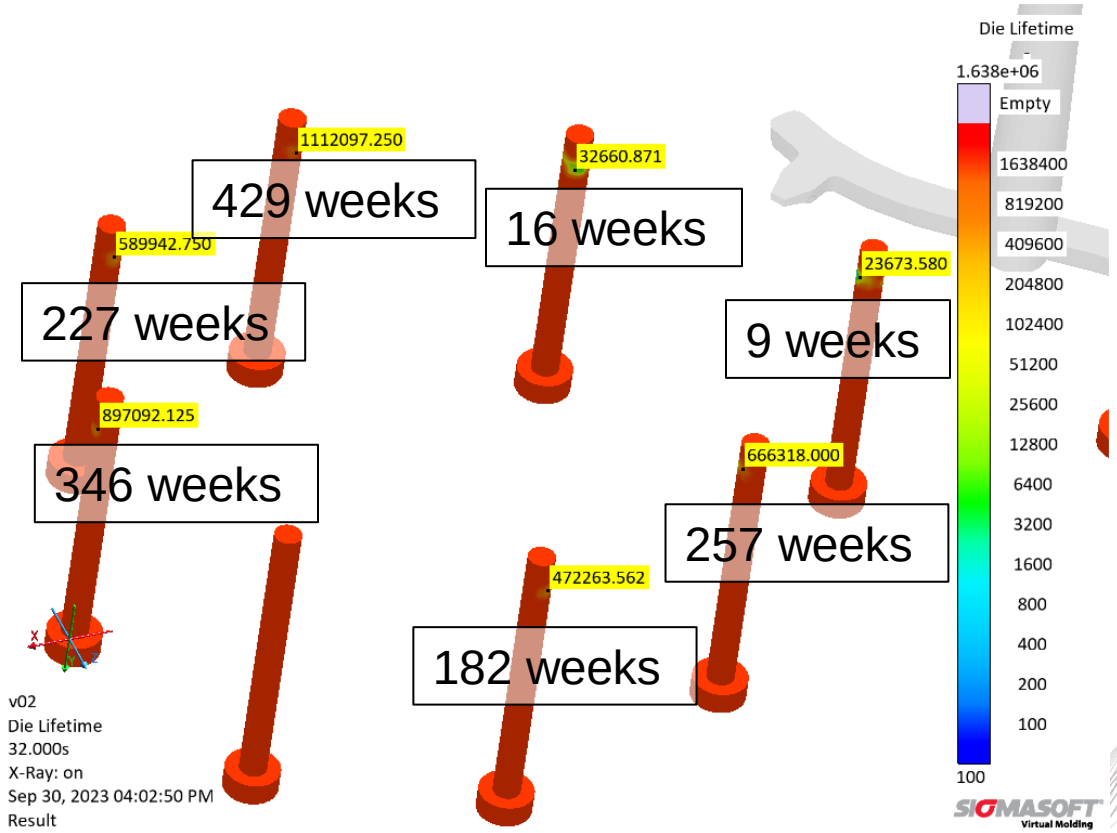
Wear and Tear

How the mold runs would determine how often the cores would need to be replaced



Wear and Tear

Assuming the tool runs 12 hours a day and 6 days a week

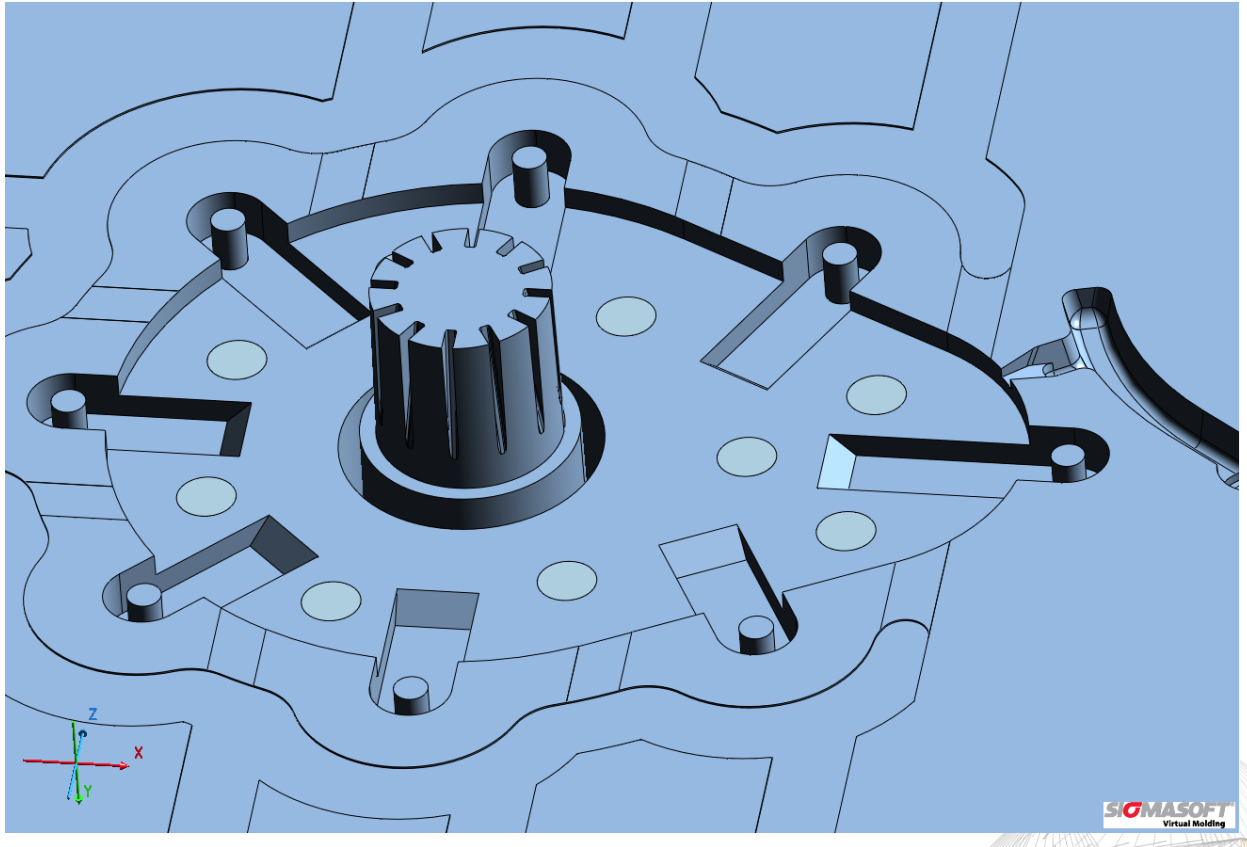


Does our Process influence the Wear and Tear?

Filling Time between 0.25 to 2 seconds

Part Temperature between 590F to 644F

Mold Temperature between 248F to 320F



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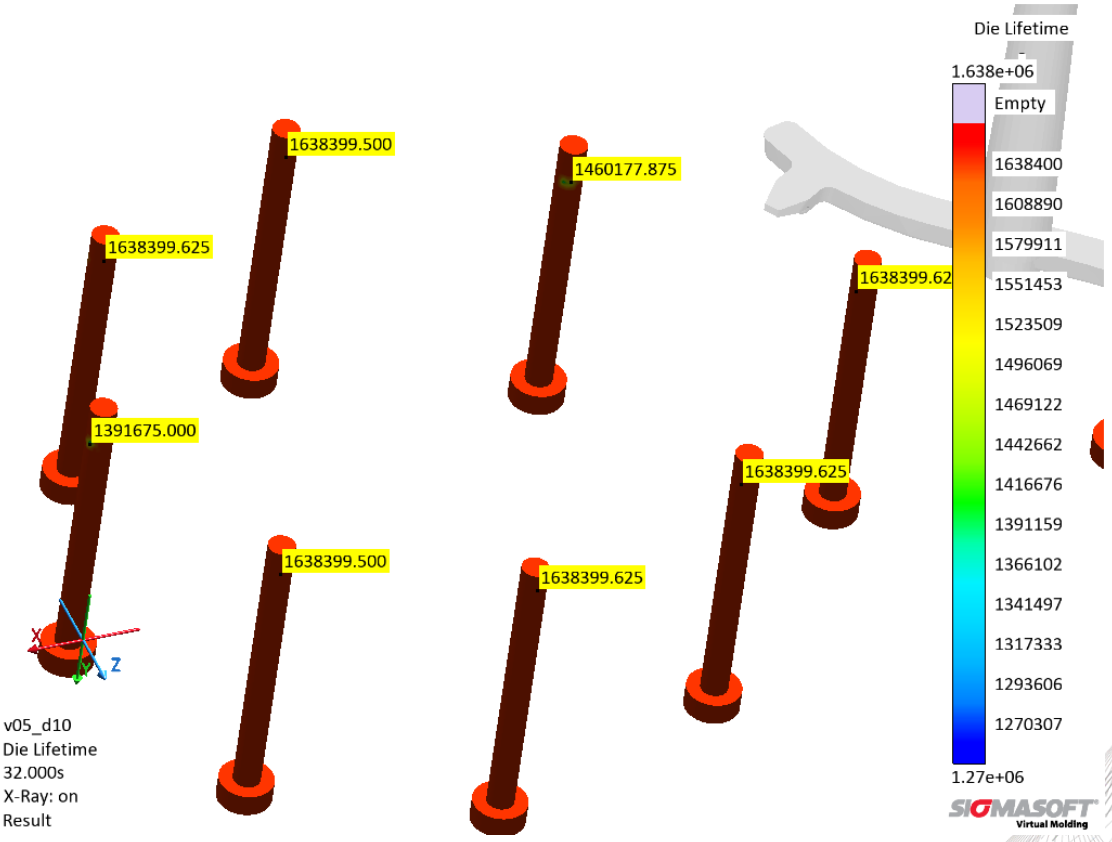
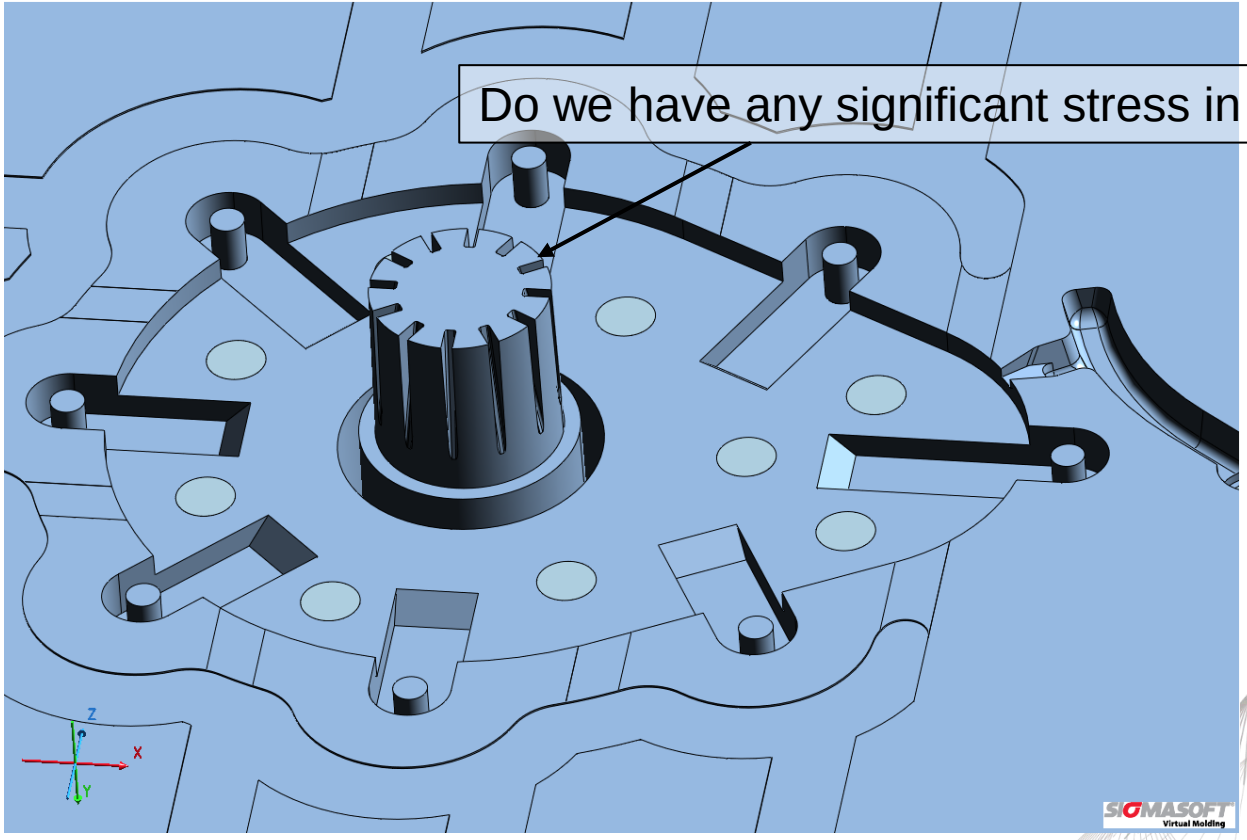
Does our Process influence the Wear and Tear?

Running a fill time slower than 0.5 seconds

However, short shots start to happen above 1.5 seconds



Next Area of concern



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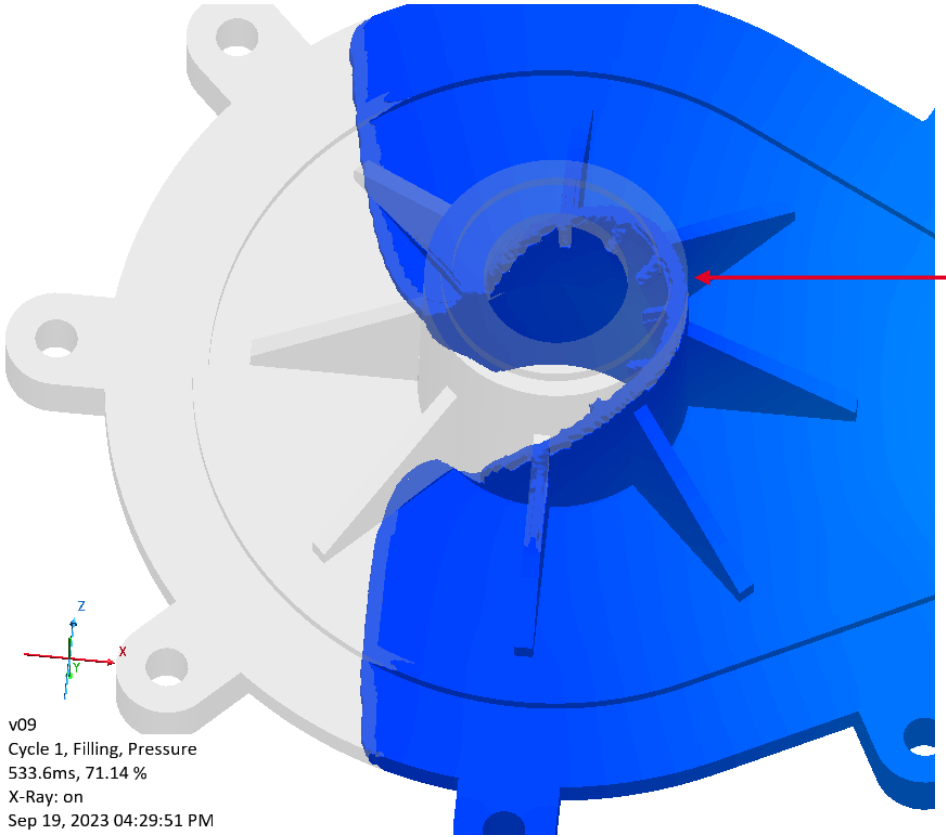
Filling Pattern



Melt is pushing on the core without any resistance from the other side

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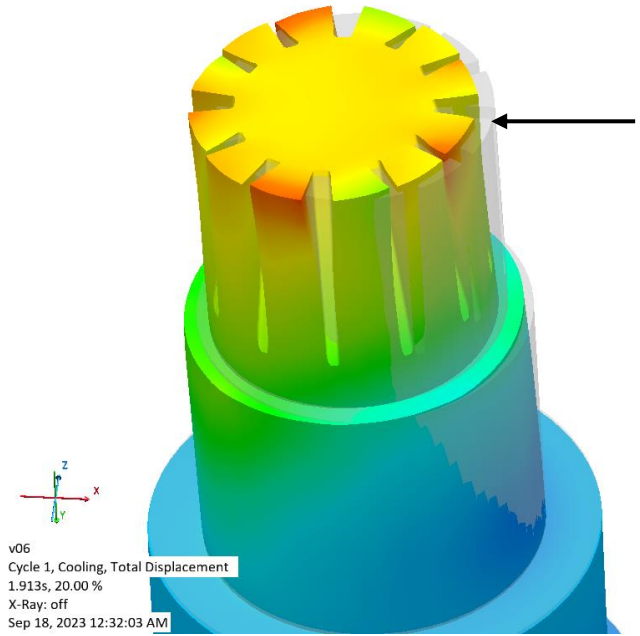
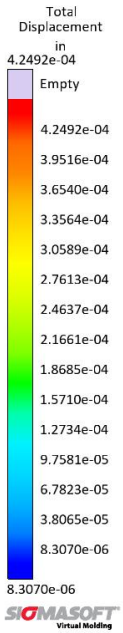
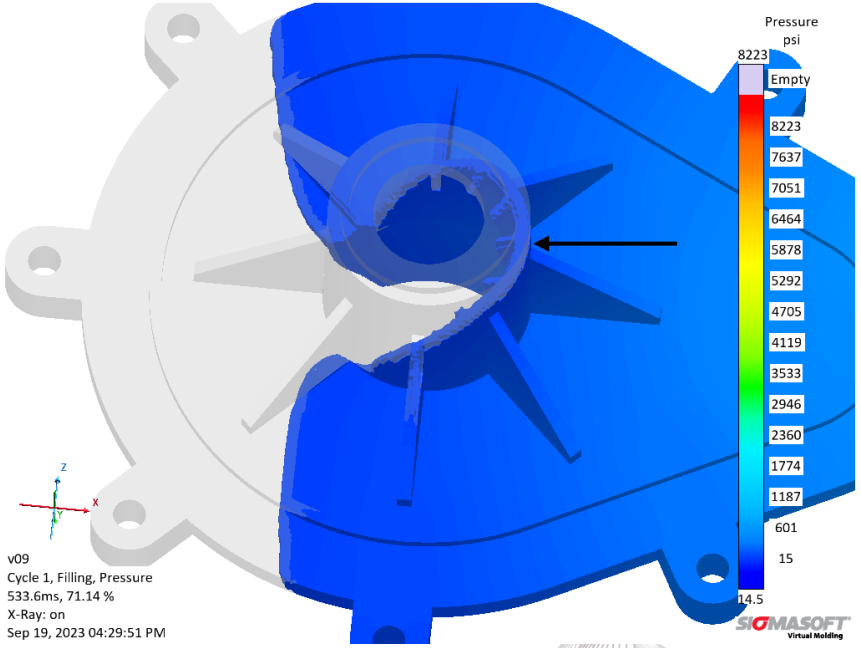
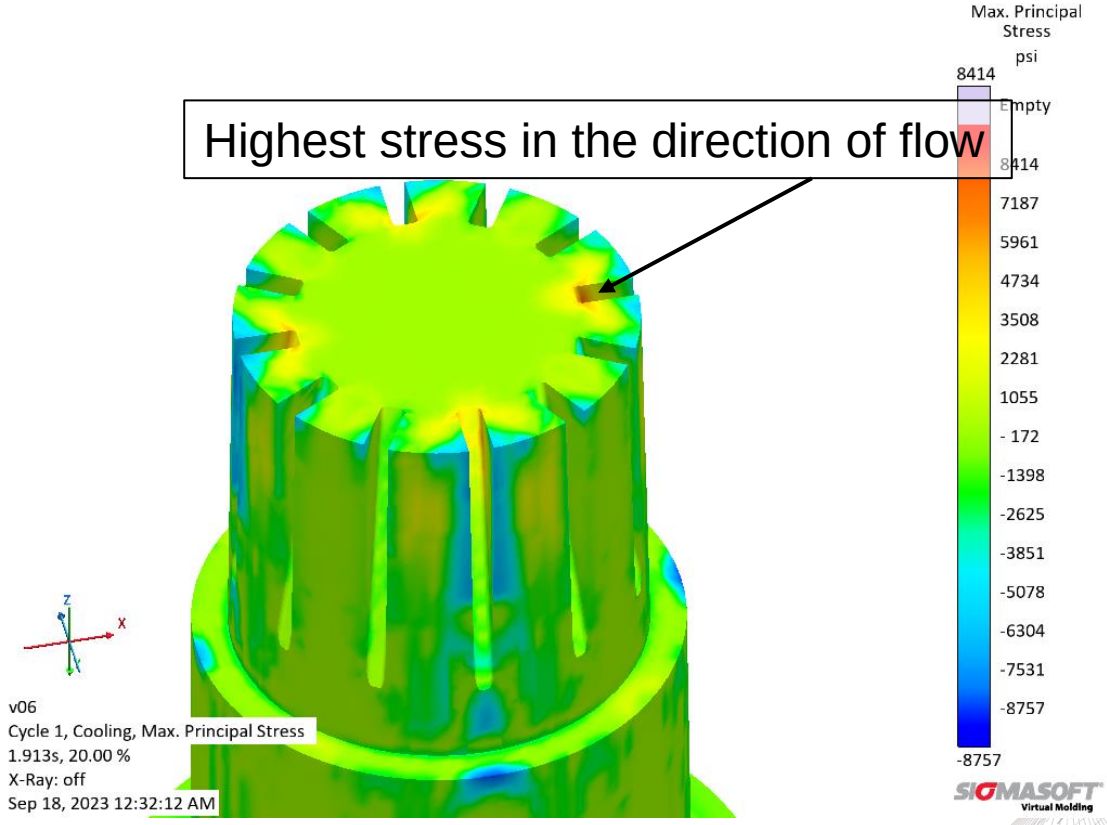
Pressure influence on the core movement







Wear and Tear



Wear and Tear

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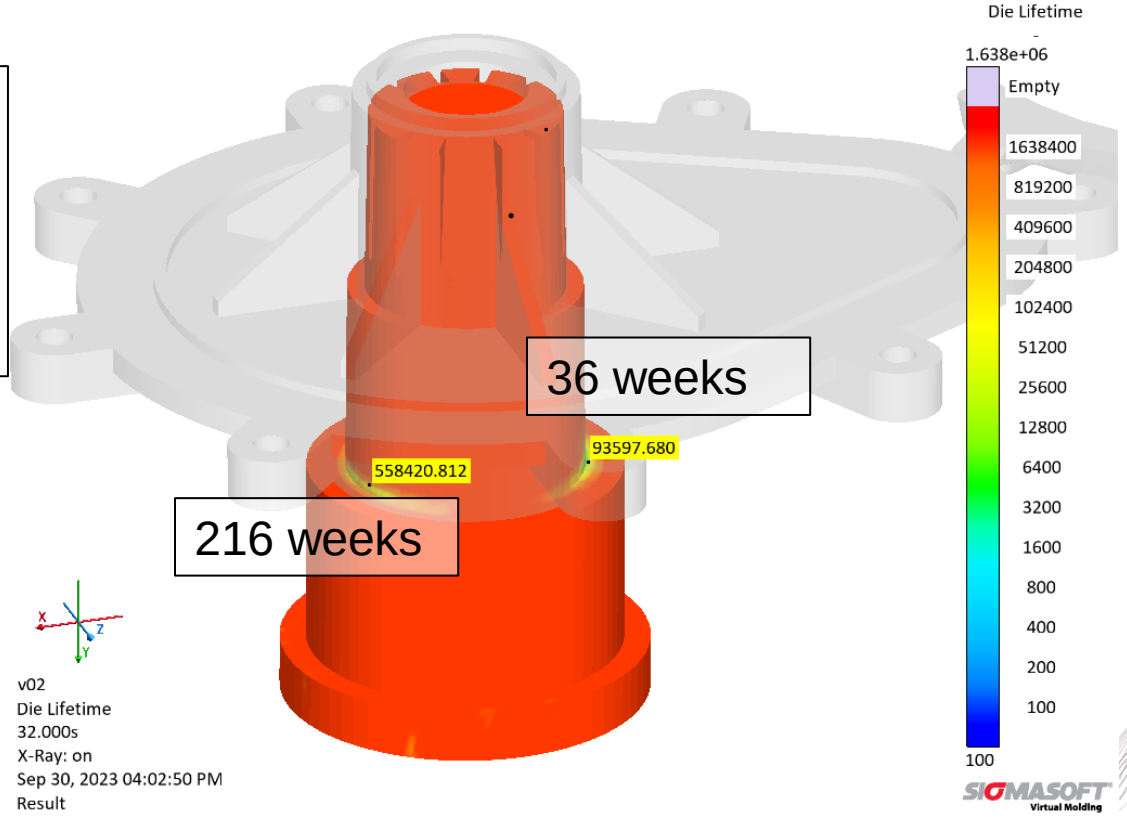
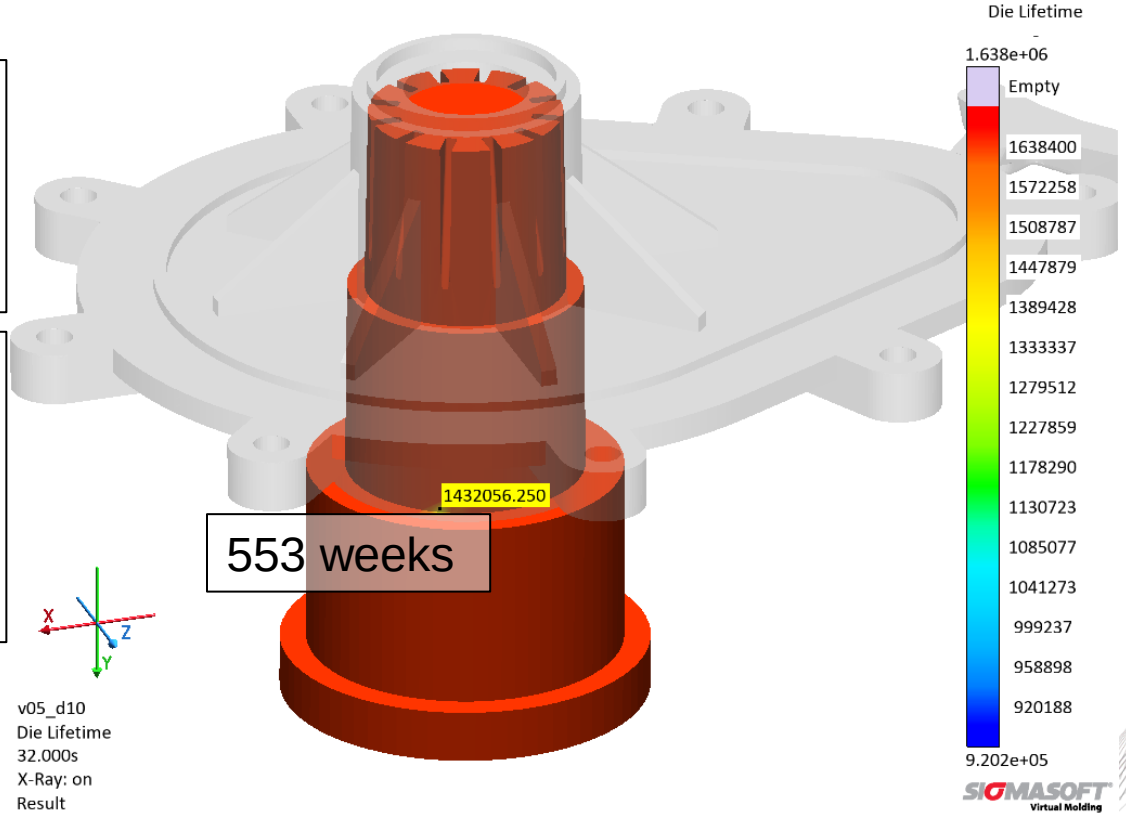


Does our Process influence the Wear and Tear?

Running a fill time slower than 0.5 seconds

However, short shots start to happen at 1.75 seconds



New Process Parameters

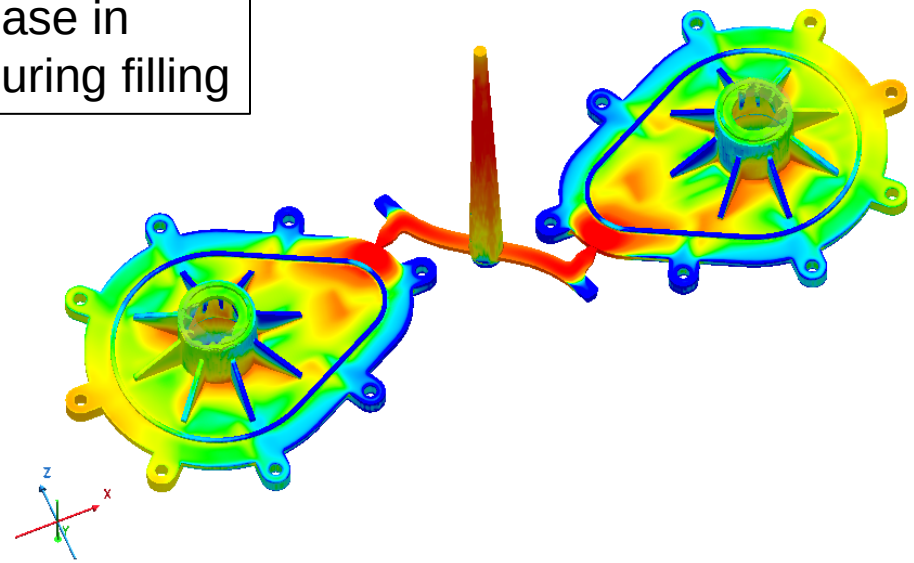
Previous	New
Polymer Temperature – 617F	Polymer Temperature – 590F
Mold Temperature – 284F	Mold Temperature – 284F
Fill Time – 0.3 seconds	Fill Time – 0.5 seconds
Packing Pressure – 15,900 psi	Packing Pressure – 14,700 psi
Cooling Time – 10 seconds	Cooling Time – 10 seconds

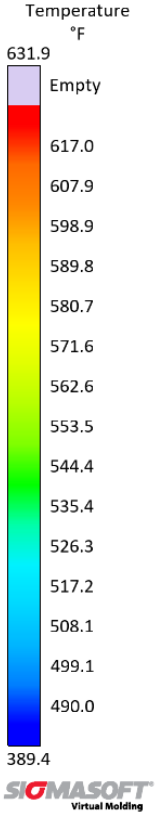
Review the final parameters to check other issues

- Filling
- Packing
- Cooling
- Shrinkage & Warpage

Filling Temperature

15F increase in temperature during filling





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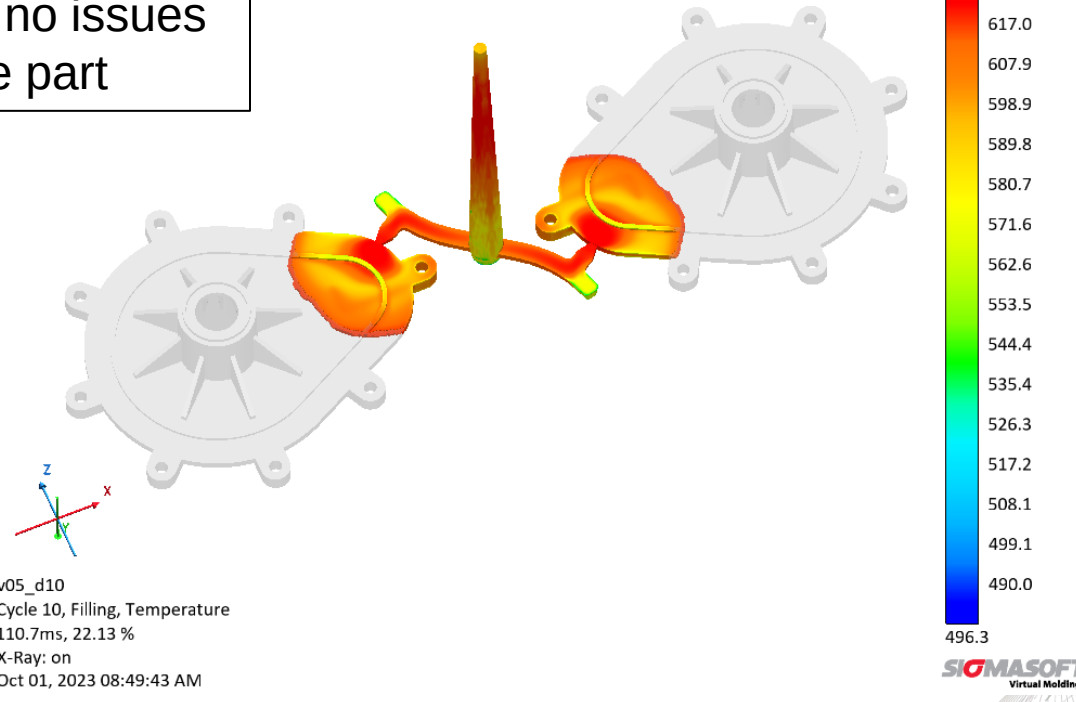
Investigating the areas cooling down quickly

Should have no issues filling the part



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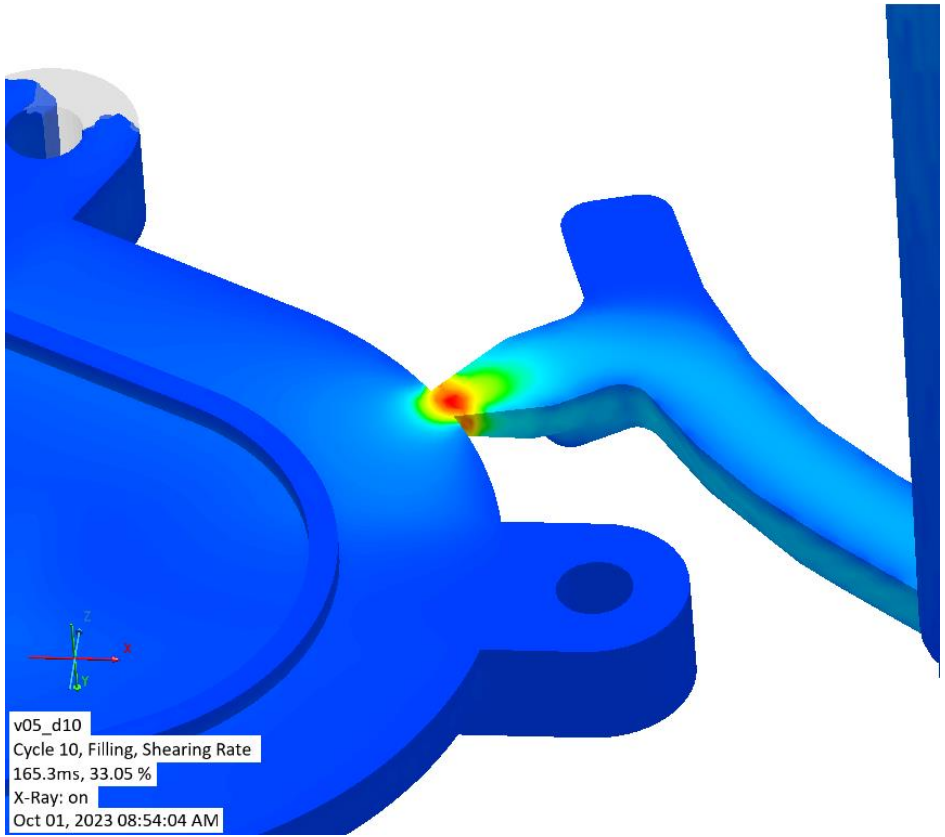
Shear Rate

The Shear Rate is 45,000 1/s

Shear rate value corresponds to the temperature increase



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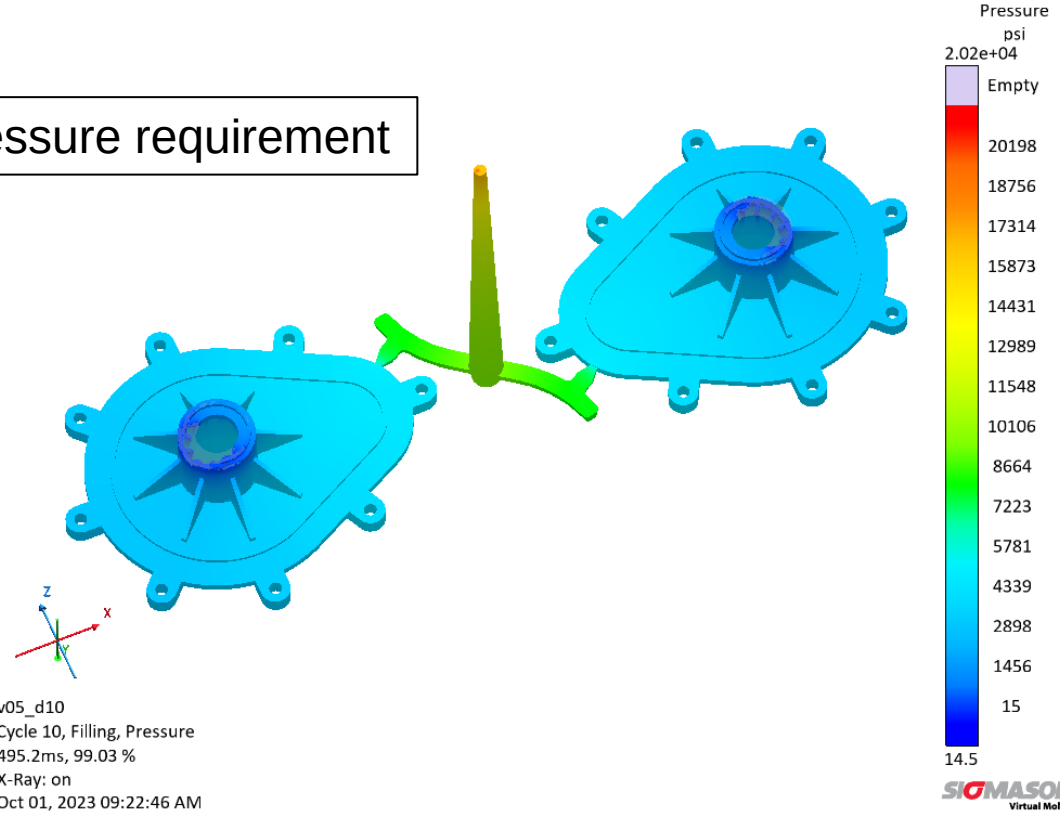
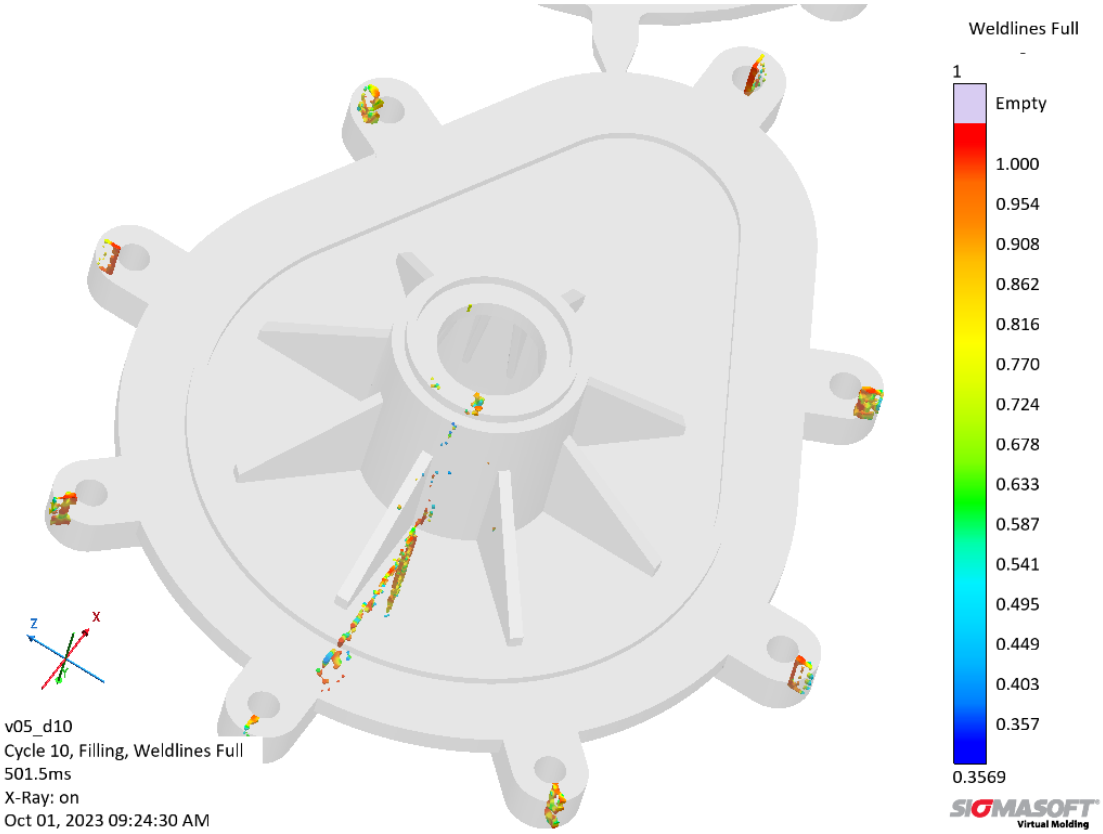
Filling Pressure

20,200 psi pressure requirement



MAPP 2023

Weldline Locations



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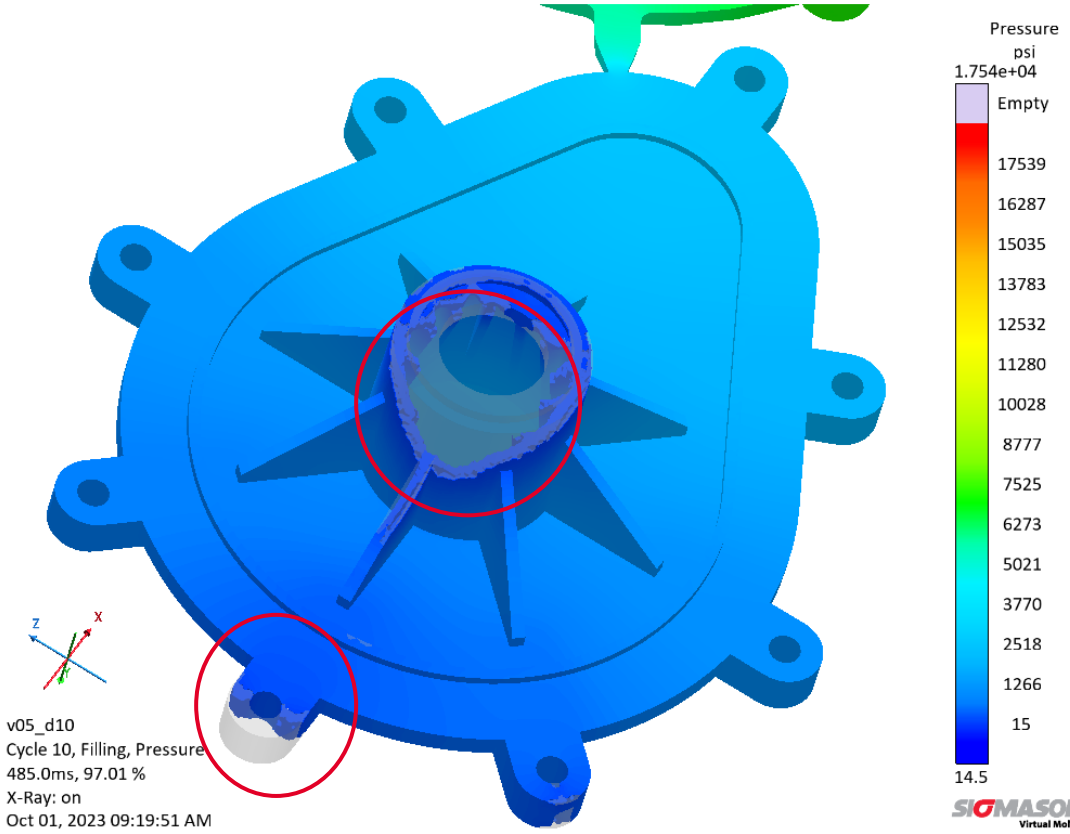
Air Entrapment



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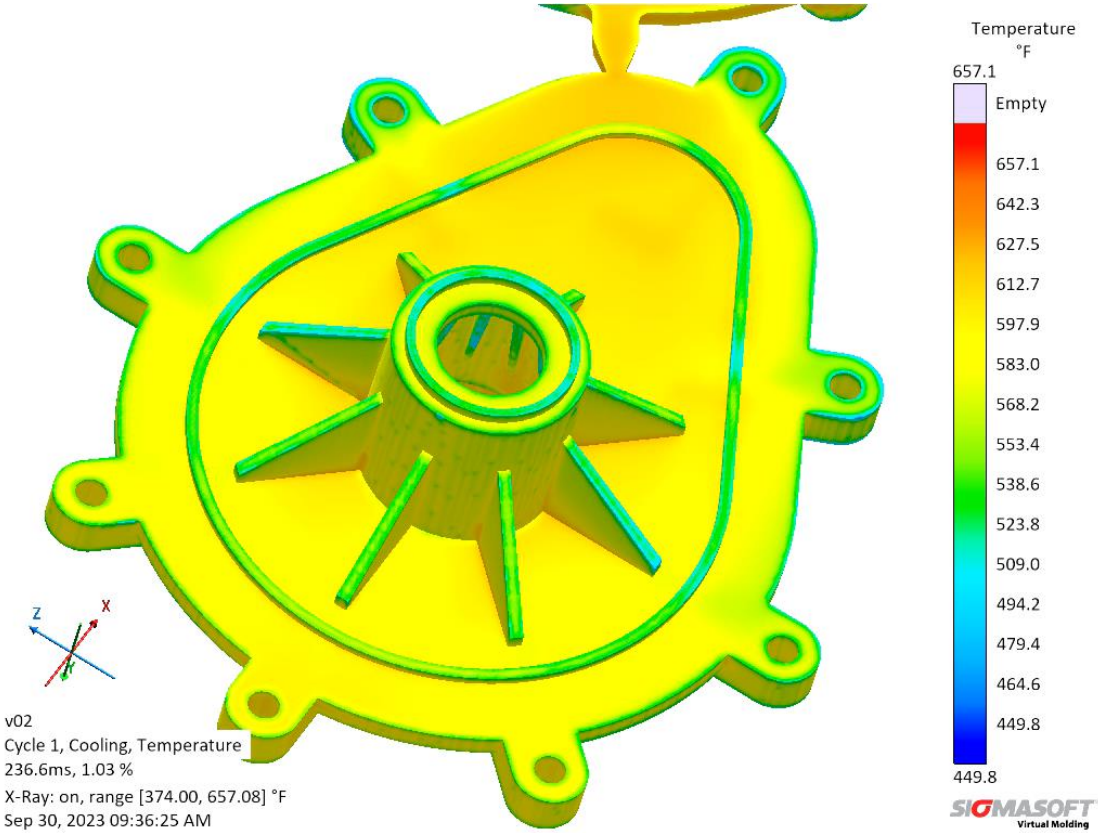
Cooling Pattern



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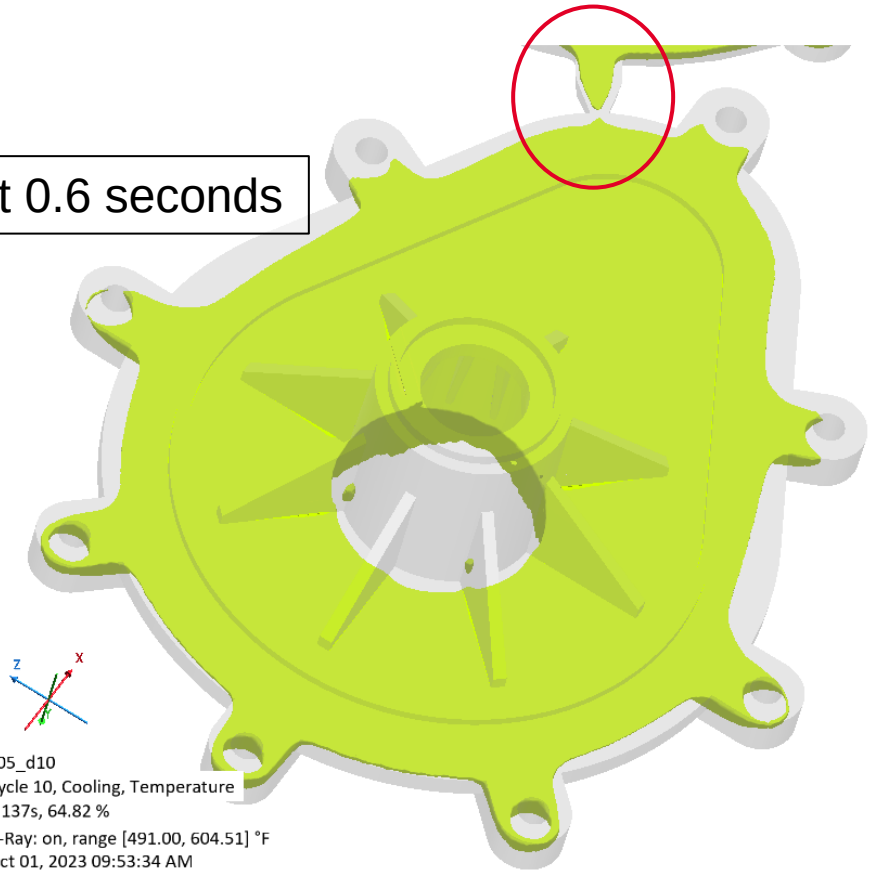
Gate Freeze

Gate Freeze at 0.6 seconds



All molten material will continue to cool down without any packing pressure

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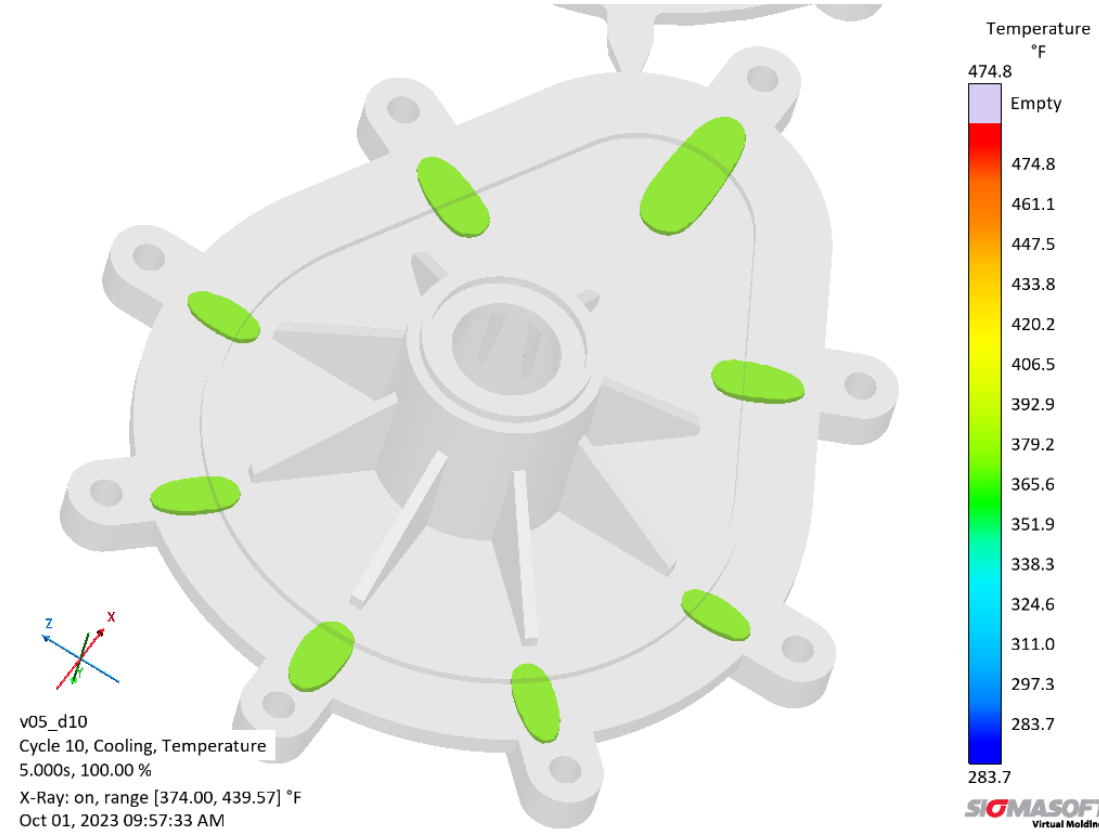
Last Areas to Cool



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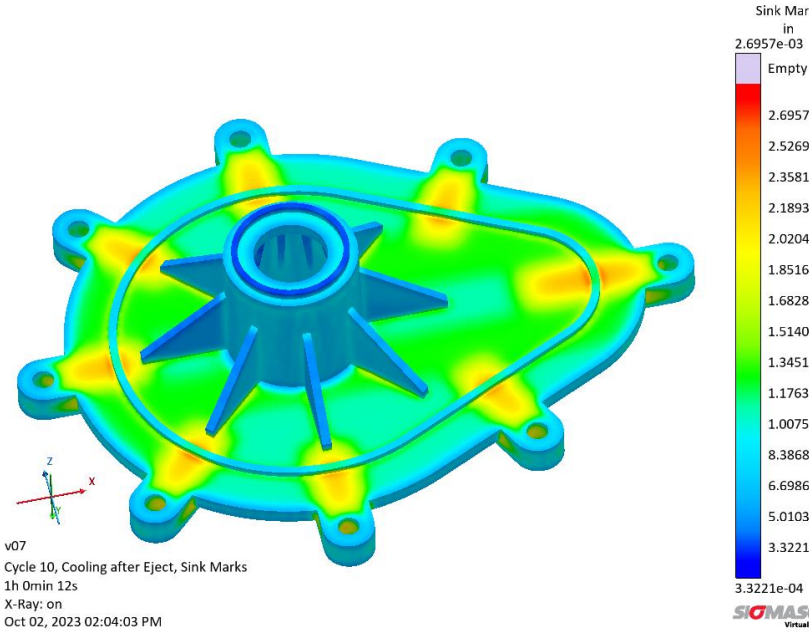
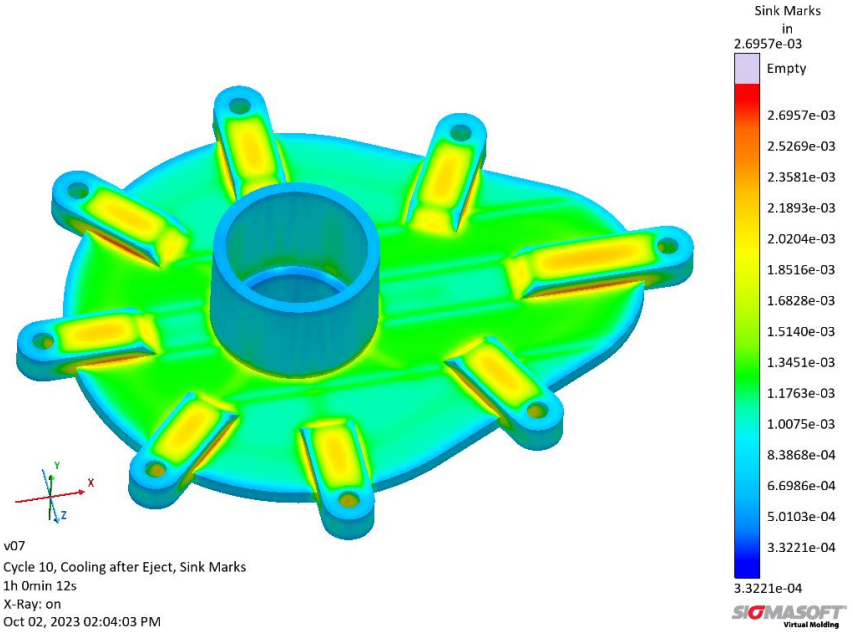
Sink Marks





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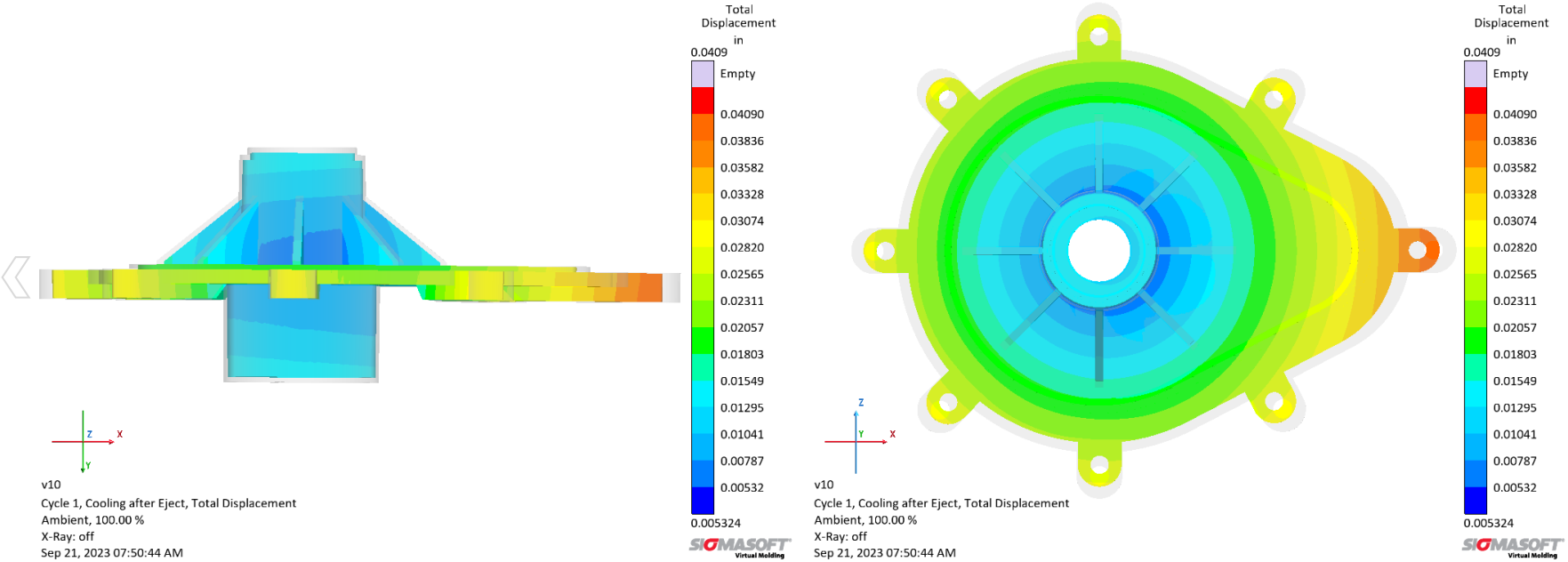
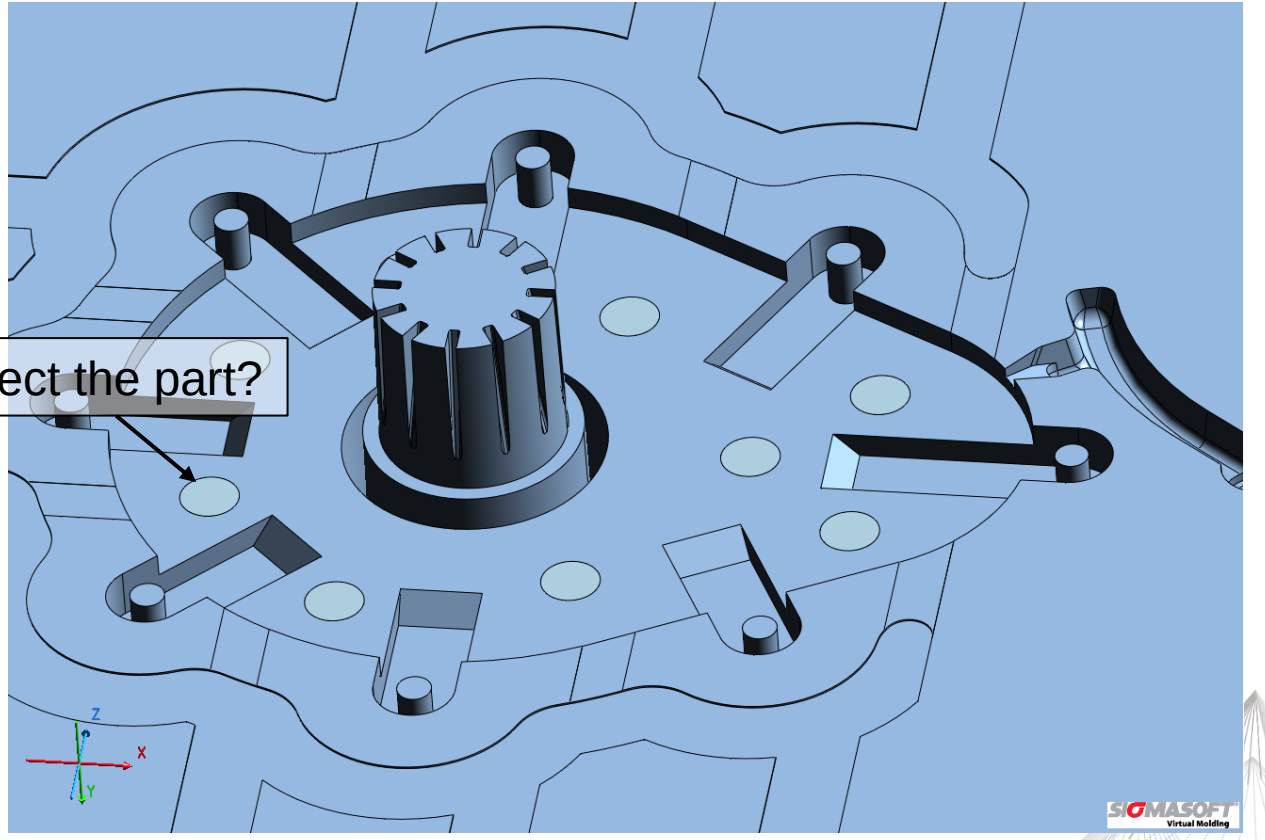
Shrinkage & Warpage



While we are investigating the mold design…



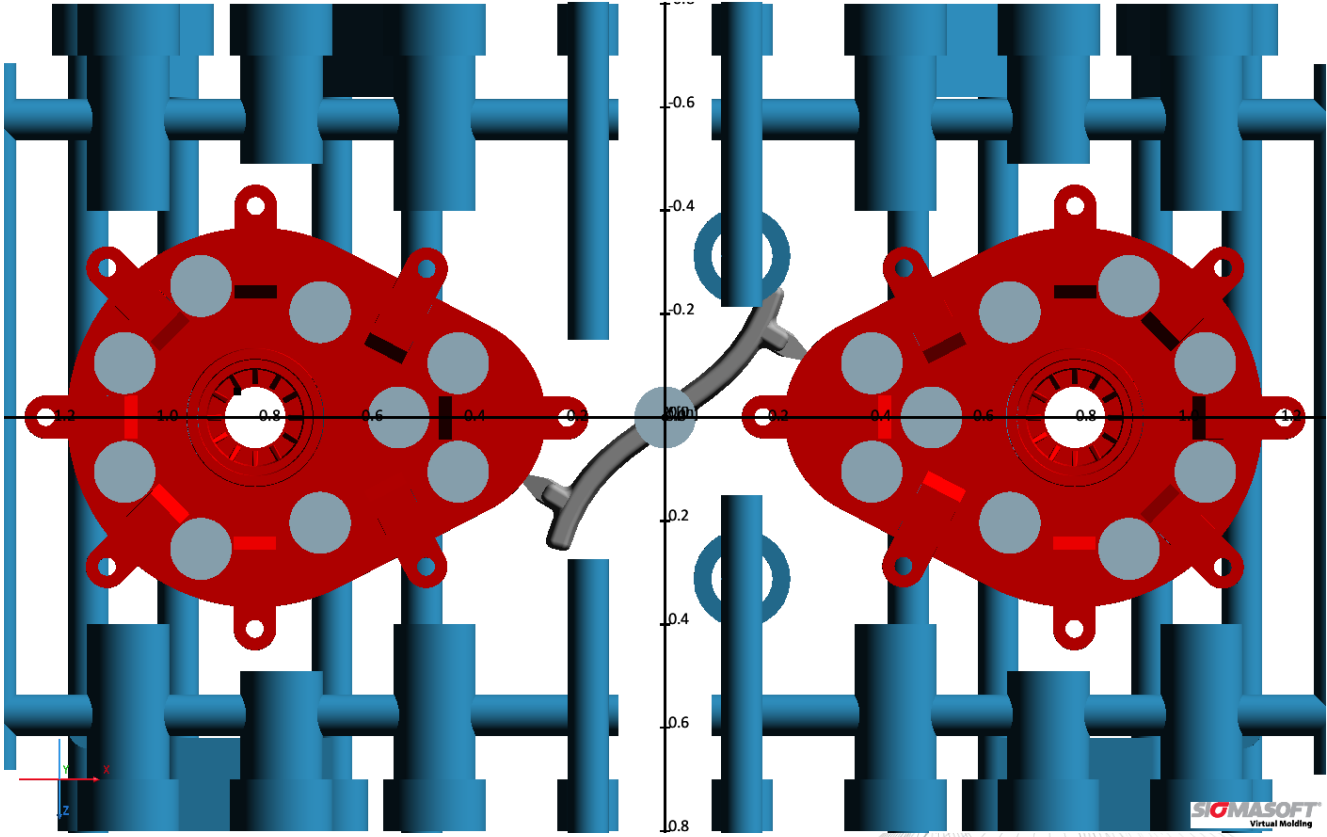
What could increase part bending and stress during ejection?

- Temperature of the part
- Speed of the ejection system
- Position of the ejector pins

Relationship between Cooling Lines and Ejector Pins

They can’t occupy the same space

Have to find a balance

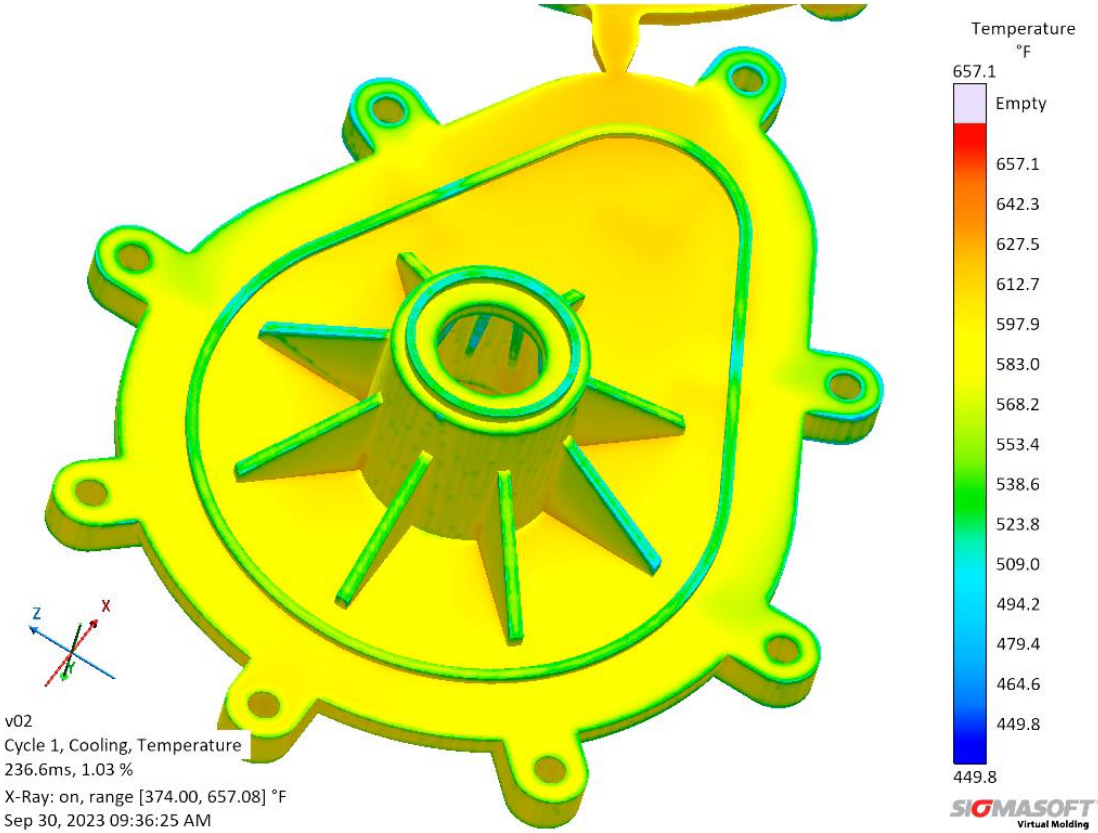


Part Material Review

MECHANICAL	Dry	Conditioned	Unit	Test Method
Tensile Modulus	2700	2800	MPa	ISO 527-1
Tensile Stress (Break) 11,600 psi	80.0	75.0	MPa	ISO 527-2
Tensile Strain (Break)	3.0	4.0	%	ISO 527-2

MAPP 2023

Cooling Pattern



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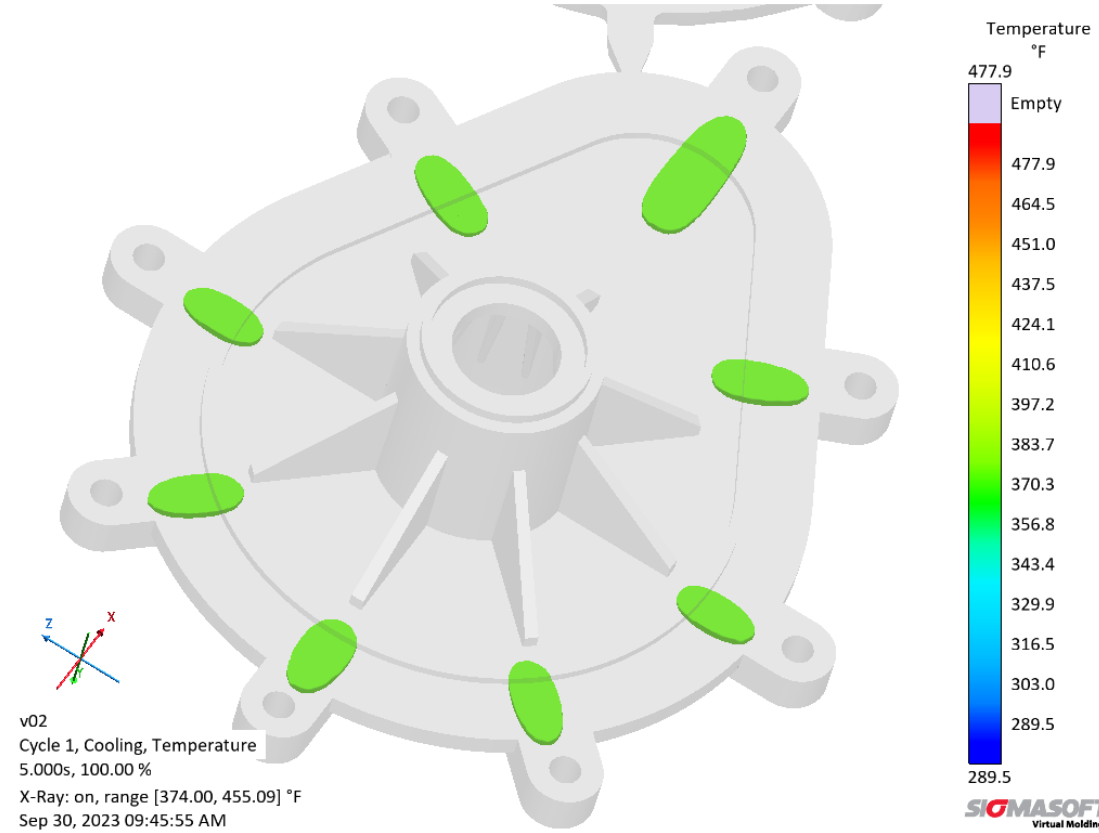
Last Areas to Cool



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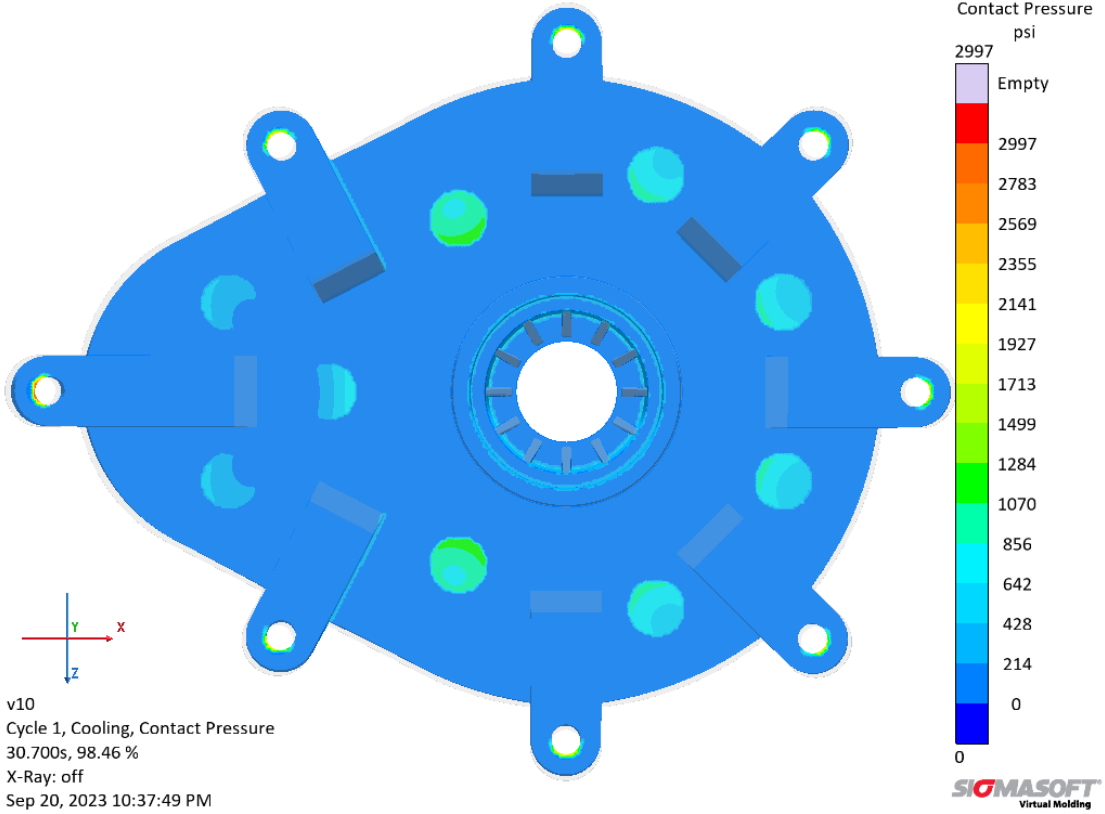
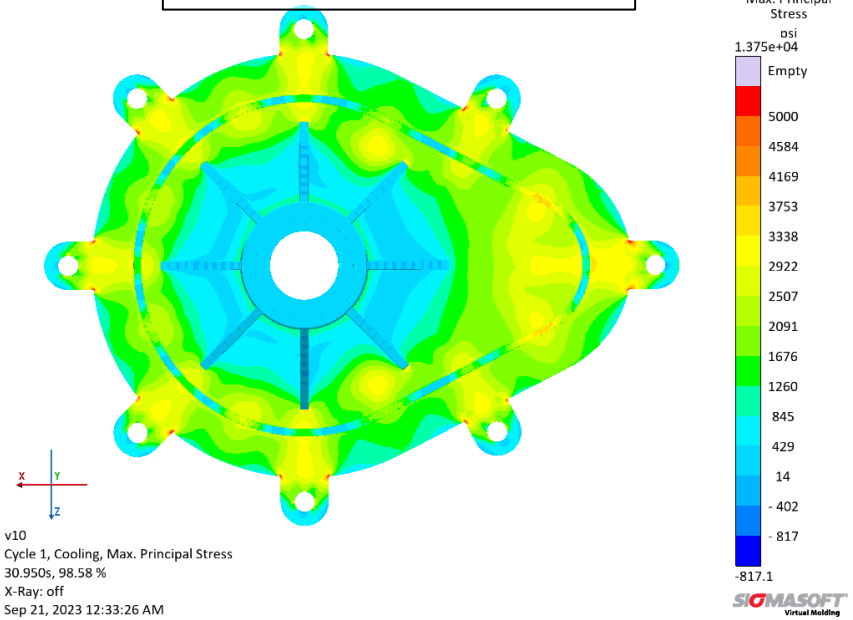
Contact Pressure Applied by the Ejector Pins

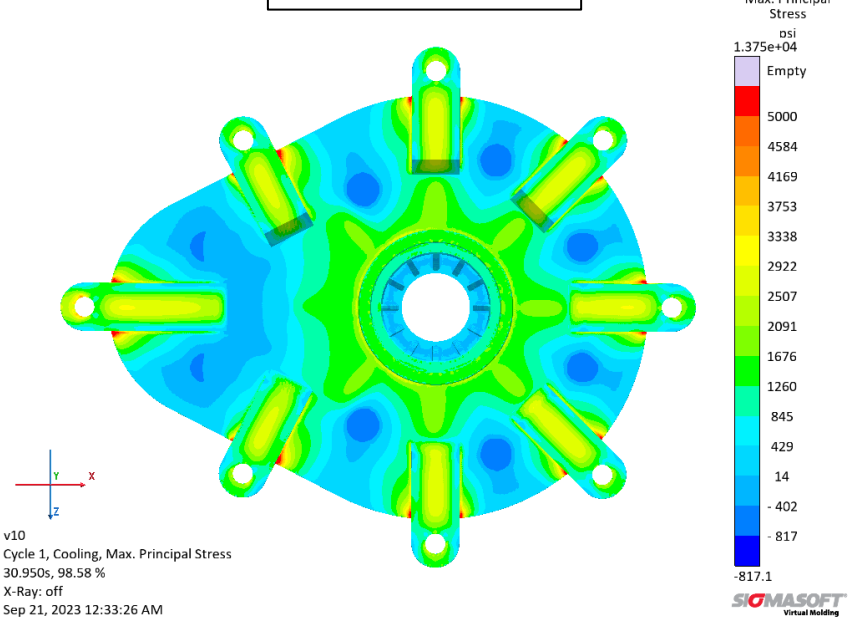


Principle Stresses in the Part

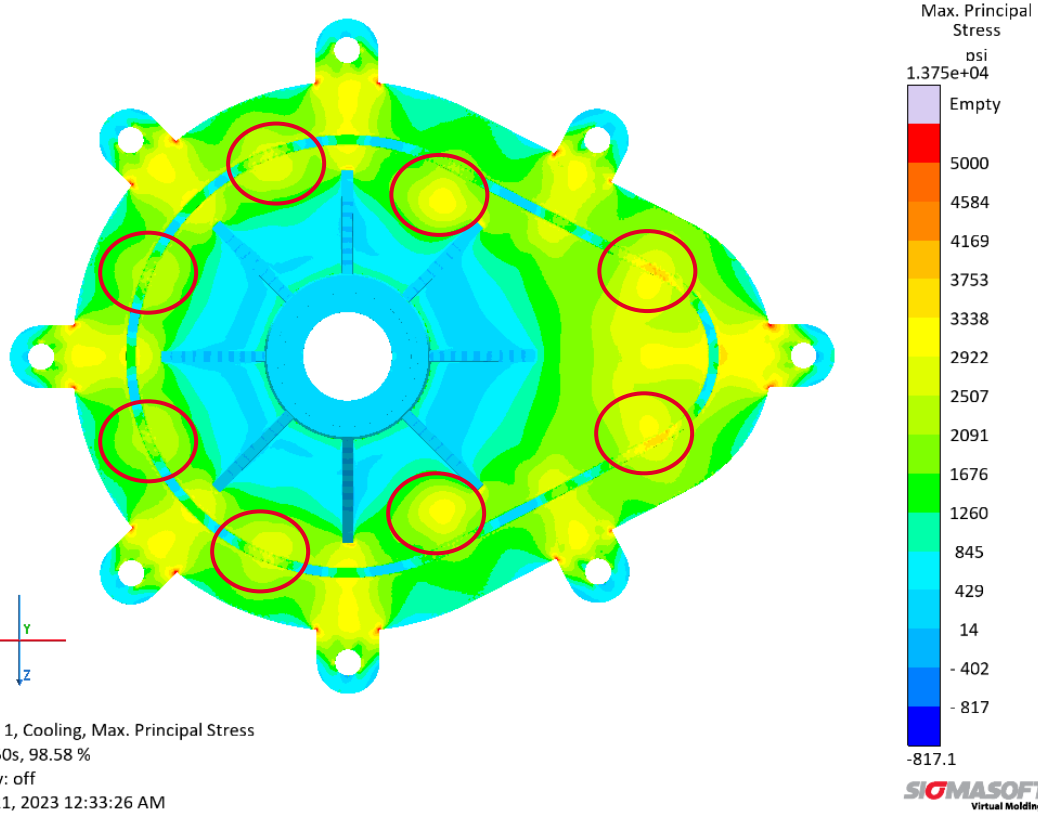
Opposite of Ejection



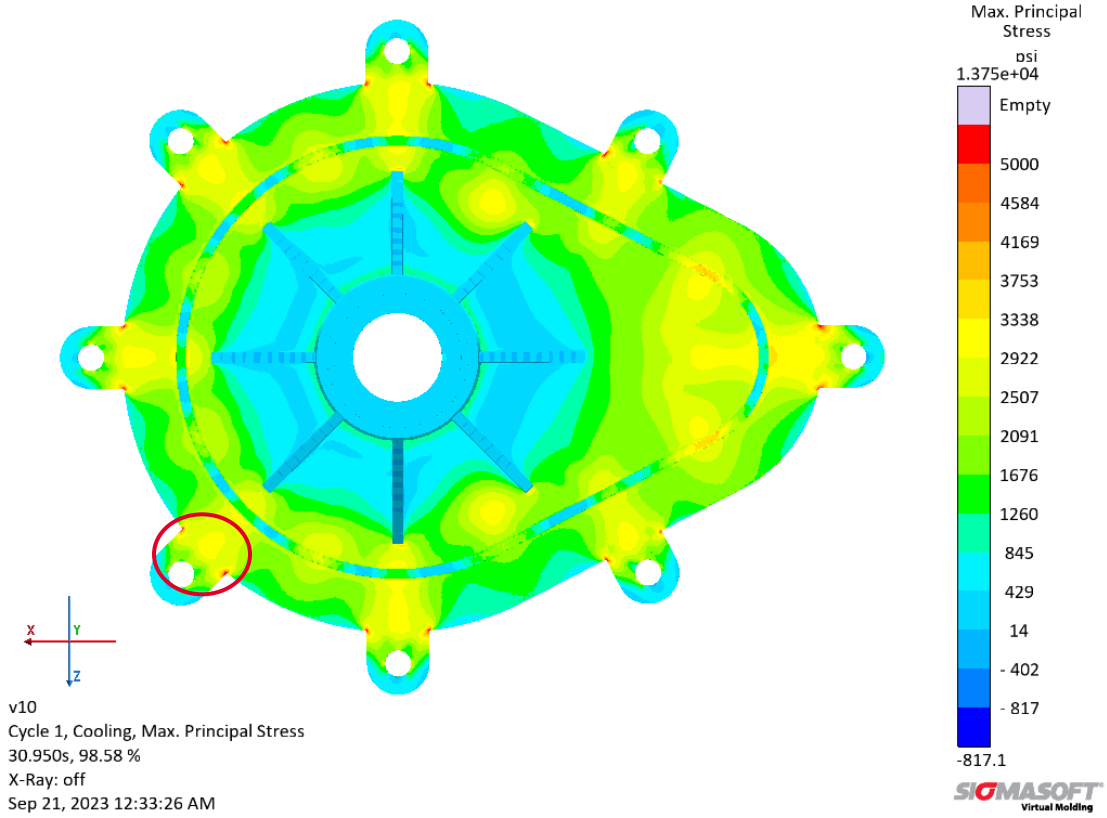
Ejection side



Do we notice any issues?



Do we notice any issues?



Final Conclusions

- Reducing the filling time to 0.5-1.5 seconds helped to reduce the stress on the mold and extend the life of the mold components

- Ejector Pins placement and speed is sufficient