Roctool® Induction Heating in Autodesk® Moldflow® Insight

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Vice President of Business Development

ROCTOOL

Agenda:

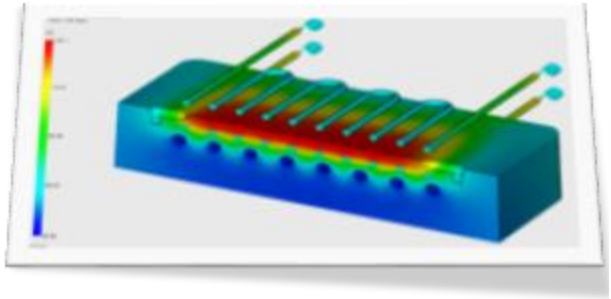
- Roctool Technology
- Induction Heating/Cooling Technology
- Autodesk Moldflow Technology
- Comparing Results

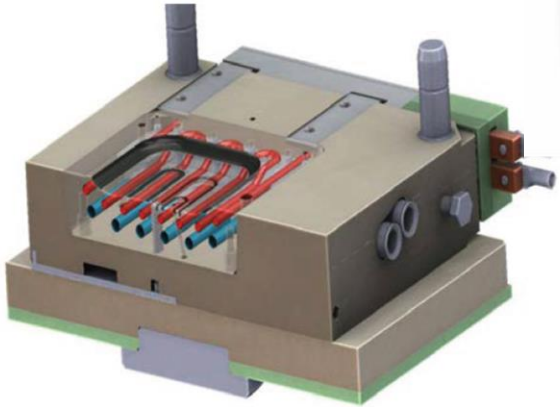
Roctool: Who We Are

- Rapid heat / rapid cool technology provider with patents based around use of induction
- Not a new technology
  - Induction used to heat and melt metals 1916
  - Roctool 2000
- Processes
  - Compression Molding, Injection Molding, Blow Molding / ISBM, Thixomolding, Die Cast
- Materials
  - Thermoplastics
    - Amorphous & Semi-Crystalline
  - Thermosets
- Markets
  - Automotive, Consumer Products, Electronics, Aerospace, Appliances, Cosmetics

Roctool: What We Offer

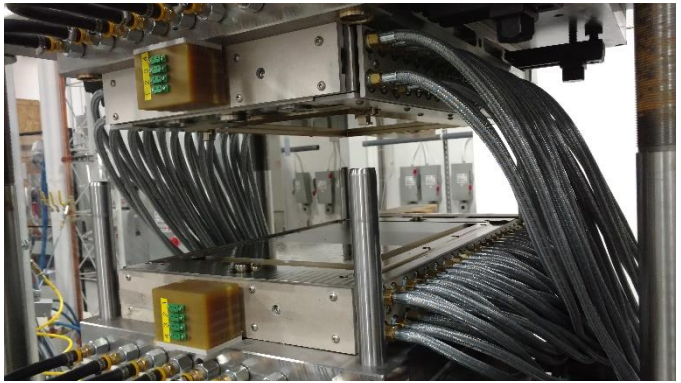
- Simulations
  - Thermal / Flow
- Design
  - Tool Design and Support
- Tool Components / Mold Hardware
- Installation & Training
- Capital Equipment
  - Generator systems, performance cooling
- Material Trials
  - Injection and Compression Trials



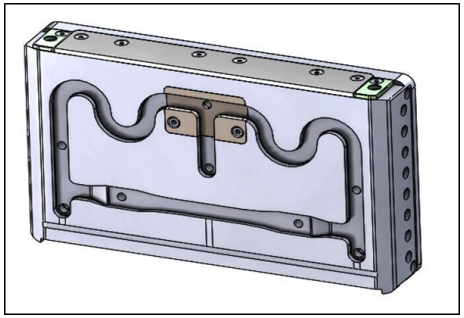


Roctool: What's New

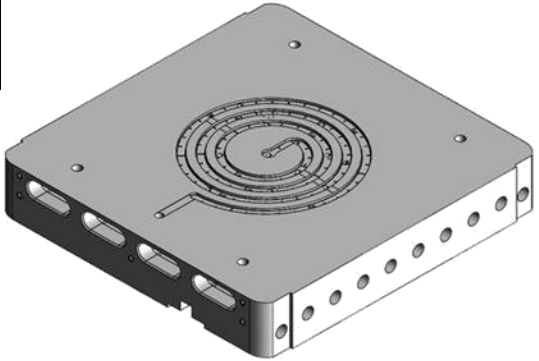
- Locations
  - Roctool Shanghai
- Compression Platform – USA
  - 300mm x 500mm Plaque
- On Staff Designers
  - Design Focus
    - Industrial Design / Creative - renderings
    - Texture Development
    - Material Testing
- Capital Equipment
  - Dual zone Generator Systems
  - Performance Cooling Units
  - C2V Valves

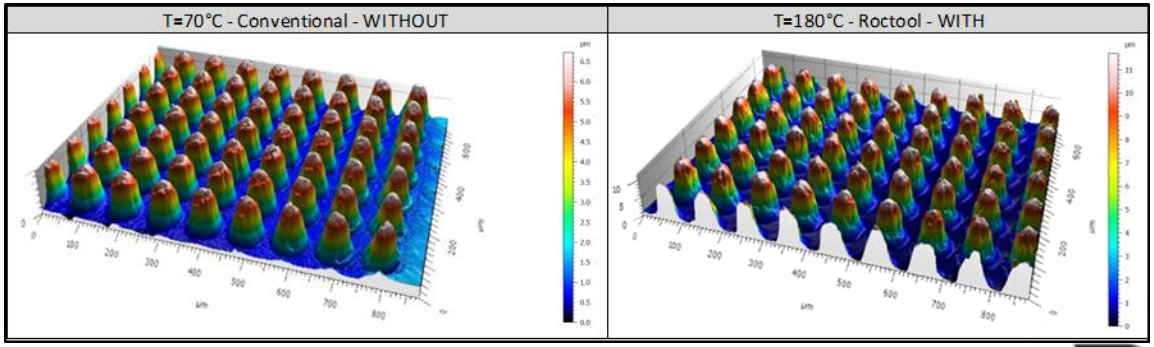


Roctool: What's New



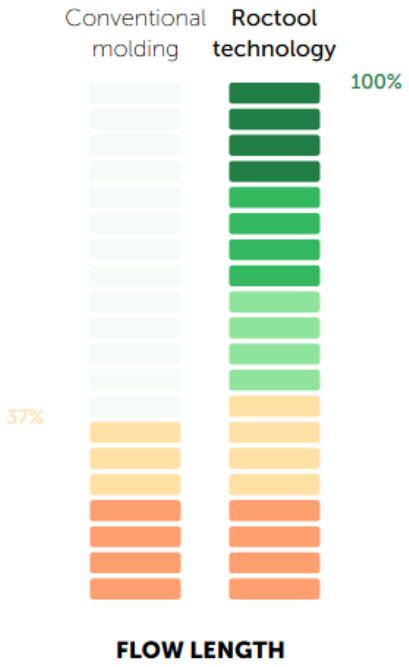
- Complete Material Characterizations
  - HD Plastics™ Database
    - Working directly with several resin providers
    - Studies
      - Surface Replication
      - Gloss Level
      - Flow Length
      - Weldline Strength
    - Visual Analysis
- Database
  - Available to Roctool Users



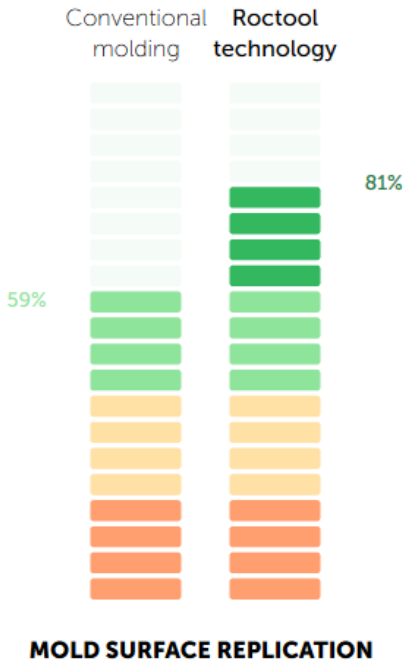


Roctool: HD Plastics™ Database

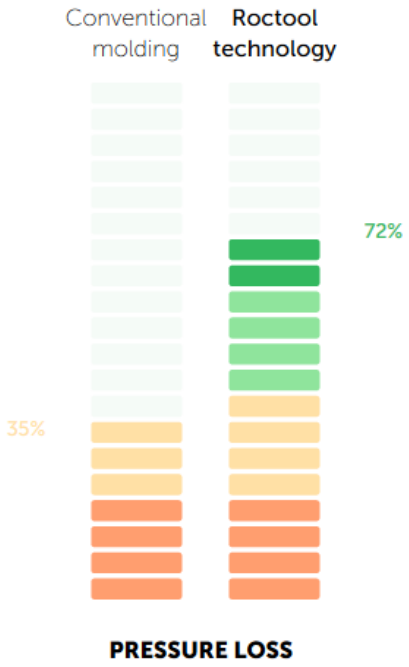
GLOSS



FLOW LENGTH

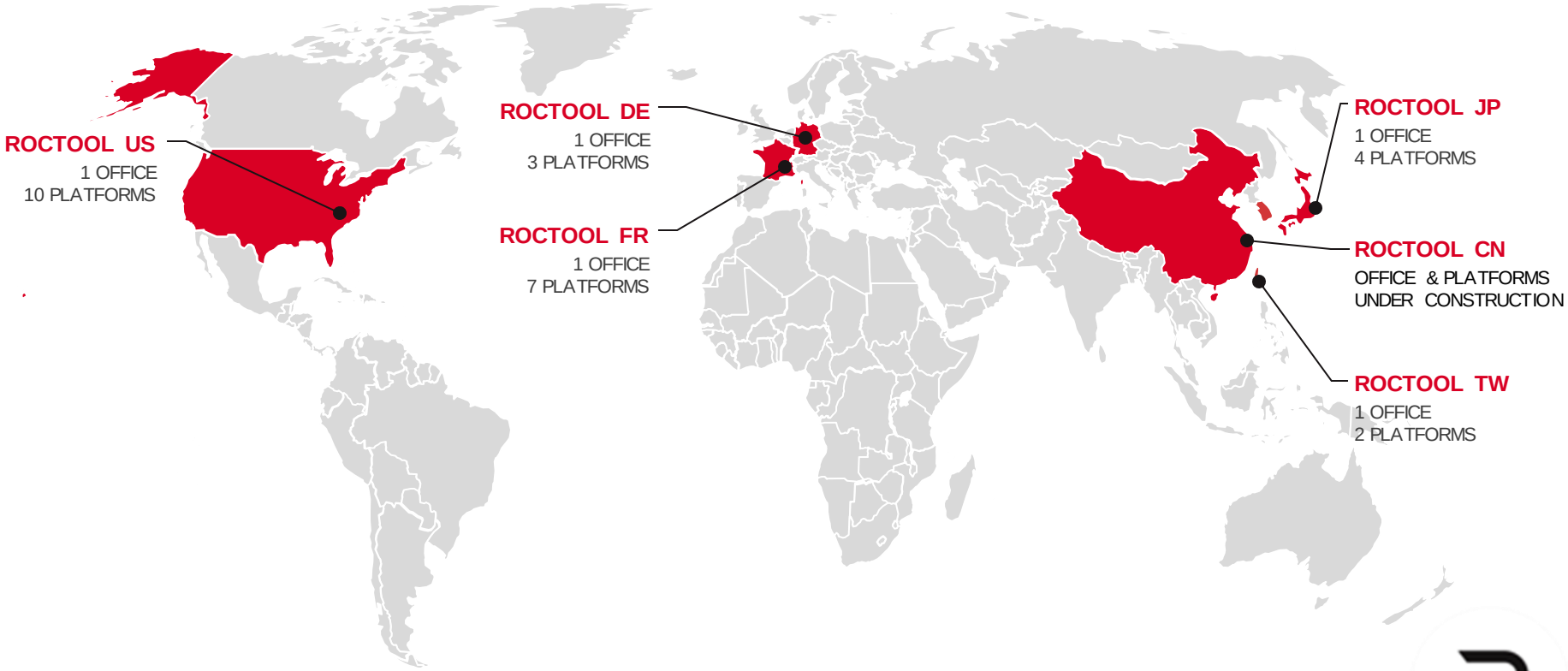


MOLD SURFACE REPLICATION



PRESSURE LOSS

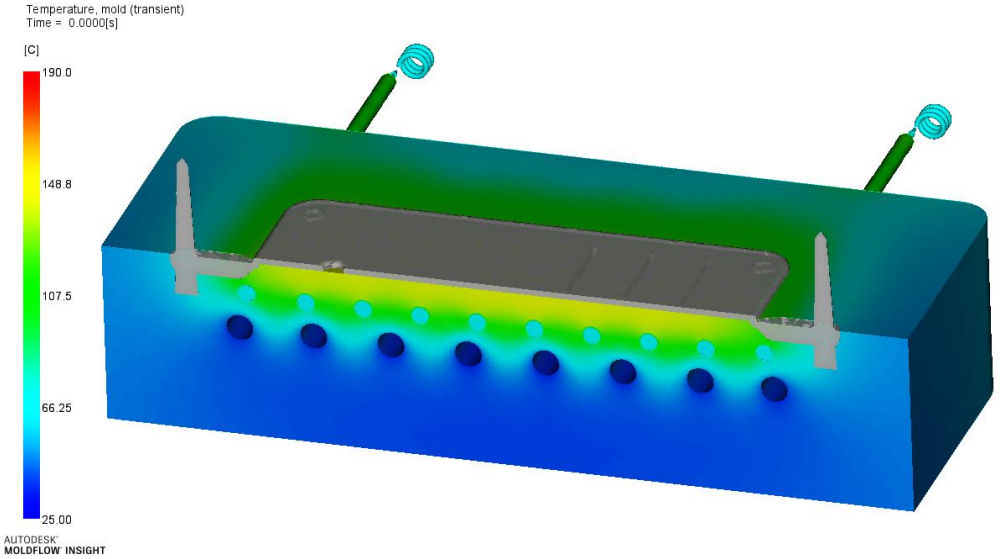
Roctool Technology Centers:



WE REVOLUTIONIZE FAST MOLDING PROCESSES FOR COMPOSITES, PLASTIC INJECTION AND METAL

\ FAST HEATING OF MOLD SURFACE WITH INDUCTION

\ FAST COOLING WITH WATER LINES

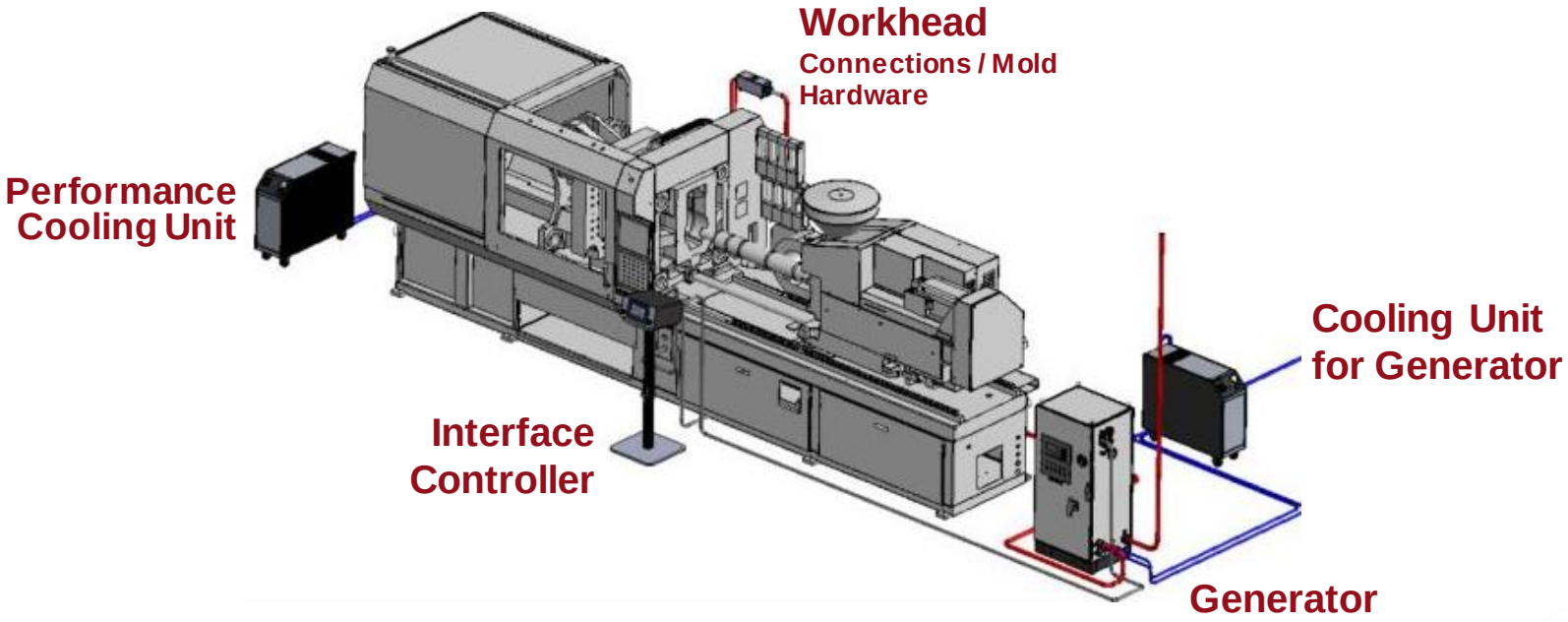


\ PRECISE TEMPERATURE CONTROL

\ BUILT WITH STANDARD STEELS

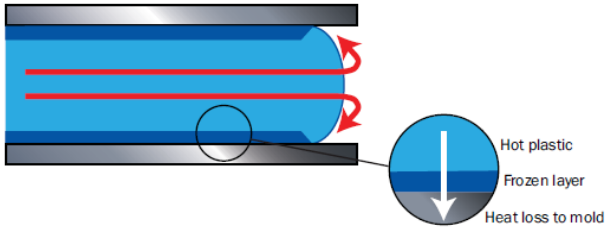
\ WORKS WITH ALL PRESS MACHINES

General Equipment Layout

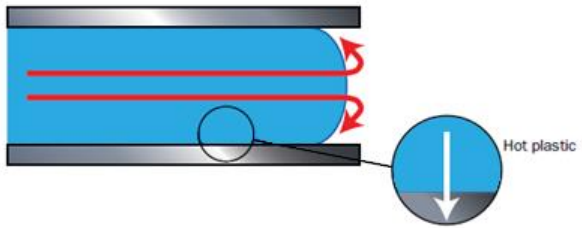


What Happens With Hot Tool Surface

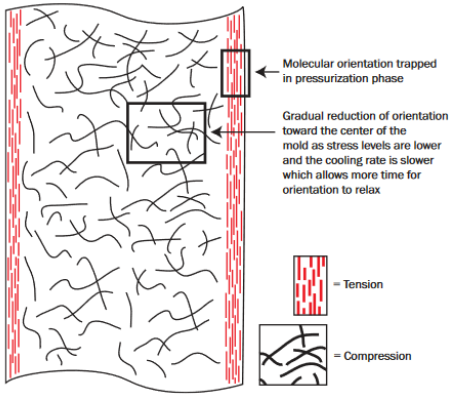
Mold Temperature < Tg Polymer



Mold Temperature > Tg Polymer



In addition, with active mold heating and cooling during the entire molding cycle, the thermal history of the polymer can be controlled so as to optimize its structure and morphology. This appears to be useful for polymers, particularly for those in which structural formation is sensitive to thermal changes within the normal time scale in injection molding



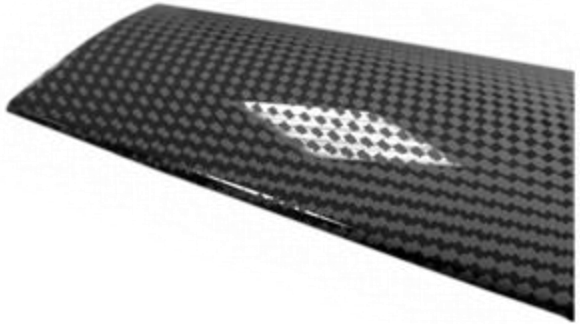
Molecular orientation through the thickness of the part

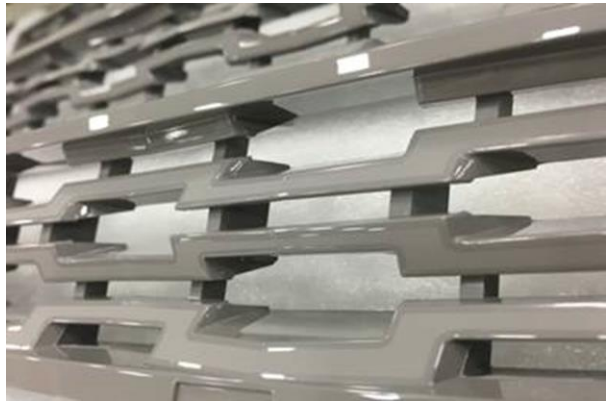
If the flow were stopped and the plastic allowed to cool down very slowly, this orientation would have time to relax, giving a very low level of residual orientation. On the other hand, if the material were kept under stress and the plastic snap frozen, most of the orientation would be trapped in the frozen plastic (Figure 1.7).

Cosmetic Advantages

- Cosmetic
  - Weldlines / Flowlines
  - Gate Blush
  - Jetting
- Replication of mold surfaces
  - High gloss / low gloss
  - Laser Textures
- Resin Rich Surfaces
  - Glass, Talc, Carbon, Foam
- Sink
  - 1 to 1 rib to wall possible without sink

Automotive Applications:

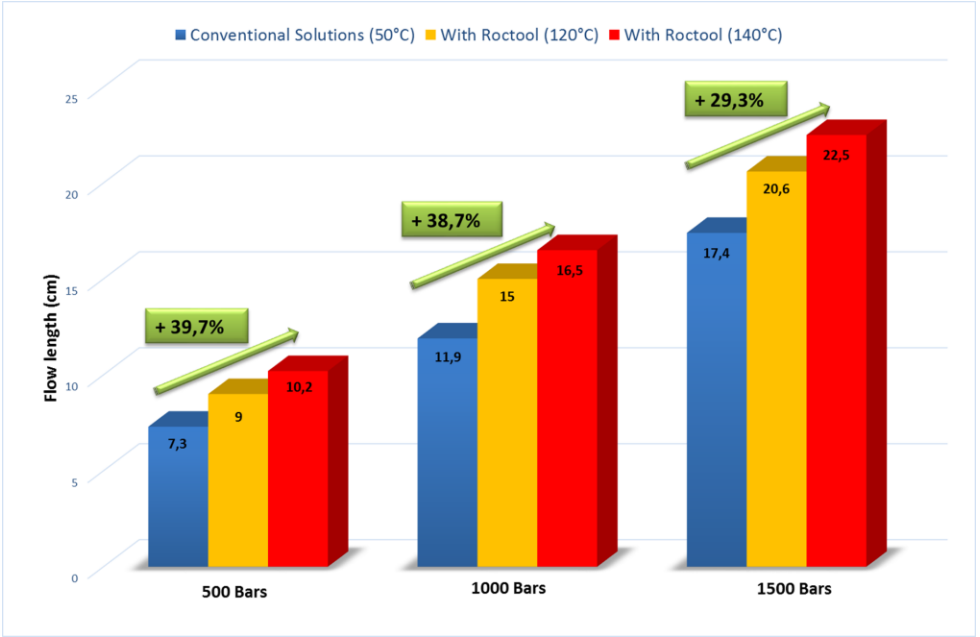




Performance & Process Advantages

- Increased Flow Length
  - Allows for thinner wall

- Increased Weldline Strength



- Reduced pressure drop / fill pressure
- Reduced Molded In Stress

Autodesk Moldflow Insight

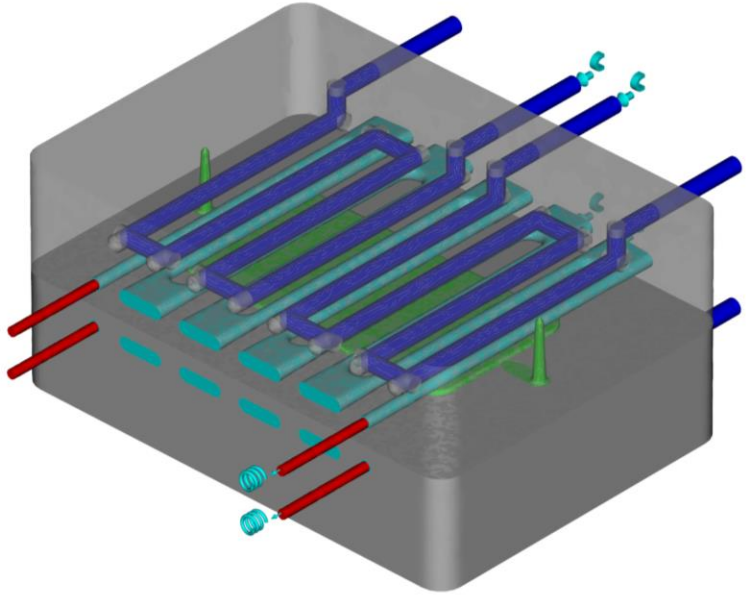
Simulation of RocTool Induction Heating Process

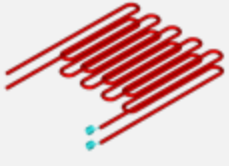
- Analysis Elements
  - **Mesh**
  - Cool (FEM)
  - Materials
  - Process Parameters

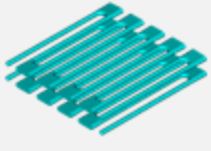
Autodesk Moldflow Insight

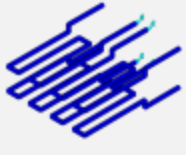
Simulation of RocTool Induction Heating Process

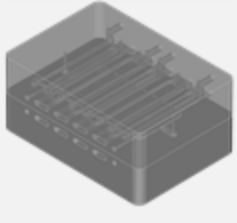
- CAD Model Requirements
  - Induction heating coil
  - Air gap
  - Coolant circuit
  - Plastic part
  - Cavity & Core inserts
  - Mold blocks

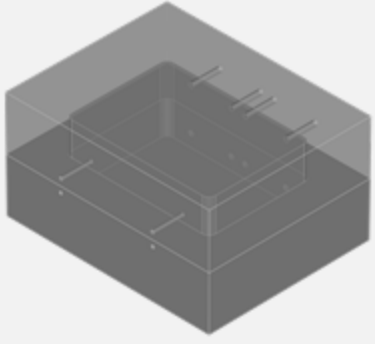








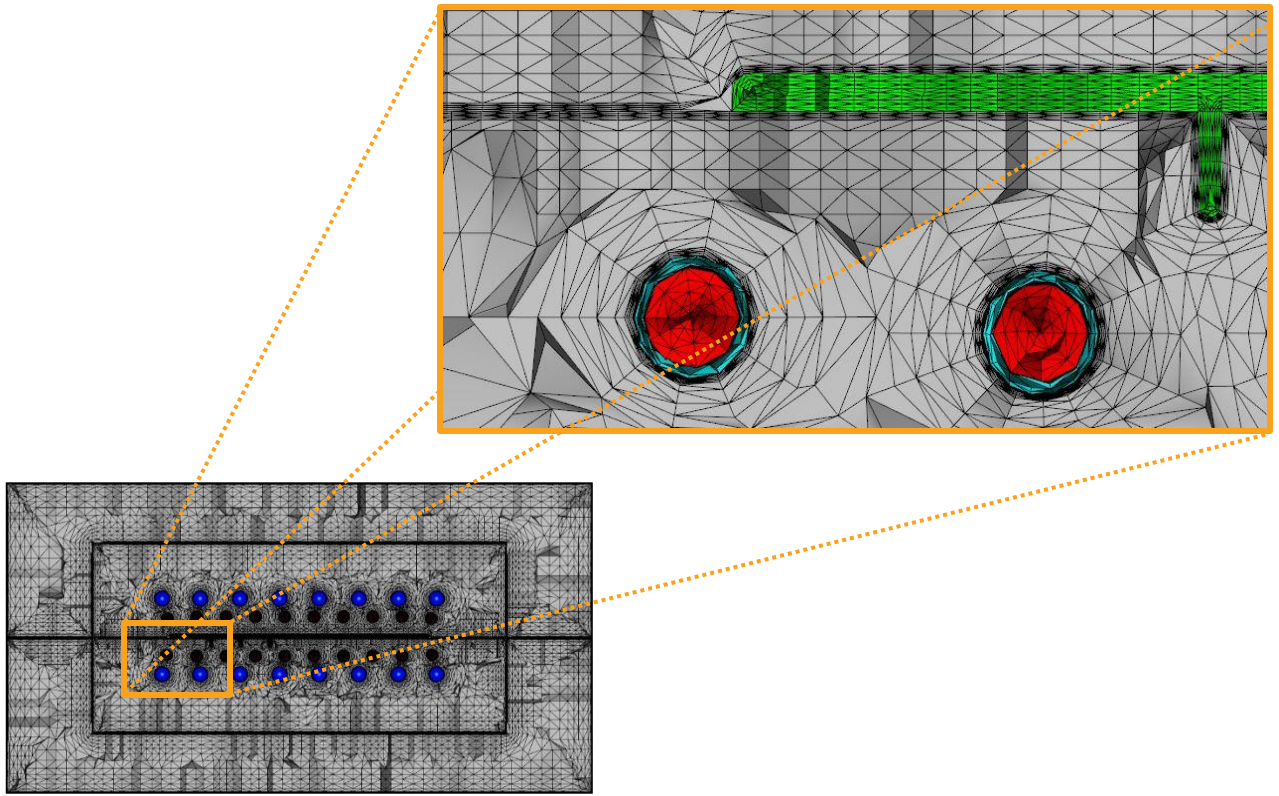




Autodesk Moldflow Insight

Simulation of RocTool Induction Heating Process

- Analysis Elements
  - **Mesh**
  - Cool (FEM)
  - Materials
  - Property assignments



Online Help topic: Meshing guidelines for Induction Heating

Autodesk Moldflow Insight

Simulation of RocTool Induction Heating Process

- Analysis Elements
  - Mesh
  - **Cool (FEM)**
  - Materials
  - Process Parameters

Autodesk Moldflow Insight

Simulation of RocTool Induction Heating Process

- Analysis Elements
  - Mesh
  - Cool (FEM)
  - **Materials**
  - Process Parameters

Plastic Material

Mold & Cavity Material

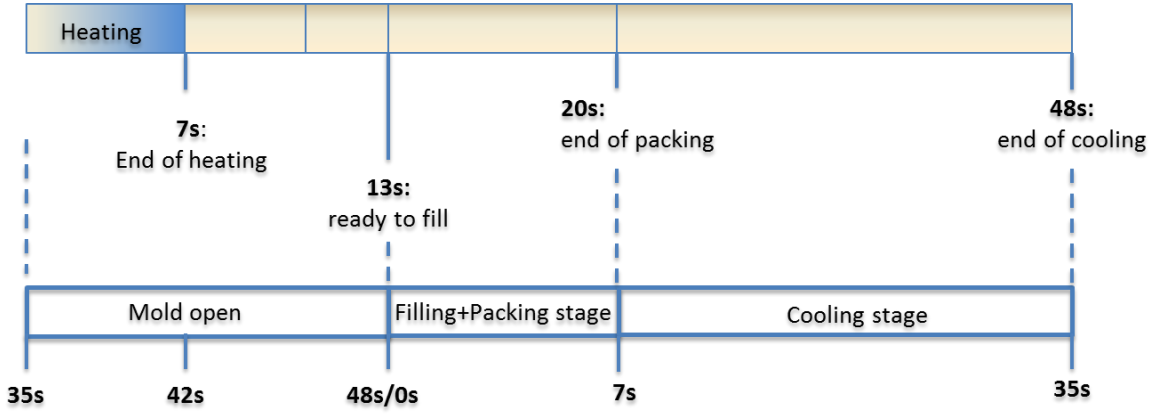
Air-Gap Material

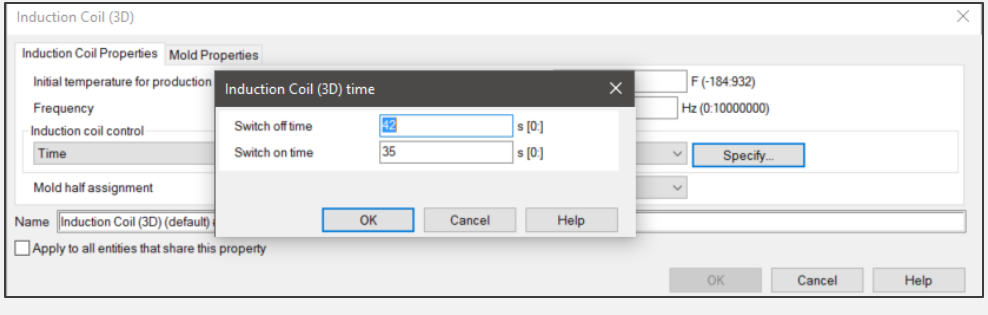
Heating/Cooling Elements Material

Autodesk Moldflow Insight

Simulation of RocTool Induction Heating Process

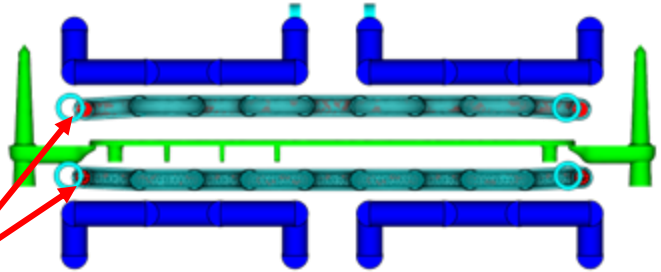
- Analysis Elements
  - Mesh
  - Cool (FEM)
  - Materials
  - **Process Parameters**



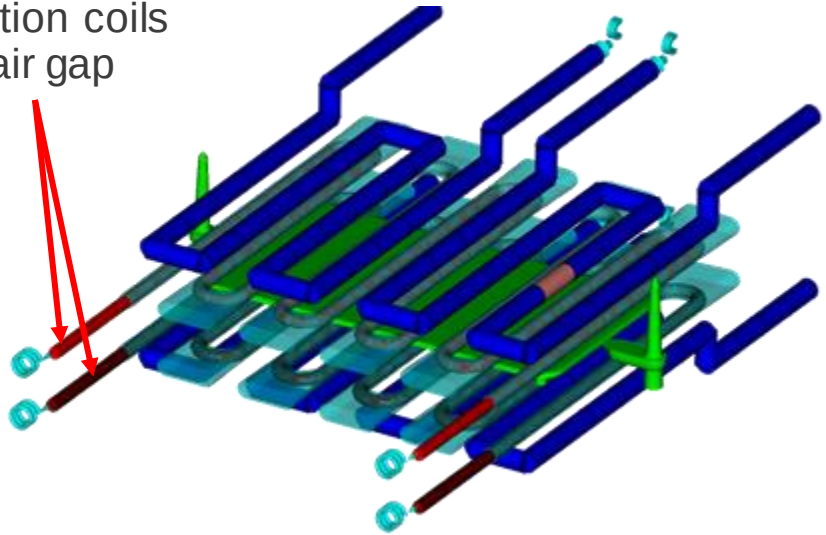


Results Comparison | What we are comparing

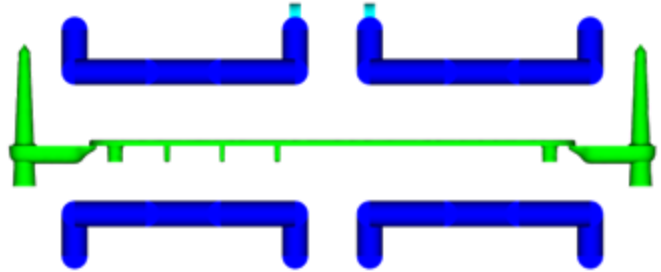
With RocTool

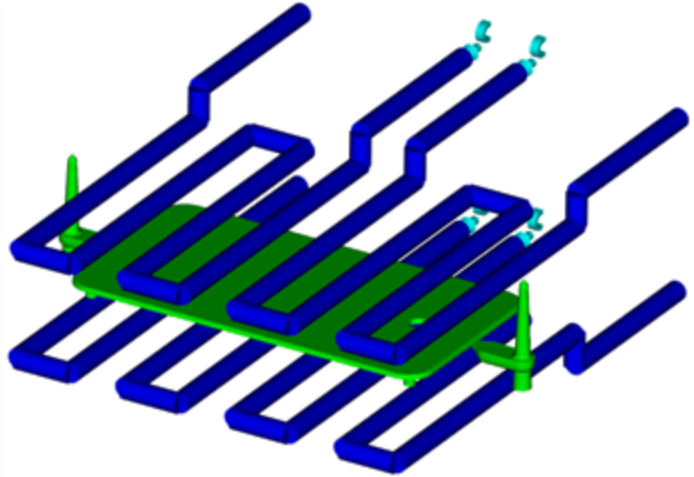


Induction coils with air gap

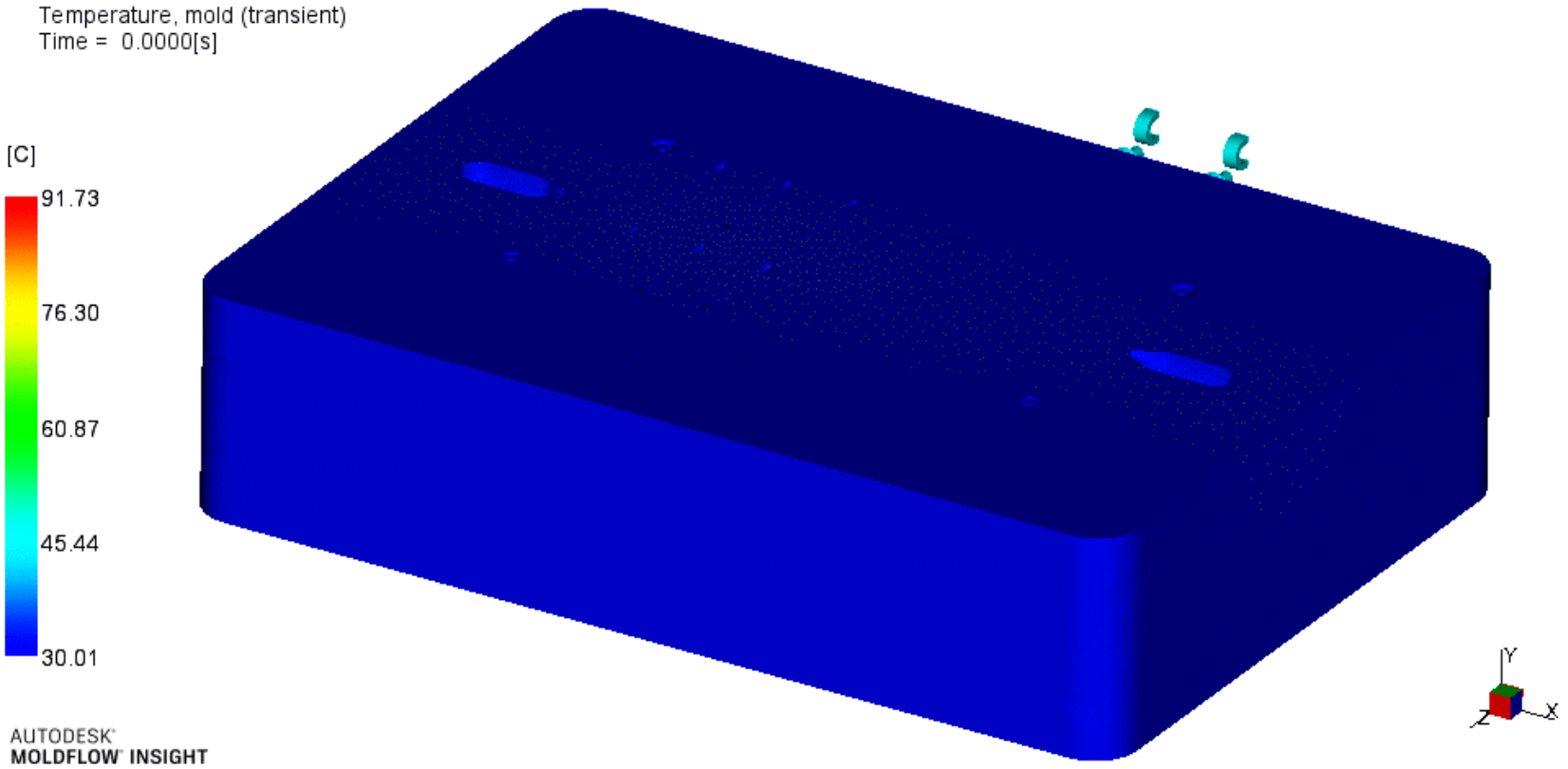


Without RocTool

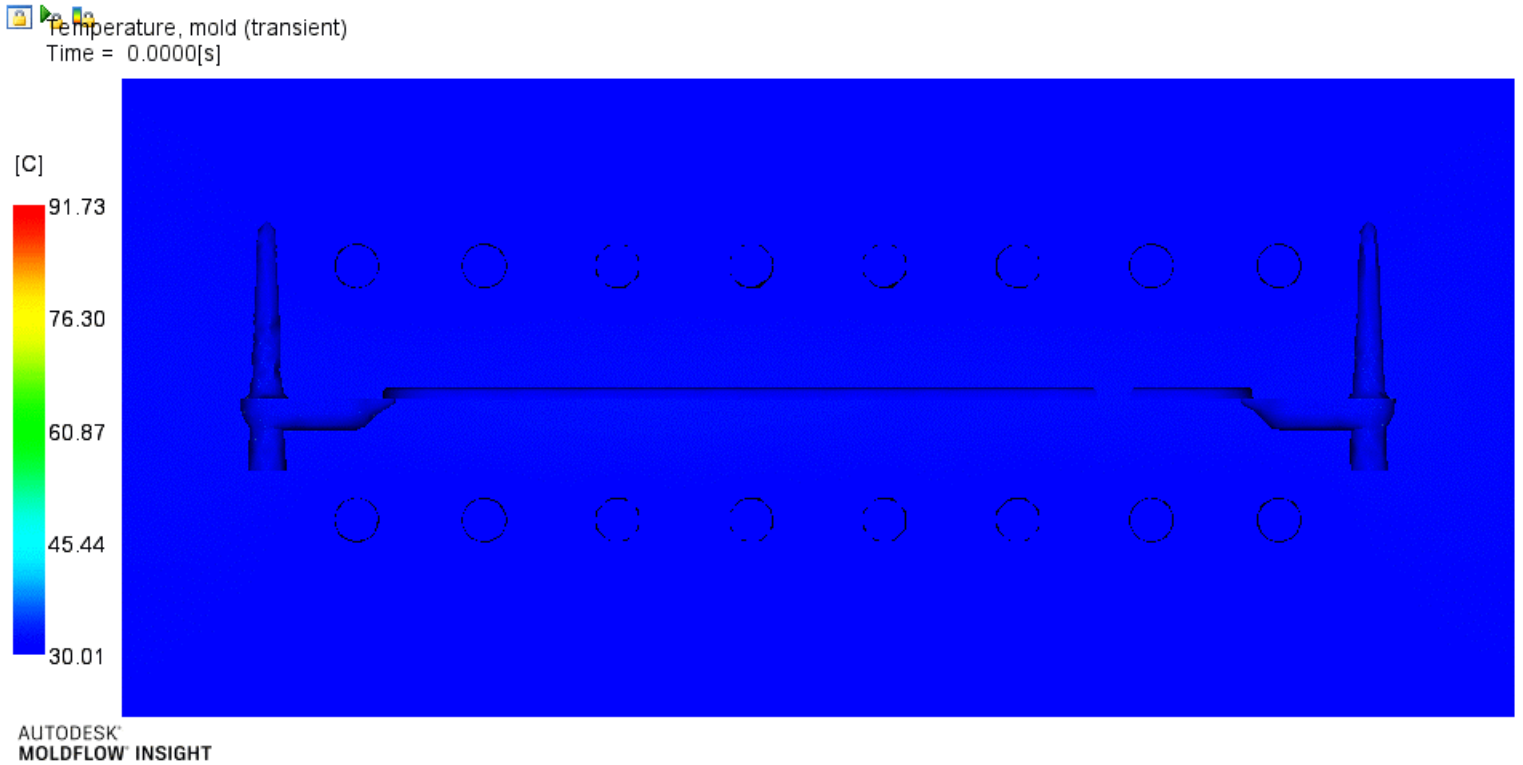




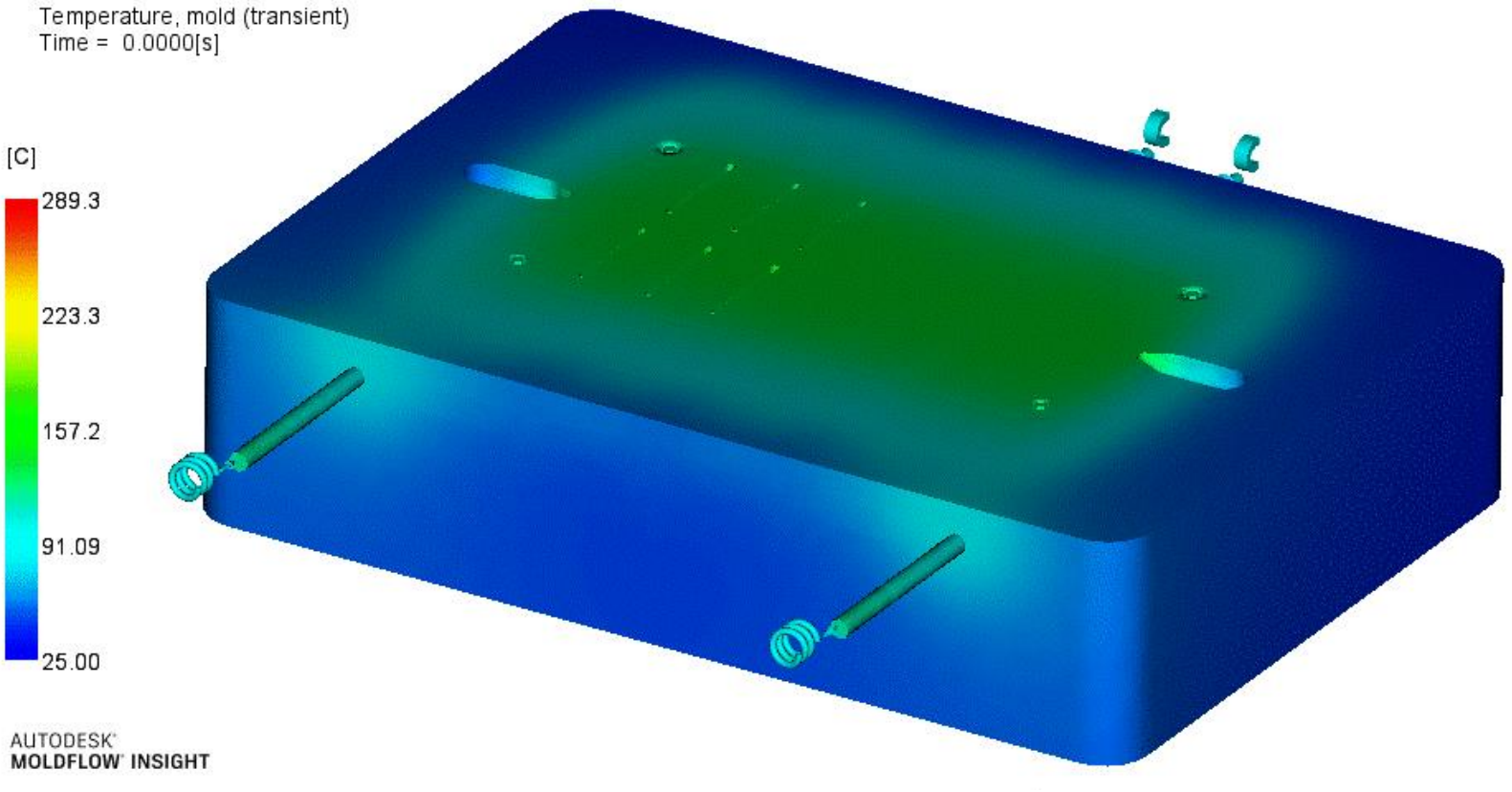
Mold Temperature over time (Conventional)



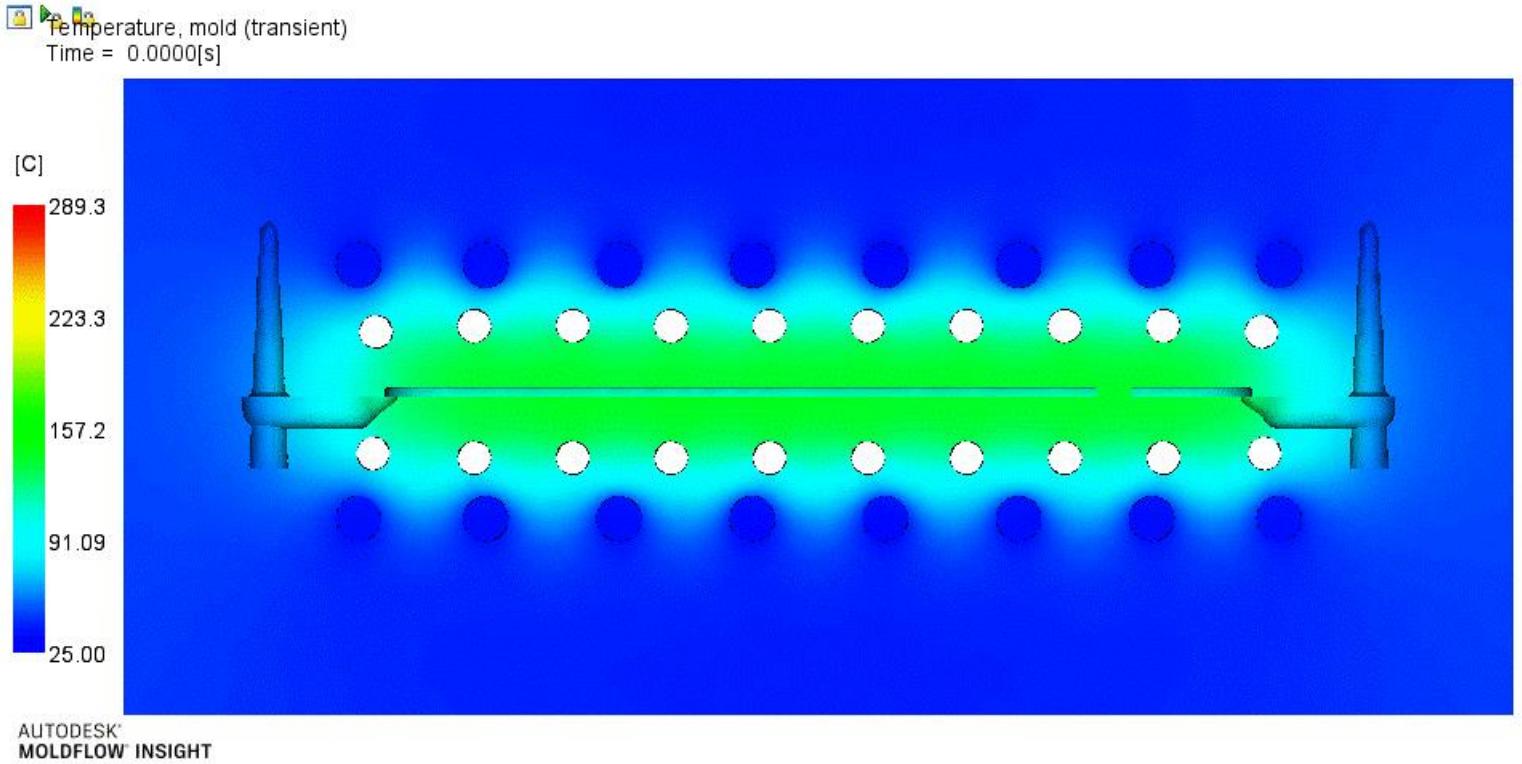
Mold Temperature over time (Conventional)



Mold Temperature over time (RocTool)

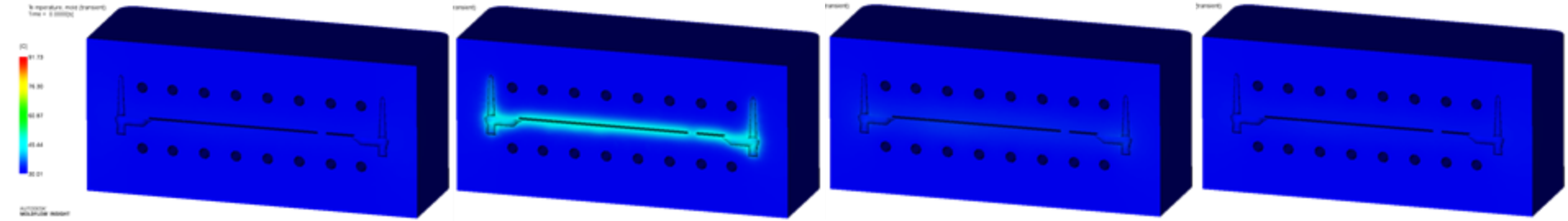


Mold Temperature over time (RocTool)



Side by side comparison of Mold Temperature

Conventional Injection Molding



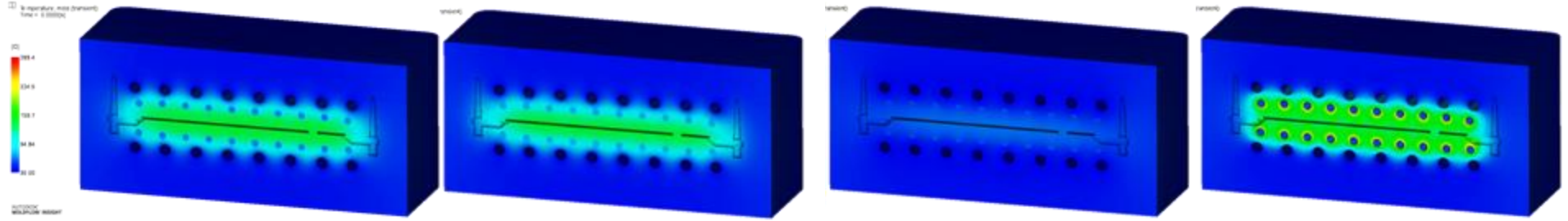
t = 0 sec
Start Injection

t = 2.11 sec
End Injection

t = 35 sec

T = 43 sec

Injection Molding with RocTool



t = 0 sec
Start Injection

t = 2.0 sec
End Injection

T = 35 sec
Start Induction

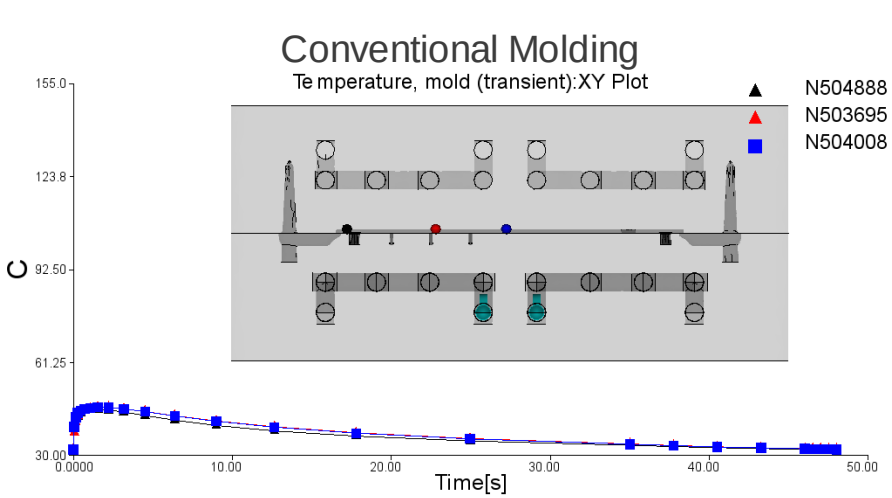
T = 42 sec
End Induction

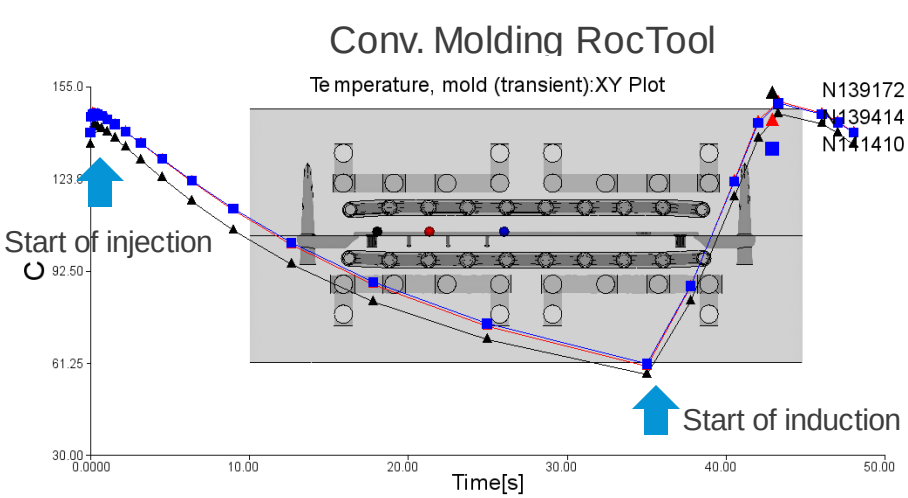
Mold Temperature over time

Transient temperature at Mold-Melt interface

With Conventional molding, plastic is injected in a ‘cold’ mold, which will instantly solidify the material at the skin.

With RocTool switched on, at the start of injection, the temperature at the skin is high, allowing the polymer at the skin to freeze more slowly, allowing for a much better surface quality.

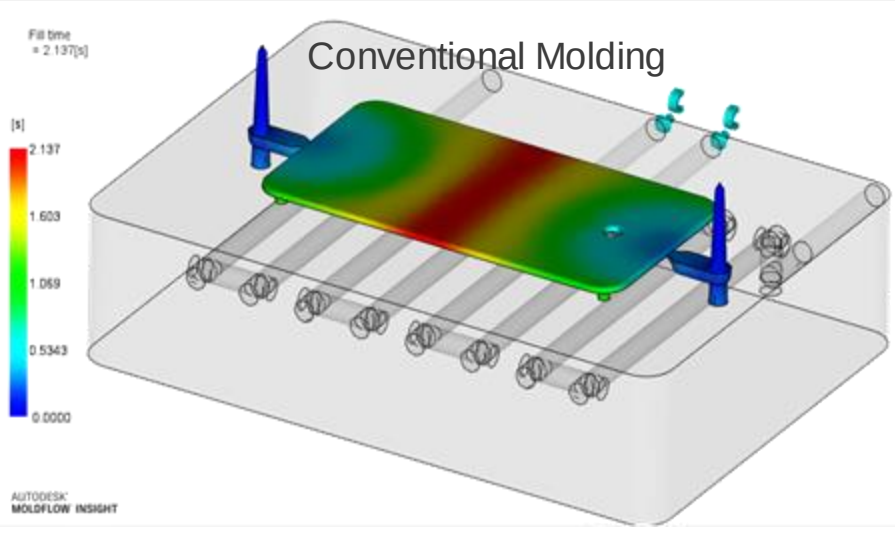


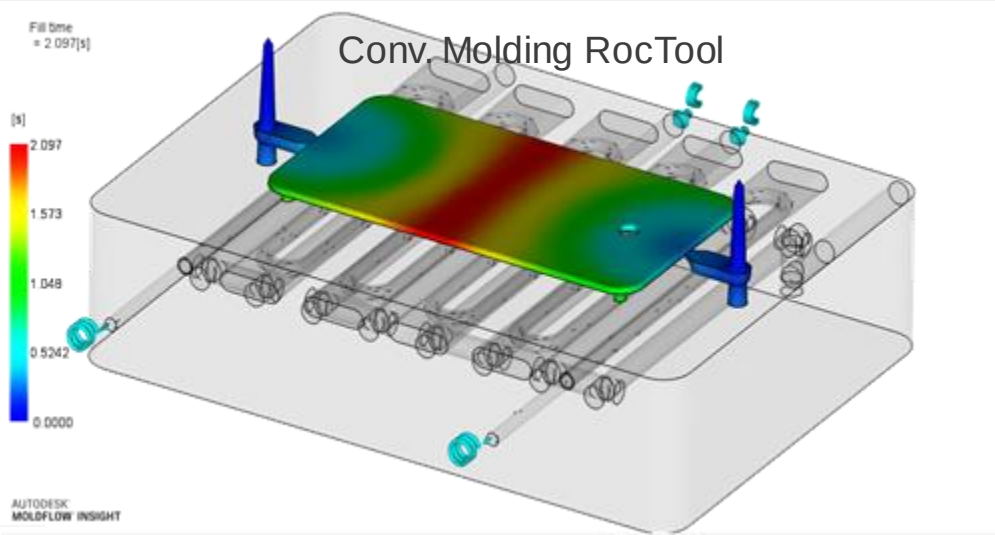


Results Comparison

Fill time

Very similar mold filling pattern, as one would expect.



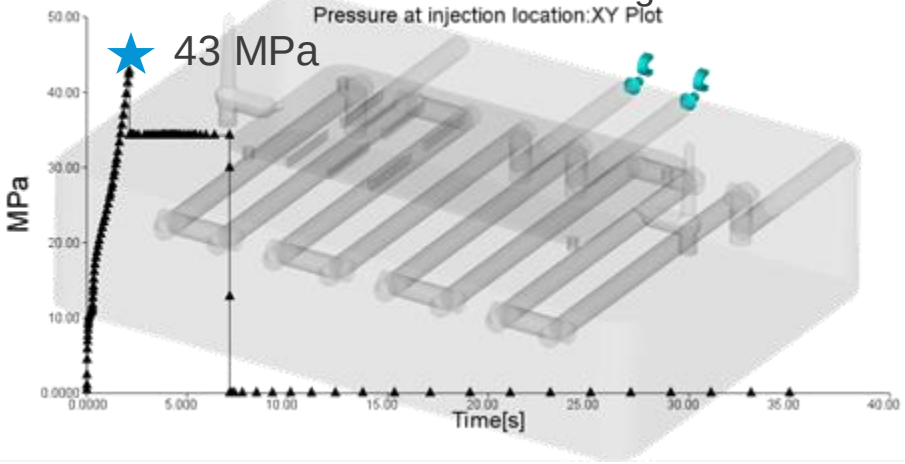


Results Comparison

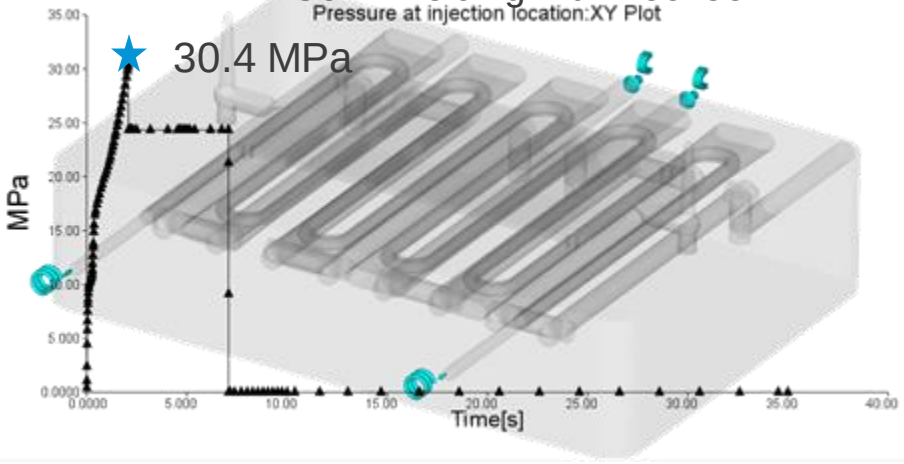
Pressure at Injection Location

Lower injection pressure with induction heating compared to conventional molding.

Conventional Molding

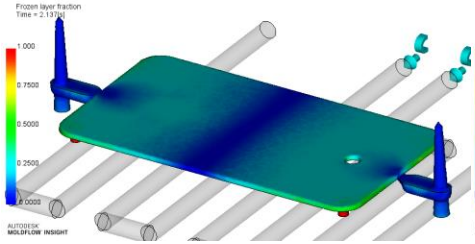


Conv. Molding with RocTool

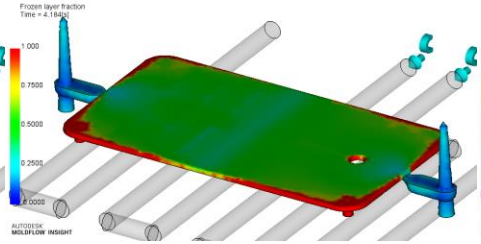


Side by side comparison of Frozen Layer Fraction

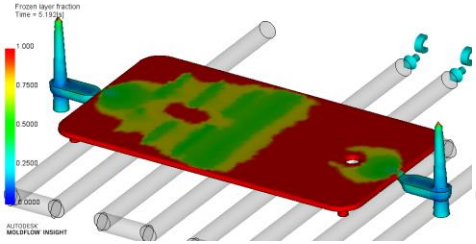
Conventional Injection Molding



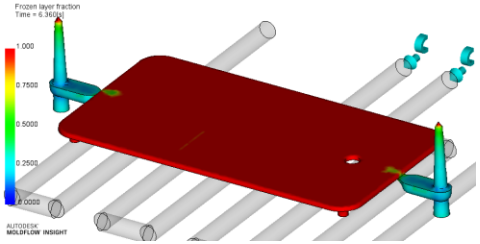
End of Fill
2.137 sec



4.184 sec

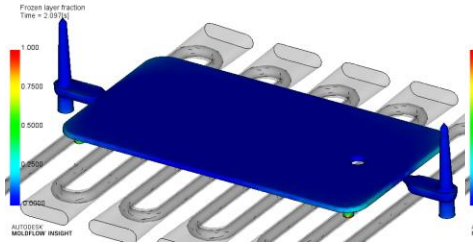


T = 5.19 sec

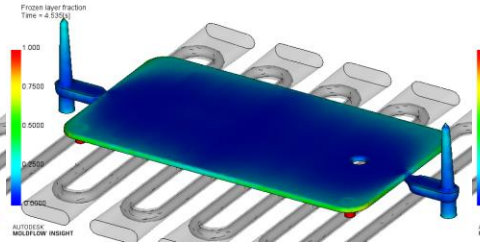


T = 6.36 sec

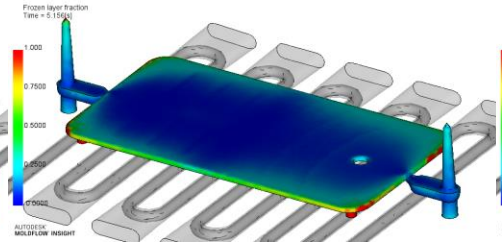
Injection Molding with RocTool



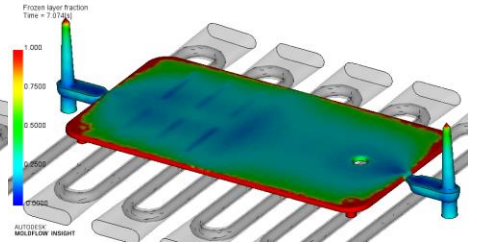
End of Fill
2.097 sec



4.535 sec



T = 5.156 sec



T = 7.074 sec

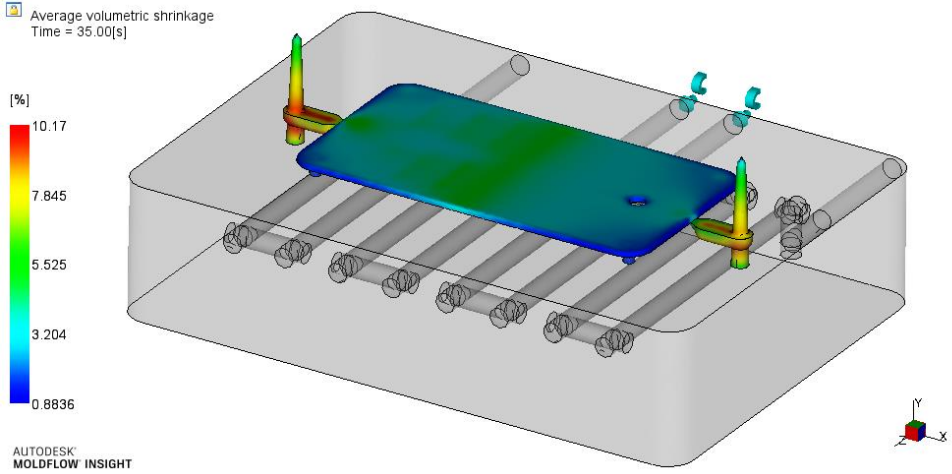
Results Comparison

Average Volumetric Shrinkage

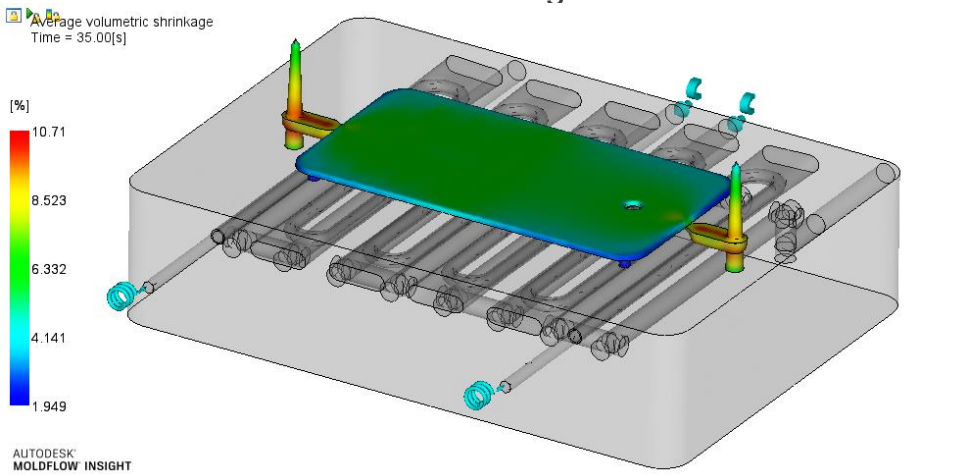
With Conventional molding we see significant variation in average volumetric shrinkage through the part.

Using induction heating, the average volumetric shrinkages are much more uniformly distributed over the part.

Conventional Molding



Conv. Molding with RocTool



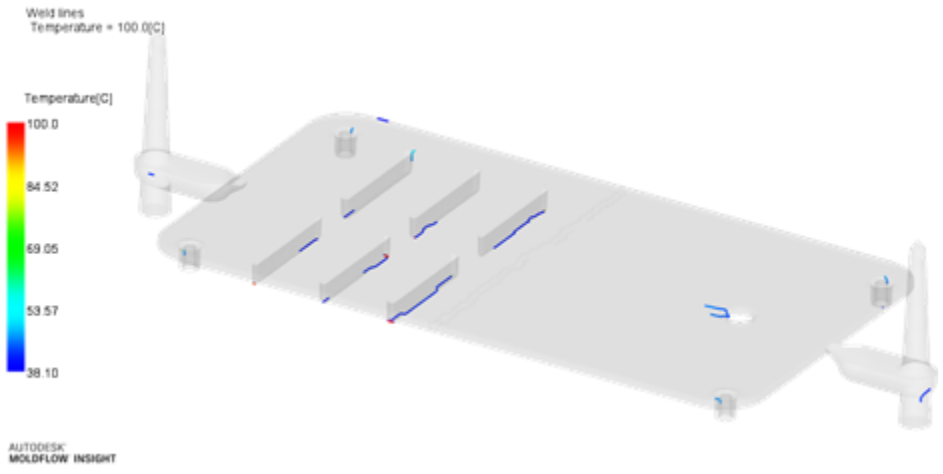
Results Comparison

Pressure at Injection Location (Temperature at end of fill overlaid)

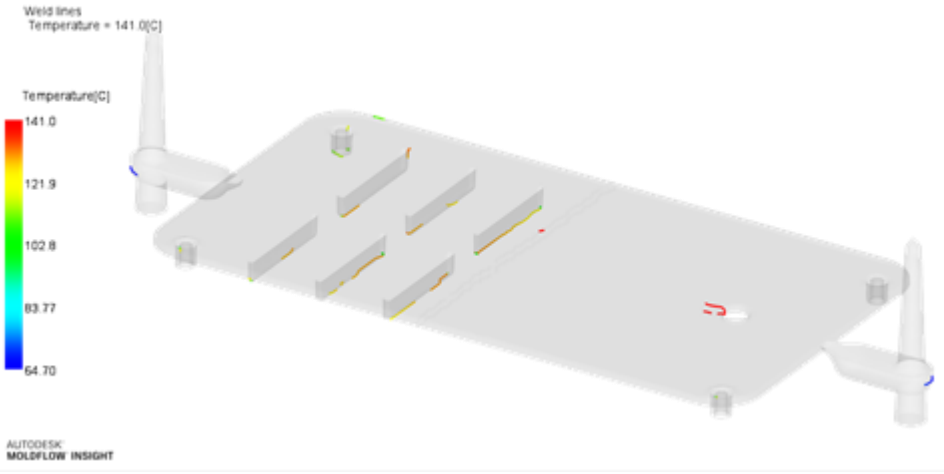
The weld line positions are more or less the same but … with conventional molding the temperature at the weld line positions are very low, which means weld lines will likely be visible.

With Induction heating, the temperature of the weld lines are close to the transition temperature, allowing the weld lines to for a good bond, heal and become invisible.

Conventional Molding



Conv. Molding with RocTool



QUESTIONS?

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