Roctool® Induction Heating in Autodesk® Moldflow® Insight

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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**: Roctool technology > 95GU (Conventional molding: 40GU, 37%)
- **FLOW LENGTH**: Roctool technology > 100% (Conventional molding: 81%, 59%)
- **MOLD SURFACE REPLICATION**: Roctool technology > 81% (Conventional molding: 72%, 35%)
- **PRESSURE LOSS**: Roctool technology > 72% (Conventional molding: 35%)
Roctool Technology Centers:

Roctool US
1 Office
10 Platforms

Roctool DE
1 Office
3 Platforms

Roctool FR
1 Office
7 Platforms

Roctool CN
Office & Platforms
Under Construction

Roctool JP
1 Office
4 Platforms

Roctool TW
1 Office
2 Platforms
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

- Performance Cooling Unit
- Interface Controller
- Workhead: Connections / Mold Hardware
- Cooling Unit for Generator
- Generator
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.

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
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Simulation of RocTool Induction Heating Process

- Analysis Elements
  - Mesh
  - Cool (FEM)
  - Materials
  - Process Parameters
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Simulation of RocTool Induction Heating Process

- CAD Model Requirements
  - Induction heating coil
  - Air gap
  - Coolant circuit
  - Plastic part
  - Cavity & Core inserts
  - Mold blocks
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Simulation of RocTool Induction Heating Process

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

Online Help topic: [Meshing guidelines for Induction Heating](#)
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Simulation of RocTool Induction Heating Process

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Autodesk Moldflow Insight

Simulation of RocTool Induction Heating Process

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Plastic Material
Mold & Cavity Material
Air-Gap Material
Heating/Cooling Elements Material
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Simulation of RocTool Induction Heating Process

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

![Diagram showing the stages of the Induction Heating Process]

- Heating: 7s: End of heating
- Filling + Packing stage: 13s: Ready to fill, 20s: End of packing
- Cooling stage: 48s: End of cooling

![Induction Coil (3D) properties dialog box]

- Induction Coil Properties
- Mold Properties
- Induction Coil (3D) time:
  - Switch off time: 0
  - Switch on time: 35
Results Comparison | What we are comparing

With RocTool

Without RocTool

Induction coils with air gap
Mold Temperature over time (Conventional)

Temperature, mold (transient)
Time = 0.0000[s]
Mold Temperature over time (Conventional)
Mold Temperature over time (RocTool)

Temperature, mold (transient)
Time = 0.0000[s]
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.
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.
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?