Improving Processing of Rubber in Injection, Transfer and Compression Molding Process

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Introduction

Mold heating time is the biggest contributor to the overall cycle time in almost all rubber molding applications.

Many molders fail to claim additional savings that can be achieved through optimized heating process.
Molding Process

Mold heating generally accounts for more than two thirds of total cycle time.

- Heating: 51%
- Pack & Hold: 29%
- Fill: 11%
- Close: 3%
- Open & Eject: 6%
Benefits of Optimum Heating Process

• Temperature Uniformity
• Reduced Residual Part Stress
• Cycle Time Reduction
• Scrap Rate Reduction
• Energy Savings
• Reduced Maintenance
Factors Affecting Mold Heating

**MOLD**
- Material Thermal properties
- Part Geometry
- Thermal breaks between plates or inserts
- Location of Thermocouple

**RUBBER PART**
- Thermal properties
- Part Thickness
- Geometry
# Thermal Conductivity of Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal Conductivity (W/m K) at 20°C</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ISOBAR</strong></td>
<td>390 – 15,000</td>
<td>****</td>
</tr>
<tr>
<td>Aluminum</td>
<td>237</td>
<td>1.6x</td>
</tr>
<tr>
<td>Beryllium Copper</td>
<td>105</td>
<td>3.7x</td>
</tr>
<tr>
<td><strong>Steel</strong></td>
<td>20 – 40</td>
<td>13x</td>
</tr>
<tr>
<td>Water</td>
<td>0.60</td>
<td>650x</td>
</tr>
<tr>
<td>plastics</td>
<td>0.15 – 0.30</td>
<td>2,400x</td>
</tr>
<tr>
<td><strong>RUBBER</strong></td>
<td>0.13 – 0.16</td>
<td>2,600x</td>
</tr>
<tr>
<td>Air</td>
<td>0.025</td>
<td>15,600x</td>
</tr>
</tbody>
</table>
Types of Isobars

- STANDARD
- FINNED
- STEPPED
- HOLLOW
Isobar - Function

HEAT IN

METAL WICK

LIQUID FLOW

VAPOUR FLOW

HEAT OUT

HEAT IN

ISOBAR SHELL

HEAT OUT

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Isobar Function and Orientation

<table>
<thead>
<tr>
<th>VERTICAL</th>
<th>HORIZONTAL / INCLINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEAT OUT</td>
<td>HEAT OUT</td>
</tr>
<tr>
<td>HEAT IN</td>
<td>HEAT IN</td>
</tr>
</tbody>
</table>

**HEAT INPUT MUST BE BELOW HEAT OUTPUT**

**HEAT INPUT AND OUTPUT CAN BE ANYWHERE ALONG THE ISOBAR LENGTH**
Isobars

- Passive Device
- Superthermal Conductors
- Thermal Uniformity of $\pm 1$ °C
- Orientation Dependent
- Operating Temperature $0 - 280$ °C
Thermal Performance of 25mm Diameter x 150mm Long Core

![Diagram of Thermal Performance of 25mm Diameter x 150mm Long Core]

- **CORE WITH ISOBAR**
  - MOLDED PART
  - CORE PIN
  - ISOBAR

- **CORE SOLID**
  - HEATER
  - HEATED MOLD PLATE

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Thermal Performance of 25mm Diameter x 150mm Long Core
Thermal Performance of 25mm Diameter x 150mm Long Core

![Graph showing thermal performance with and without isobars for core top and base.]

- Core Top
- Core Base

Temperature (°C) vs. Length (Cm) with and without isobars.
Examples of Cores with Isobars
Isobar Design in Heated Cores

TEMPERATURE UNIFORMITY OF HEATED CORE

No Isobars

With 4 Isobars

Indirect Heating of Isobars
Isobar Design in Heated Cores

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Isobar Design in Transfer Molding
Tree Bar Mold

Core Pin

Tree Bar

Isobar
Heater
Isobar Design in Heated Cores

Epoxy Plug

ISOBAR

3 mm

257 mm

57 mm
Rubber Molding over Flat Plates
ISOPLATEN

Bi-Level Matrix of Heaters and Isobars
STANDARD PLATEN
24” x 24” x 3”
With 5 heaters

Temperature (°C)

Heaters ON
Thermocouples
STANDARD PLATEN
24” x 24” x 3”
With 5 heaters
One Heater disconnected

Temperature (°C)

Heaters ON
Heater OFF
Thermocouples
HEATER TEMPERATURE PROFILE VS LENGTH

Temperature (°C)

Length (Cm)

Heater Leads End
ISOPLATEN
24” x 24” x 3”
With 5 Heaters
With 13 Isobars
1 Heater Disconnected

ISOPLATEN
24” x 24” x 3”
With 5 Heaters
With 13 Isobars
One heater disconnected
Isoplaten vs. Standard Platen

ISOPLATEN
1 Heater Disconnected

STANDARD PLATEN
1 Heater Disconnected

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Isoplaten vs Platen Consideration

- Thermal uniformity $+/-2 \, ^\circ C$ vs $+/- 15 \, ^\circ C$

- Single Zone vs Multiple Zone Control
Rubber Molding of Automotive Gaskets

EXAMPLE#1
Rubber Molding of Automotive Gaskets

EXAMPLE #2
Middle Cavity Plate

Isobar
Heater
Rubber Molding of Automotive Seals
Example#3
Rubber Molding Tool
Example#4
Single Cavity Tool

Ø25mm X 7.5" LG. ISOBARS- 12 PCS
STANDARD

Ø25mm X 6.5" LG. ISOBARS- 15 PCS
REVERSE
Thermoset Molding of Automotive Head Lamp Reflectors
2 Cavity Thermoset Head Lamp Reflector Mold

Heater
Isobar
Thermocouple
2 Cavity Thermoset Head Lamp Reflector Mold

Heater Isobar

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Isobar Design in Head Lamp Molds

- Isobars shown Prior to Install
- Optic Surfaces
- Electrical Box Shown with heater Leads and T/C Mold Insulated
Isobar Design in Head Lamp Molds

Cooling

Isobars

Heaters

Heat Generation In mold Inserts
Isobar Design in Head Lamp Molds

Heating Zone

Electrical Box

Heat Generation In mold Shoe

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Isobar Design in Head Lamp Molds

Heat Generation In mold Shoe With Isobars in Slides

Slide with Isobars

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