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Top ~~10~~ 11 Things Every Molder Should Know About a Molding Job

Co-Sponsors:

Paulson Training Programs

Orbital Plastics Consulting

Presentation Overview

- Welcome, Introductions & Overview
- Top ~~10~~ **11** Things Every Molder Should Know About a Molding Job
    1. Plastic Temperature
    2. Plastic Flow Rate
    3. Plastic Pressure
    4. Plastic Cooling Rate & Time
    5. What Does Start Up Entail?
    6. Initial Sampling
    7. Process with No Mold Release
    8. Effects of Adjusting Injection Speeds
    9. MFI & Material Lot Number
    10. Textured Parts
    11. Tool Tear Down & Inspection
- Conclusion, Summary & Questions

About Paulson Training Programs

- For over three decades, Paulson Training Programs has been the leading source for training in the plastics industry.
- 3,000+ plants and over 30,000 employees trained.
- Strong training alliances with over 80 colleges and universities.
- Library includes over 300 hours of interactive plastics training and 2,000+ hours of additional business and manufacturing training titles.
- New SkillBuilder and SimTech products, software based injection molding machine simulation programs.
- Record of innovation and quality.
- Partner and co-founder in Paulson School of Molding with Orbital Plastics Consulting.

About Orbital Plastics Consulting, Inc.

- Co-founder & Partner in Paulson School of Molding
- Injection molding processing & troubleshooting
- Injection molding training – processing & part design
- Expertise in selecting and implementing in-mold instrumentation.
- Provides suggestions regarding material selection and plastic part design.

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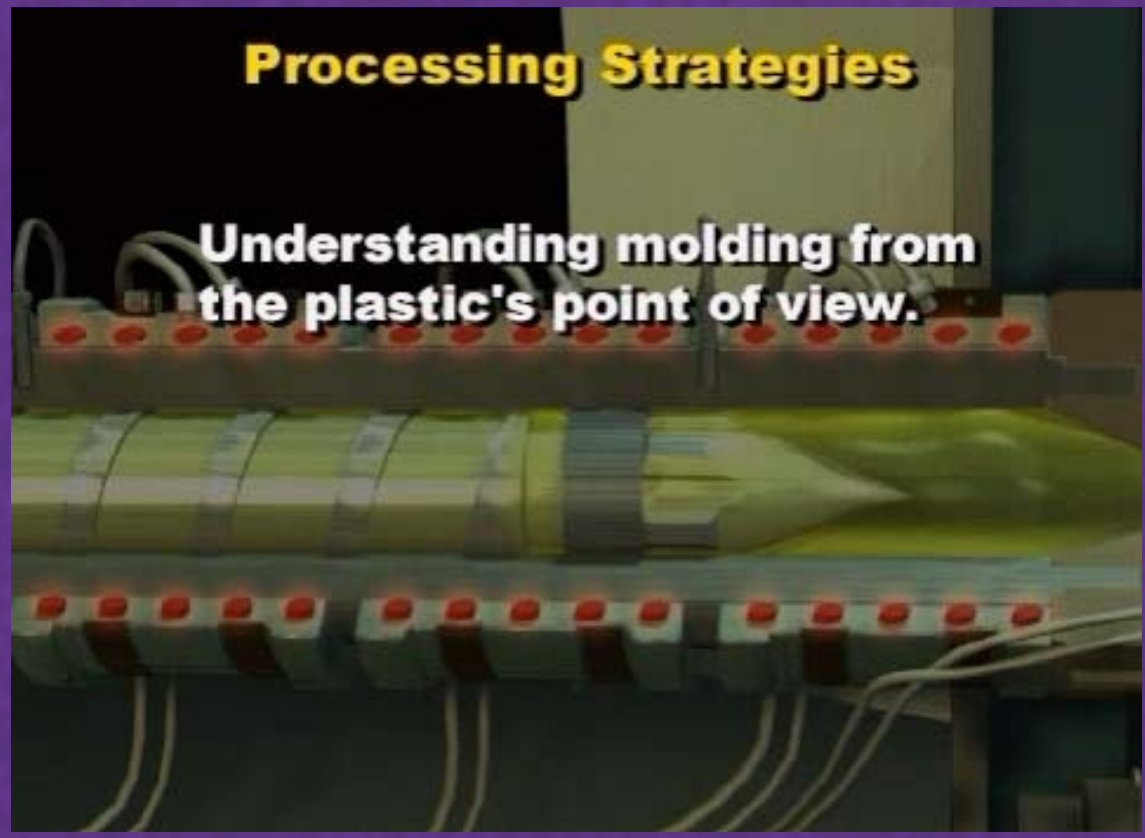
The Four Primary Plastic Conditions



What does the plastic care about?

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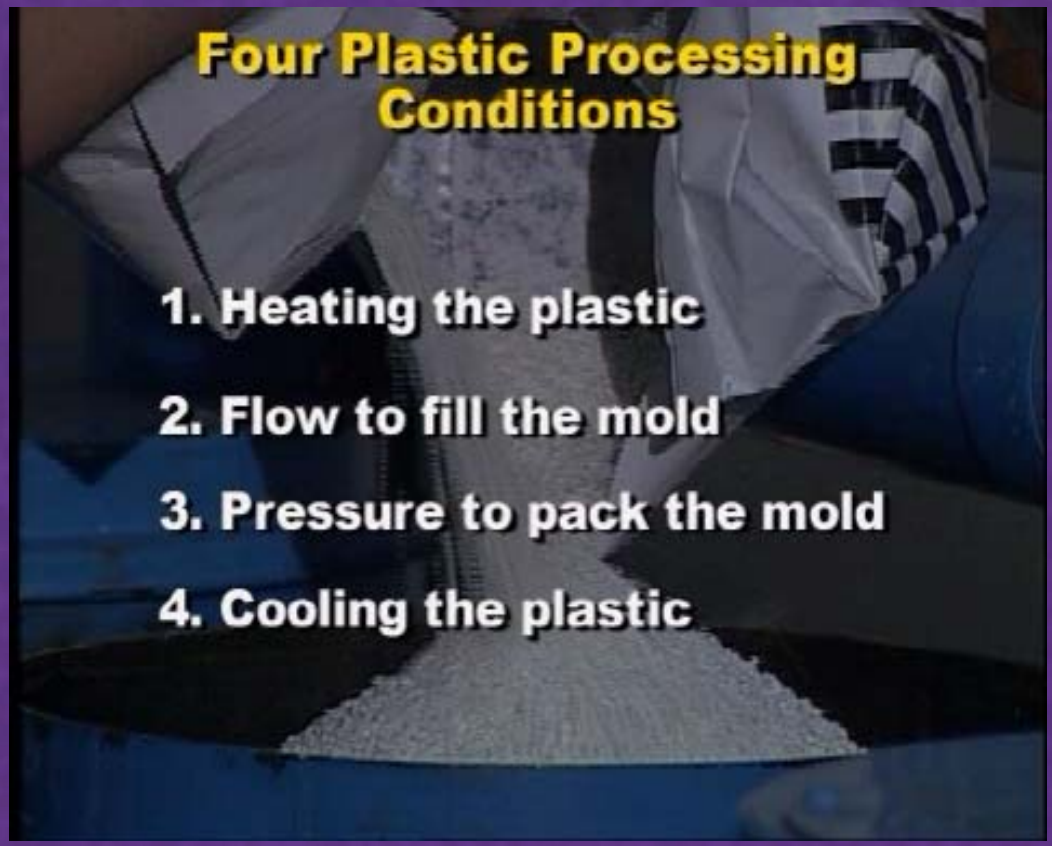
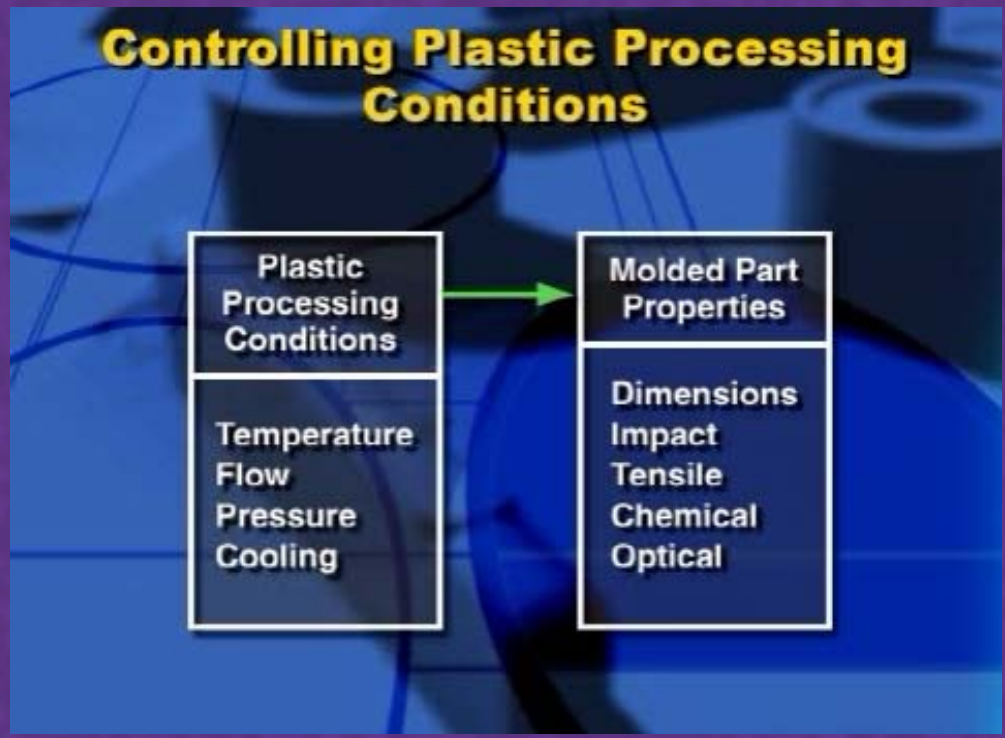
The Four Primary Plastic Conditions



The four primary plastic conditions

The Four Primary Plastic Conditions



No injection molding machine exists with these four controls.

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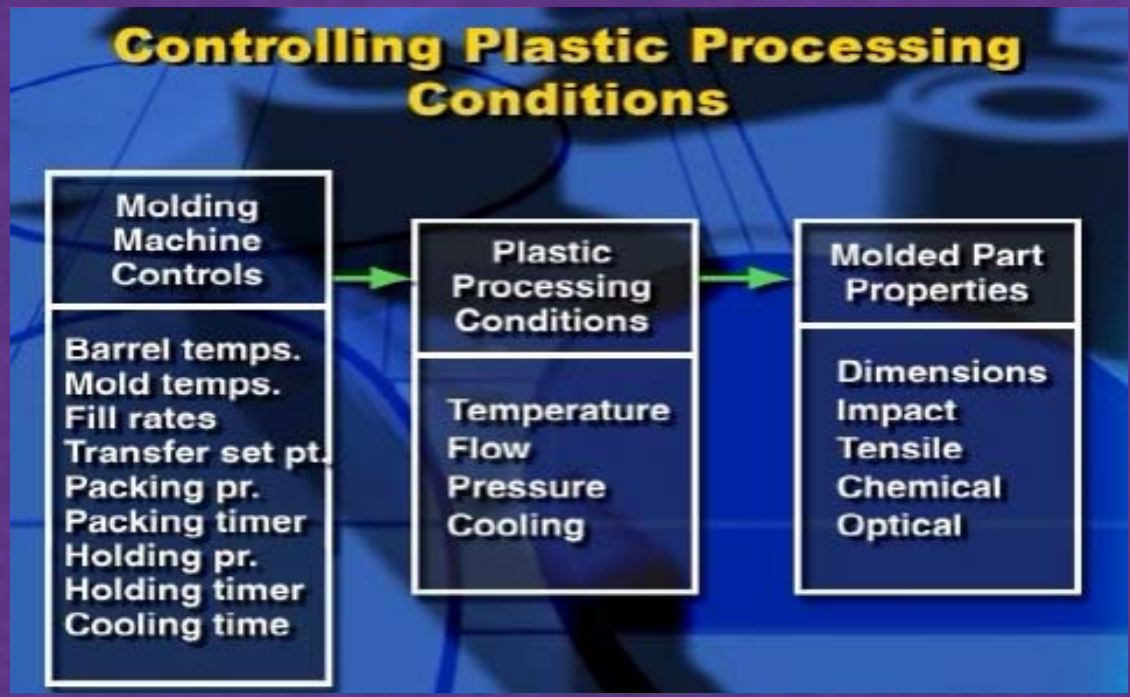
The Four Primary Plastic Conditions



We must use the machine and mold adjustments to control the plastic processing conditions.

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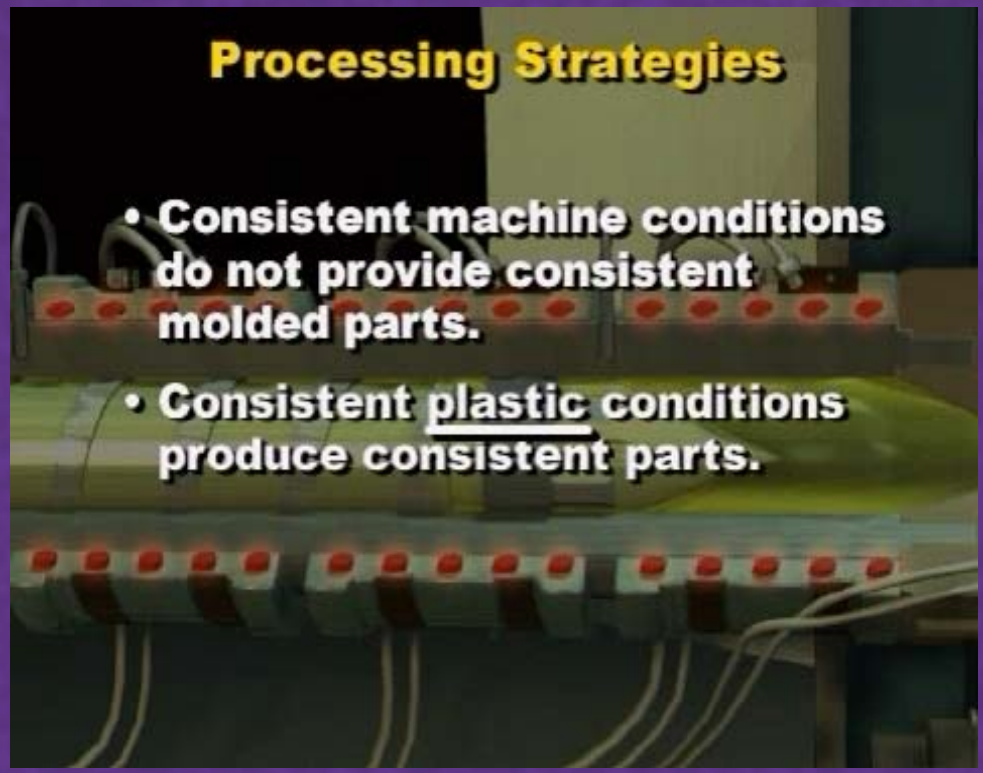
The Four Primary Plastic Conditions



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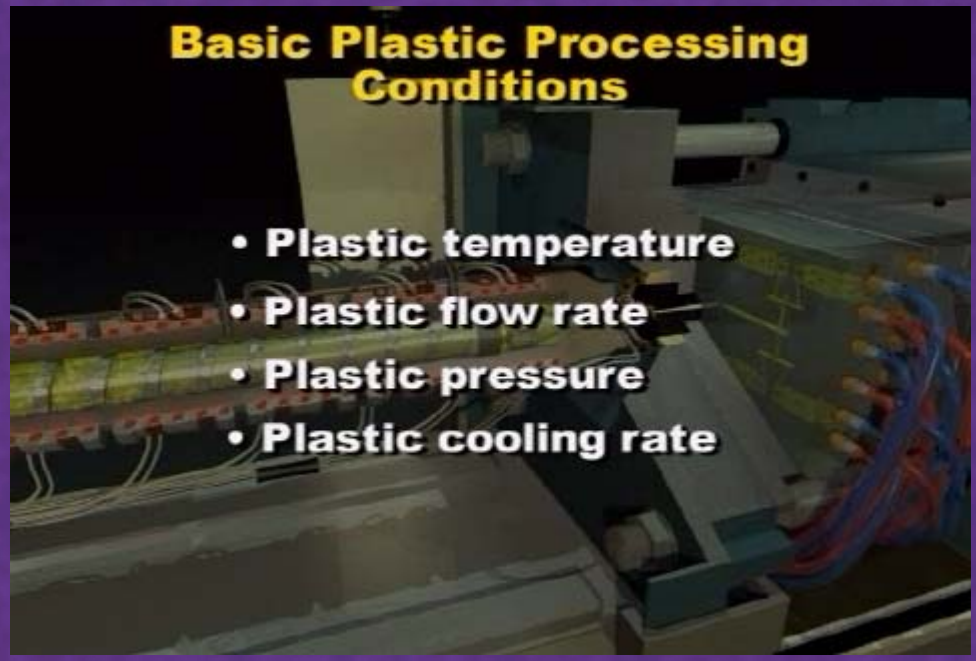
The Four Primary Plastic Conditions



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1

Plastic Temperature

A Primary Plastic Processing Condition

Plastic Temperature

1. Screw Design / Configuration
2. Barrel & Nozzle Heats
3. Screw Speed or RPM
4. Back Pressure
5. Feed Throat Conditions

Plastic Temperature

Screw Design & Configuration

Specialized screws available: Nylon, PE, Barrier, mixing sections, etc.

Configuration: Compression Ratio and L/D Ratio

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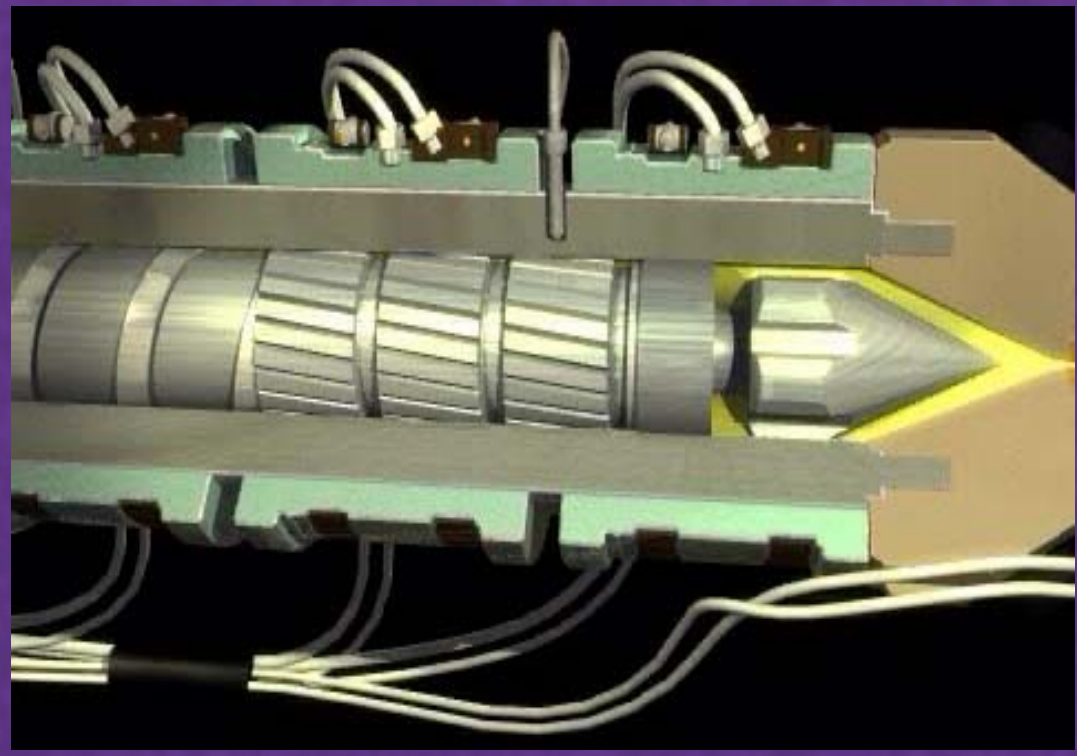
Plastic Temperature

Screw Design & Configuration



Mixing Section:

Generates extra mixing of the polymer melt and provides more uniform melt temperature and color dispersion.

Breaks up the tornado-like flow of plastic in screw flights.

Must not cause high localized shear.

Faster purging/quicker color change.

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Plastic Temperature

Barrel & Nozzle Heats

Barrel & Nozzle Controls:

Typically 20-30% of the heat needed to melt or soften the plastic is from the barrel heaters.

Nozzle temperature control is necessary to keep plastic from freezing when the nozzle is against a mold.

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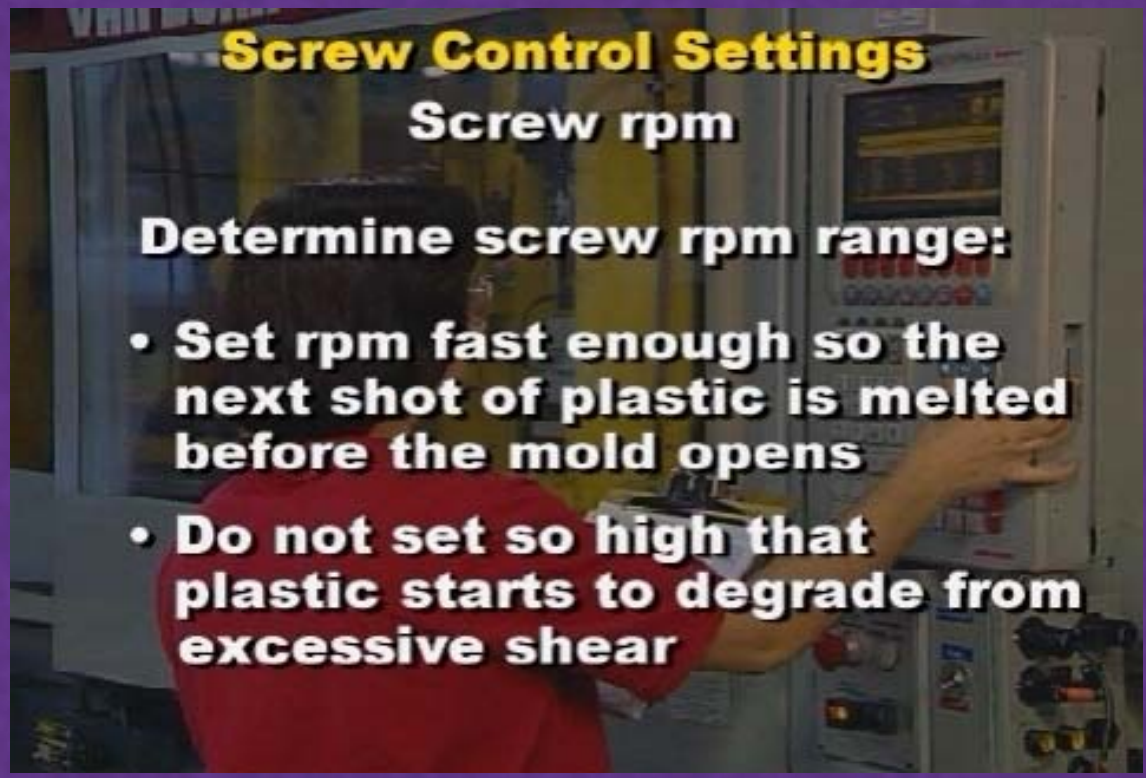
Plastic Temperature

Screw RPM



Plastic Temperature

Back Pressure

Back pressure resists the screw during plastication.

Plastic pressure causes the screw to return during plastication.

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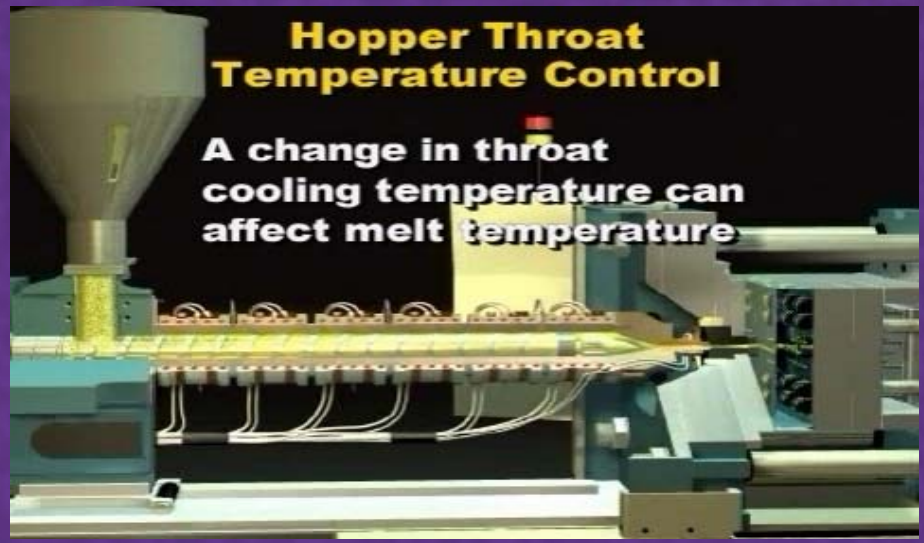
Plastic Temperature

Feed Throat Condition



Cooling channels keep the plastic from melting in the feed throat.

This area is often overlooked by many molders but is critical.

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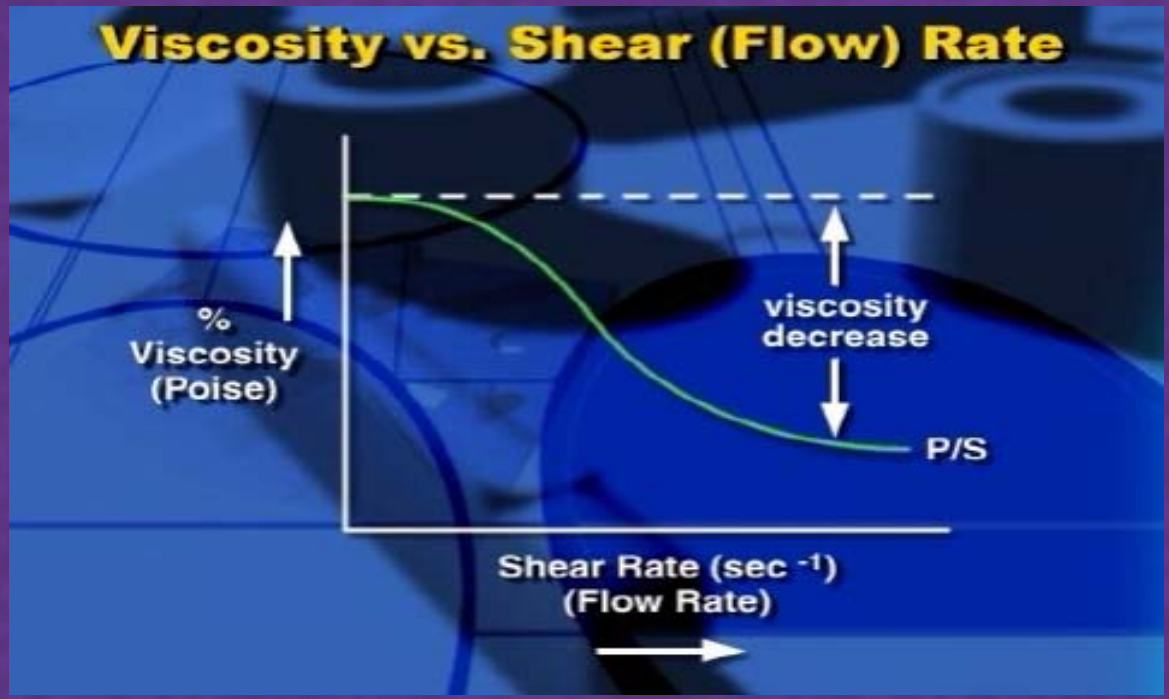
Plastic Flow Rate

A Primary Plastic Processing Condition

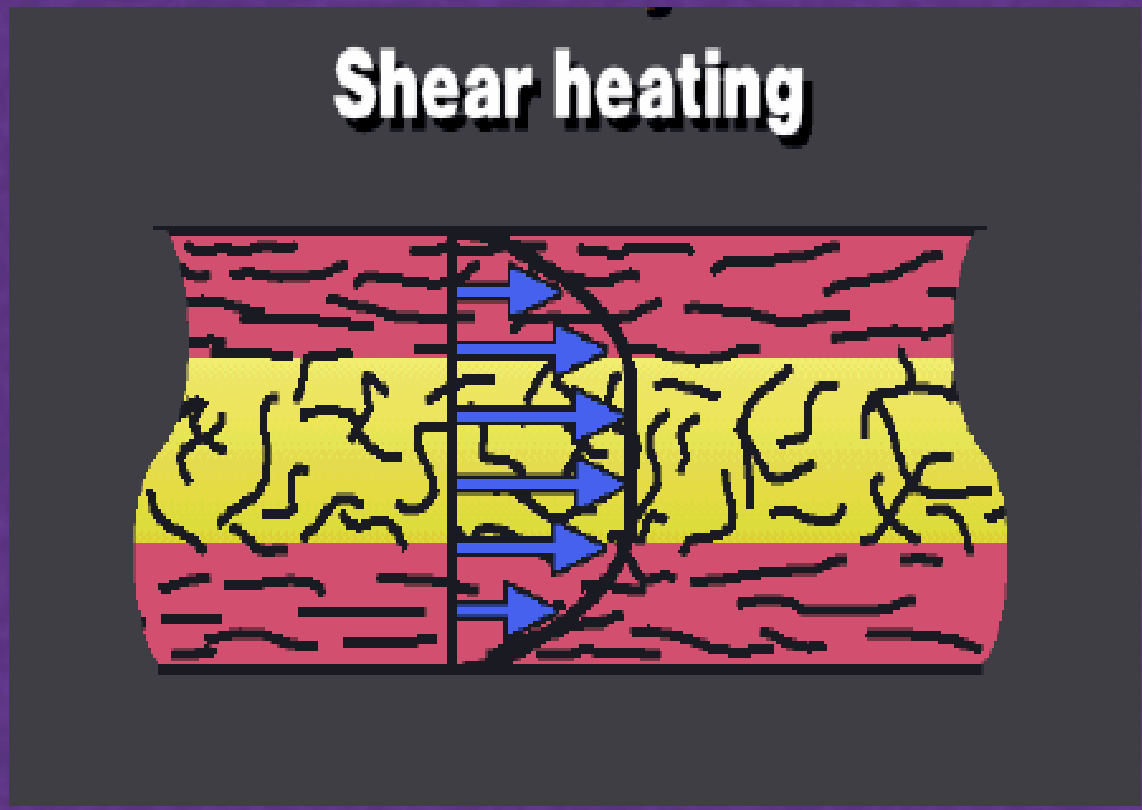
Plastic Flow Rate



Viscosity continues to decrease as the flow increases.

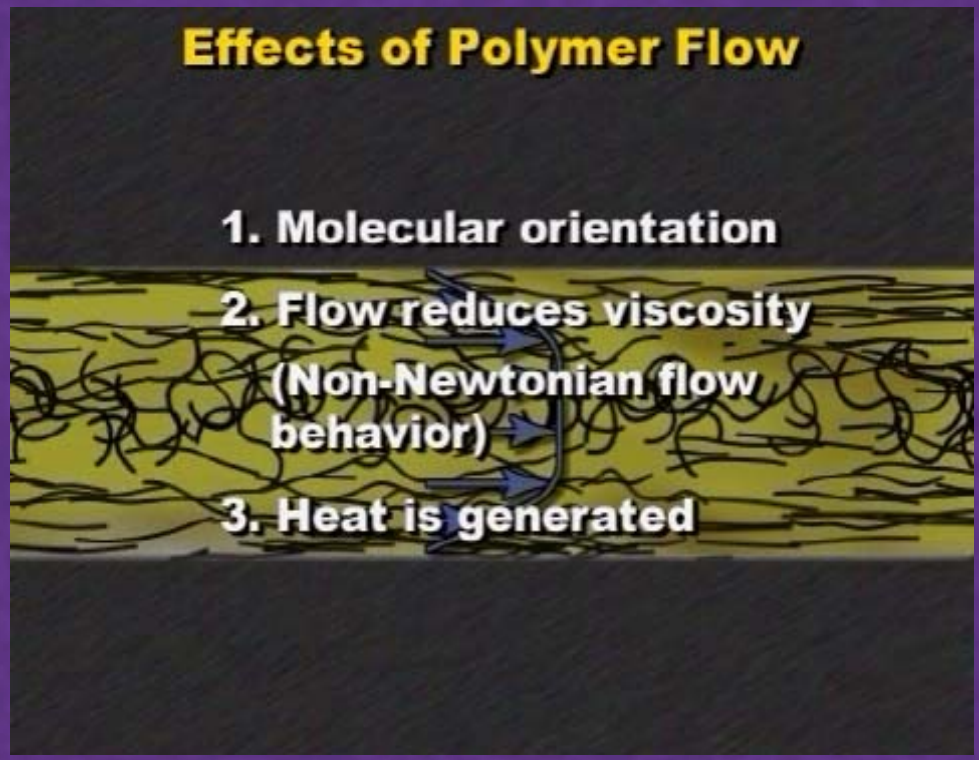
Polystyrene viscosity can drop as low as 1/20 of its starting viscosity.

Plastic Flow Rate



Heat is generated by the shearing that occurs between the flowing molecules.

Summary: Plastic Flow Effects in the Mold



3

Plastic Pressure

A Primary Plastic Processing Condition

Plastic Pressure

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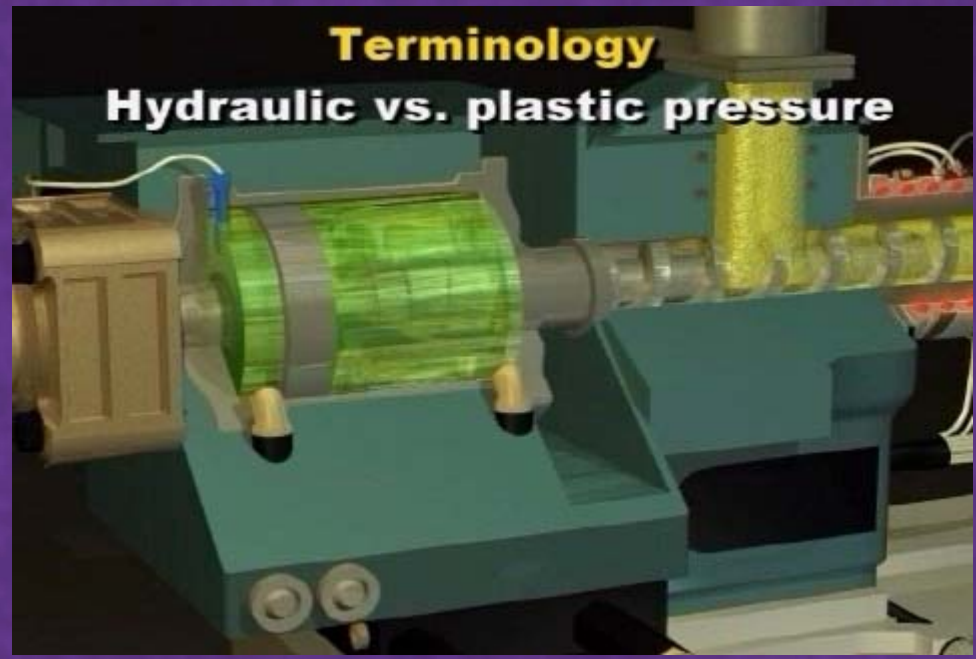
Plastic Pressure



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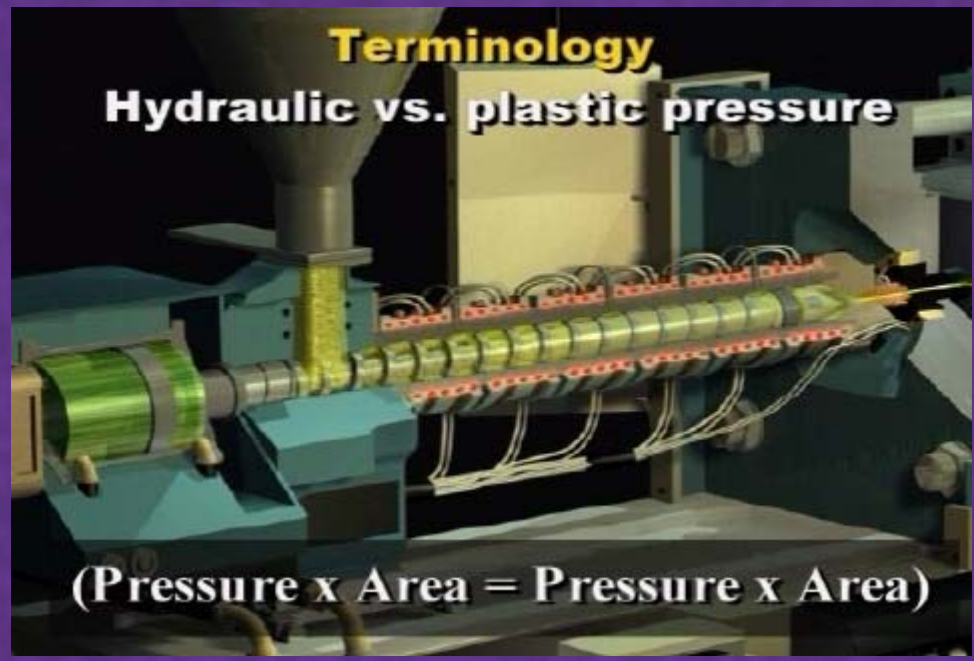
Plastic Pressure



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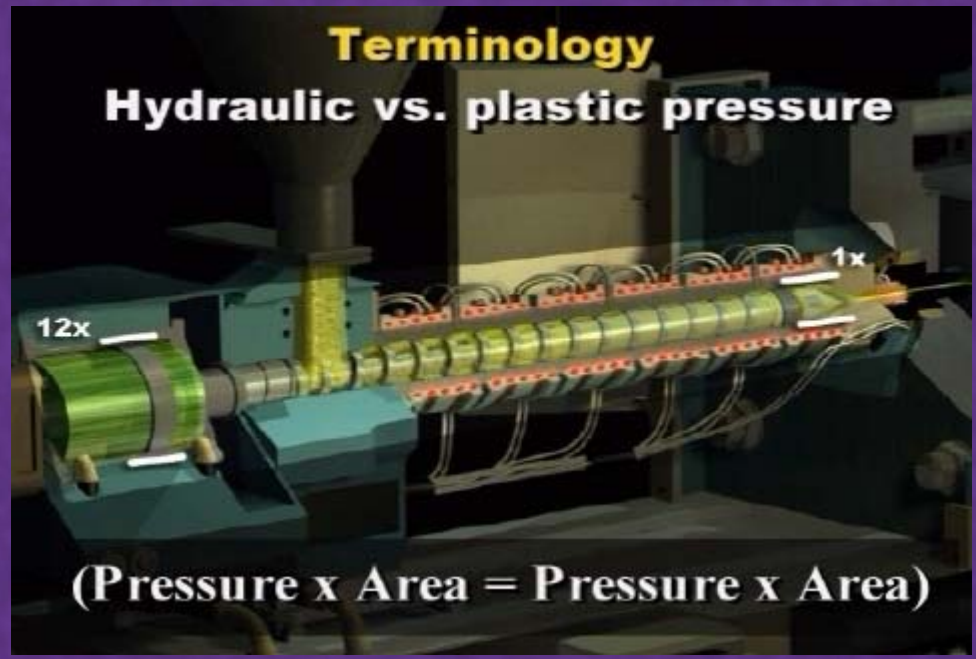
Plastic Pressure



The hydraulic injection cylinder has a much larger cross sectional area than the front of the screw.

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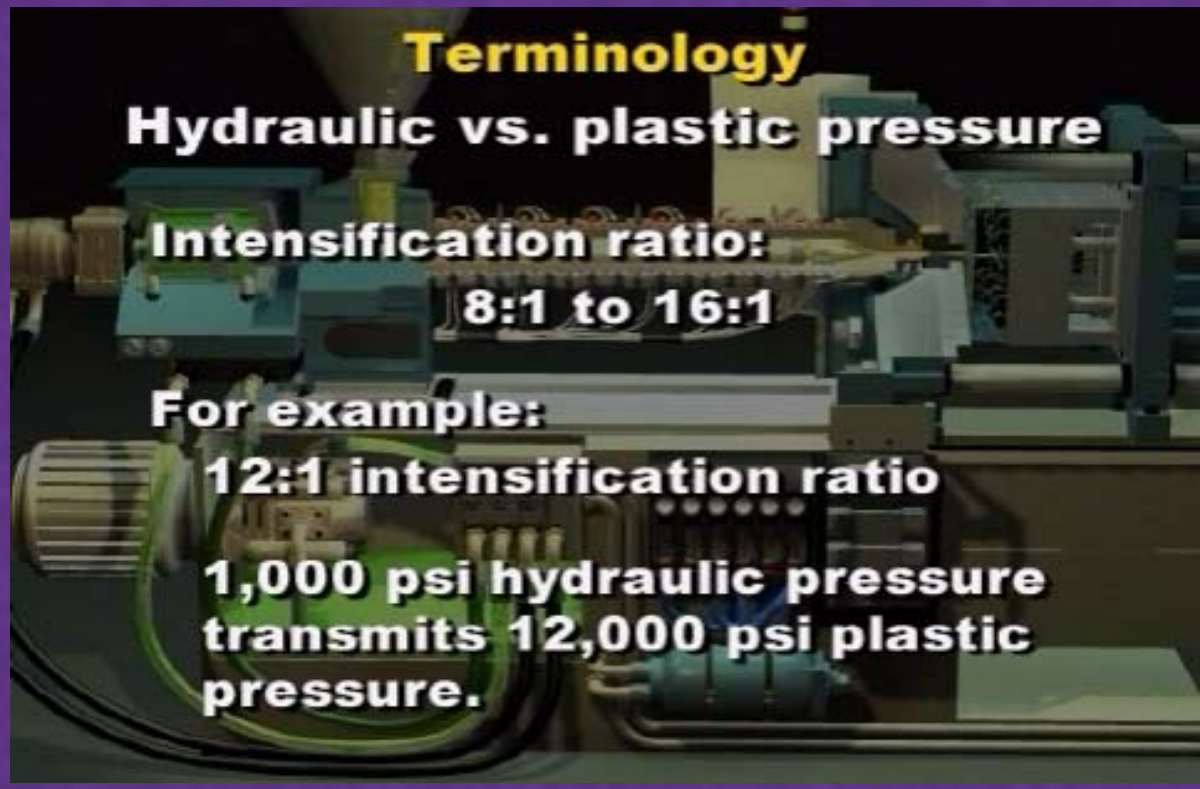
Plastic Pressure



Intensification ratio converts hydraulic pressure to plastic pressure.

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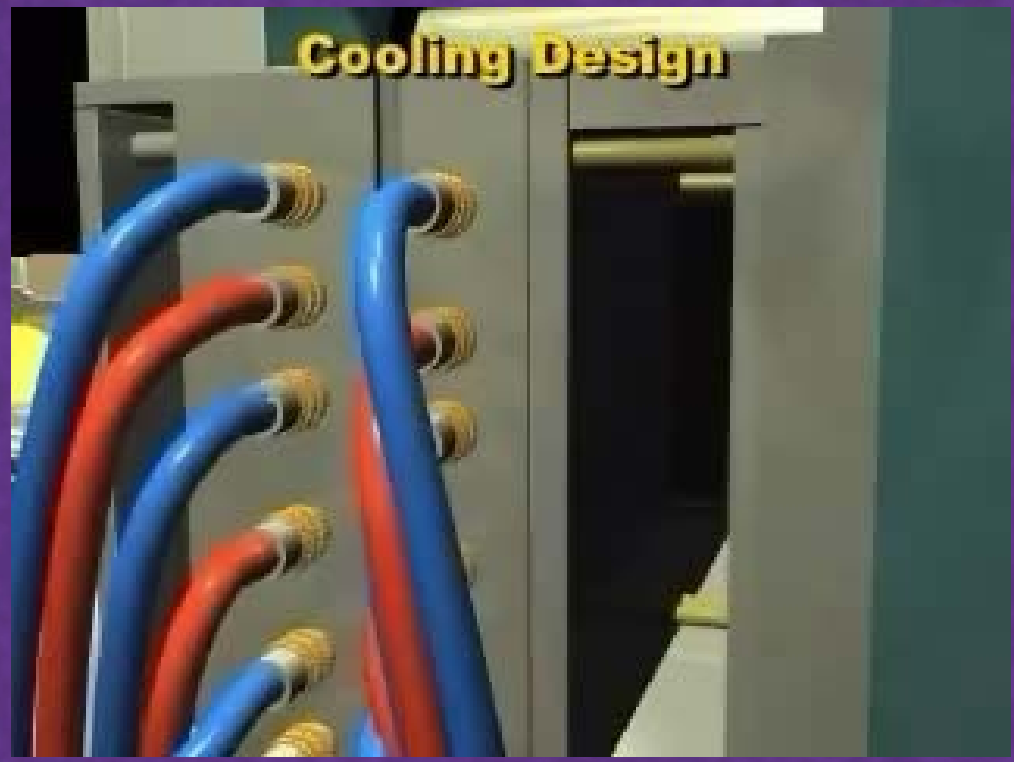
4

Plastic Cooling Rate & Time

A Primary Plastic Processing Condition

Plastic Cooling Rate & Time



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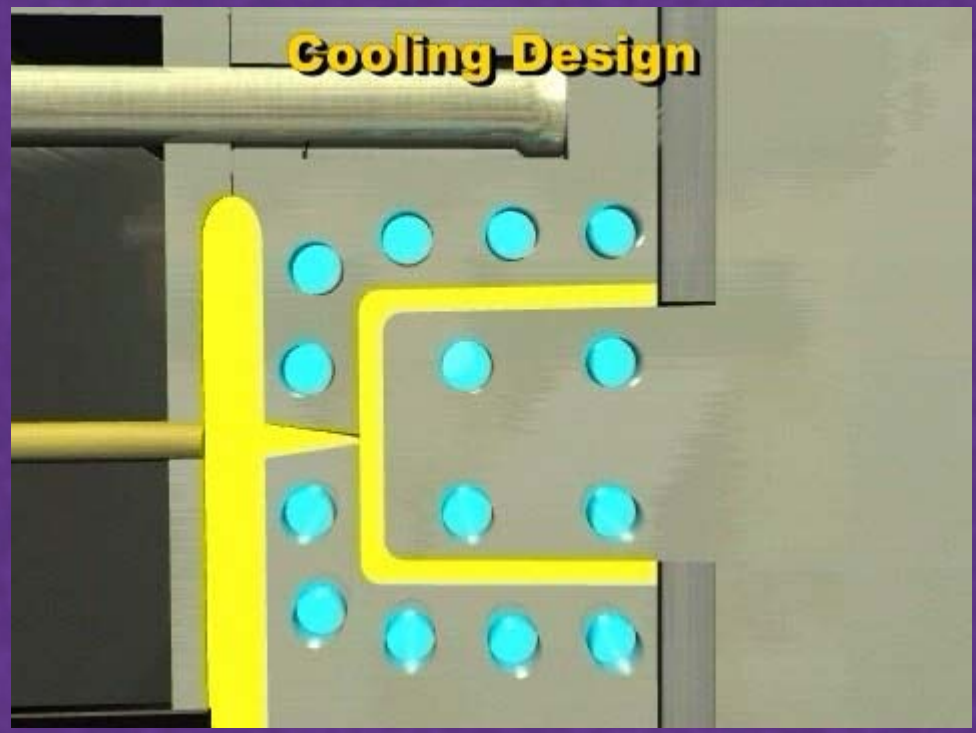
Plastic Cooling Rate & Time



Heat is removed from the plastic by a coolant, usually water, flowing through the coolant passages or channels.

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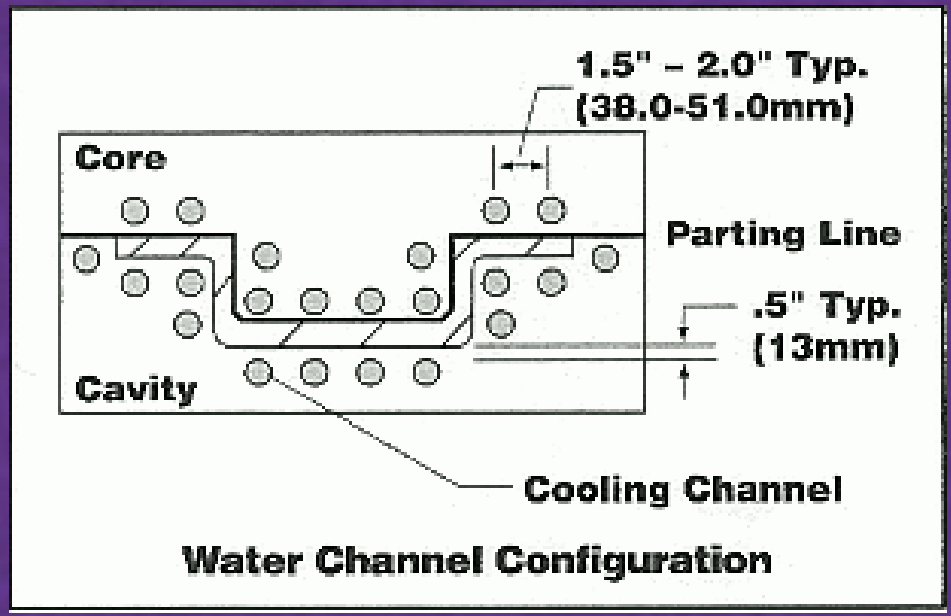
Plastic Cooling Rate & Time



Water Channel Configuration

3 critical dimensions for cooling channels are "DDP"

1. Depth - distance from the center of a cooling channel to the part surface.
2. Diameter - diameter of water line.
3. Pitch - distance between the center lines of the cooling channels.

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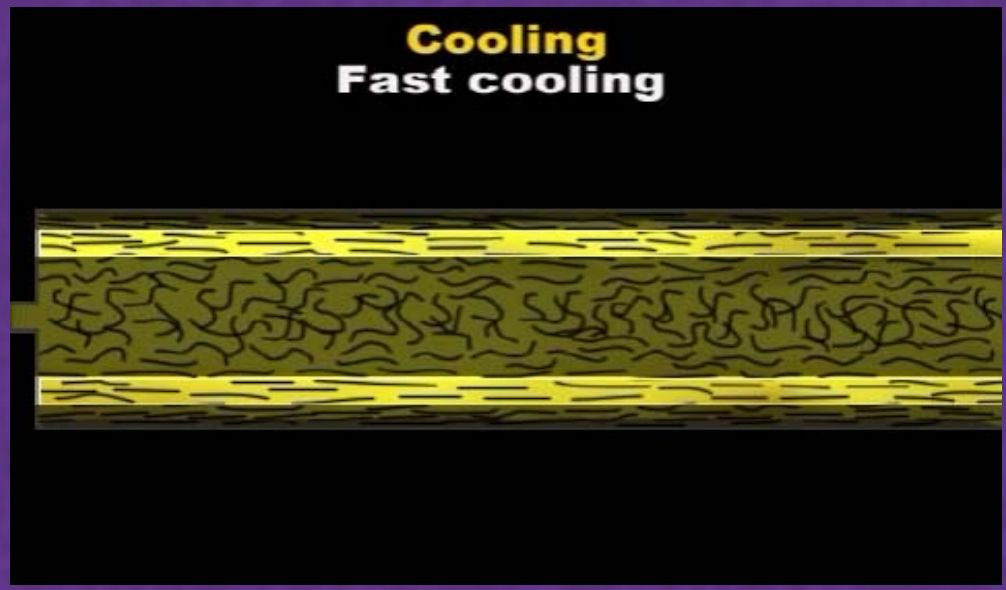
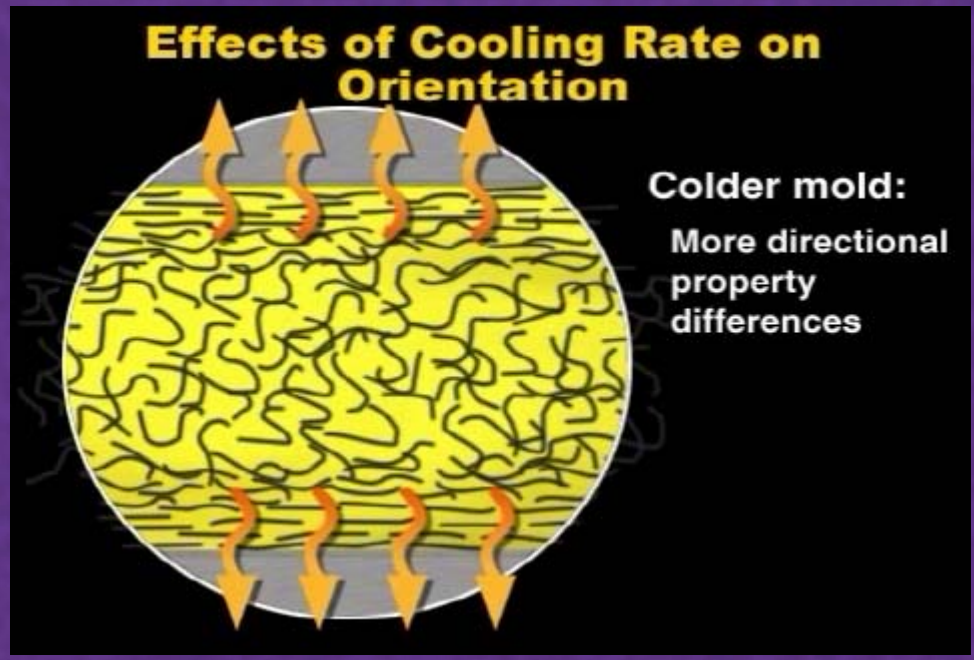
Plastic Cooling Rate & Time



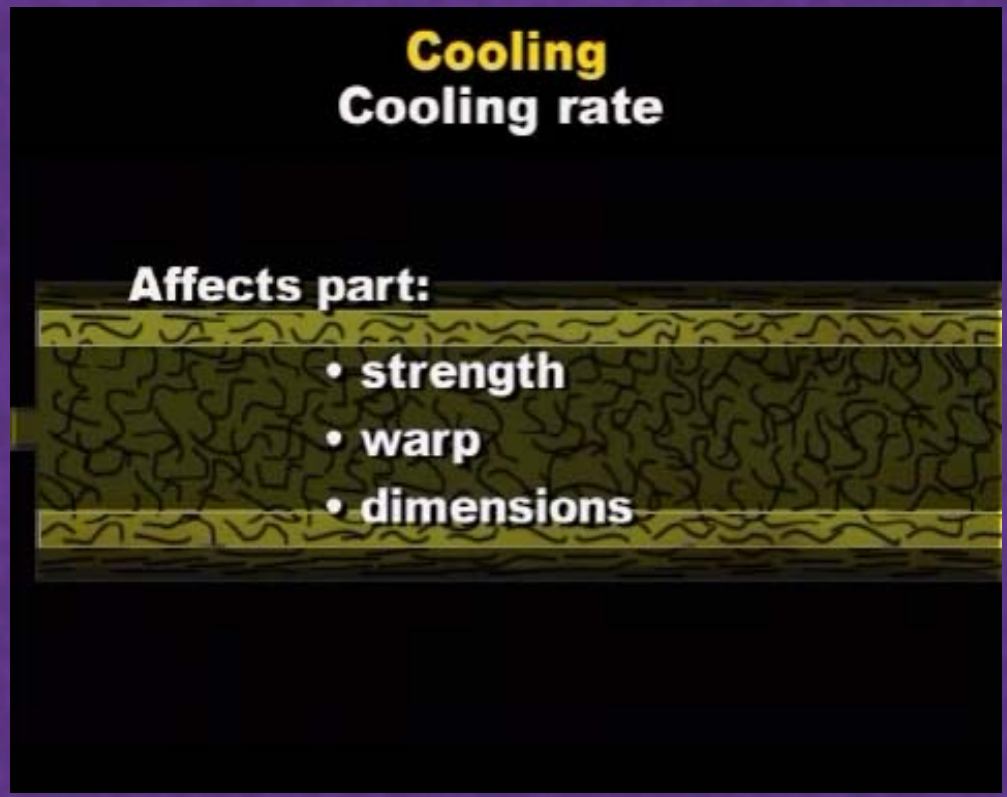
Fast cooling = Low mold temperature

Why do parts warp days or even weeks after molding?

Plastic Cooling Rate & Time

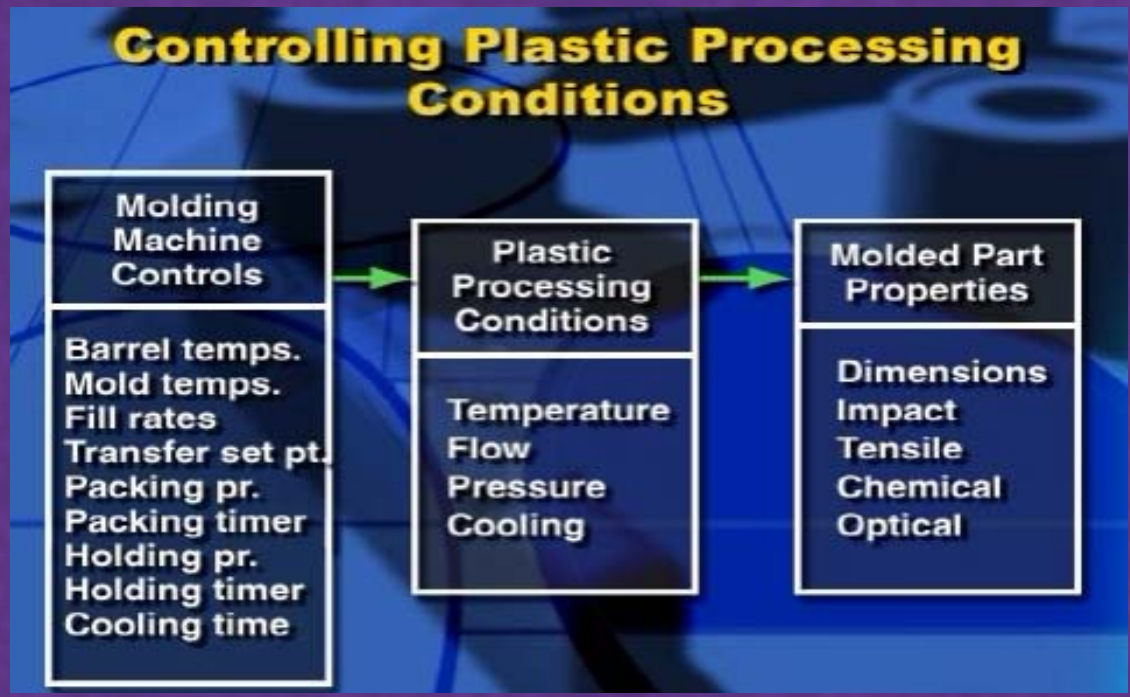


Plastic Cooling Rate & Time



Plastic condition that has greatest effect on overall cycle time.

The Four Primary Plastic Conditions



We must use the machine and mold adjustments to control the plastic processing conditions.

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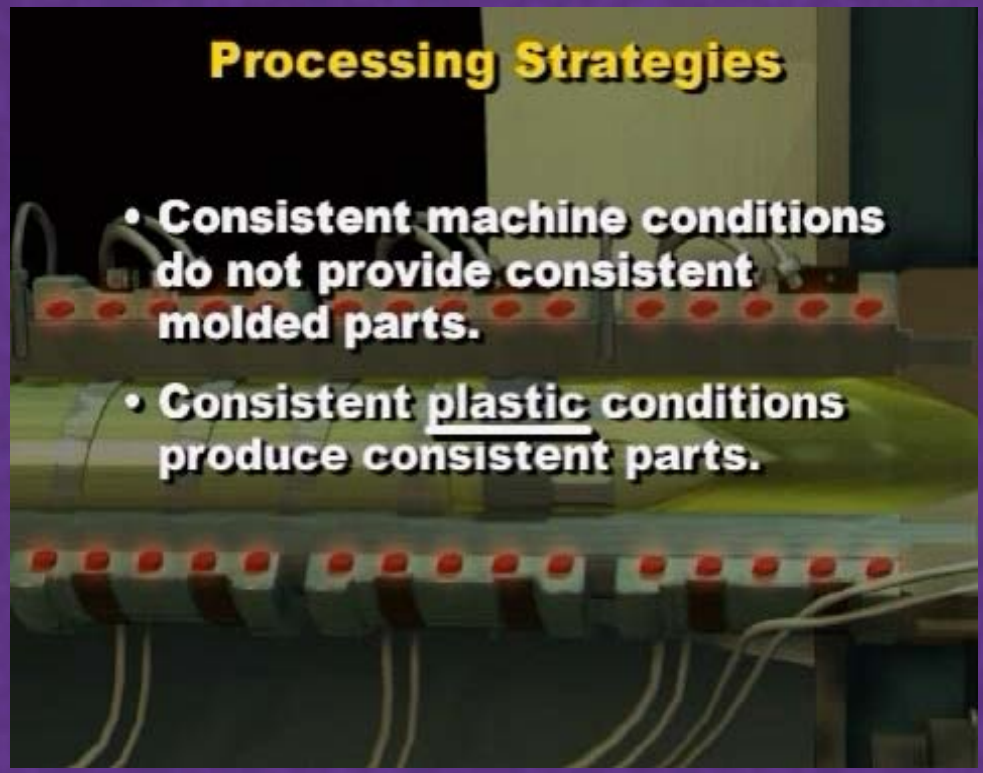
The Four Primary Plastic Conditions



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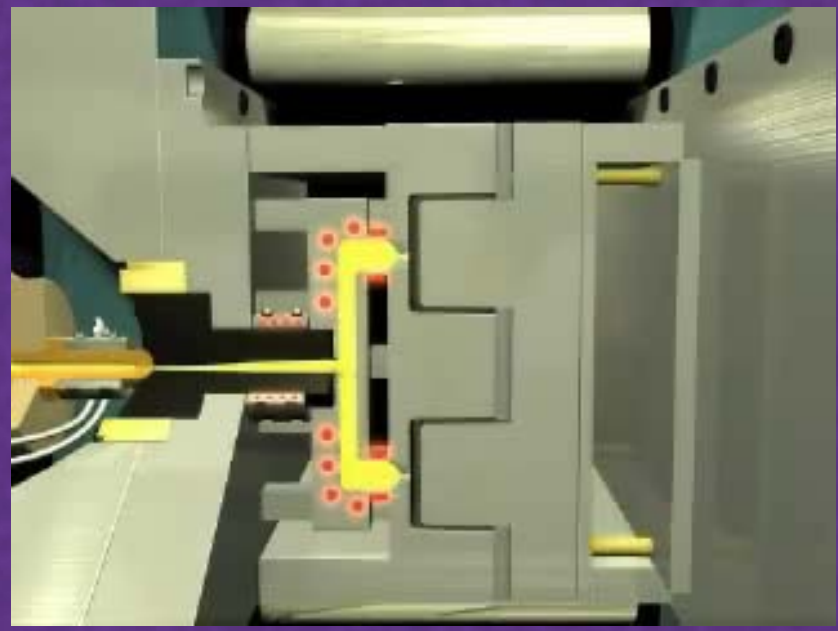
5

Start Up

What Does It Entail?

What Does Start Up Entail?

Runner system stays hot inside the mold



- Multi-cavity start-up for Hot Runner
  - Boost temperatures?
  - Troublesome cavity or cavities?
  - Drooling?
  - Cavity balance
- Time to start and get to full cavitation

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6

Initial Sampling

Initial Sampling

- Start machine while present
  - Verify Thermolator and Hot Runner set points and operation.
- Pack & Hold Pressures set to zero
- Do short shots eject?
- Do parts pull to the movable half?
- Maximum short shot – 50%?
- Develop a checklist

7

Process with No Mold Release

Process with No Mold Release

Mold release hides tool problems

- Sticking
- Tearing
- Poorly designed areas

8

Effects of Adjusting Injection Speeds

Effects of Adjusting Injection Speeds

- Fill fast as possible
- Venting issues
  - Shorts
  - Burns
  - Vents lead to atmosphere

Escape of Air

Air must be allowed to escape during injection.

Escape of Air

Examples of molded parts where the plastic has burned at its leading edge.

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Escape of Air

Solution to trapped air is to add venting.

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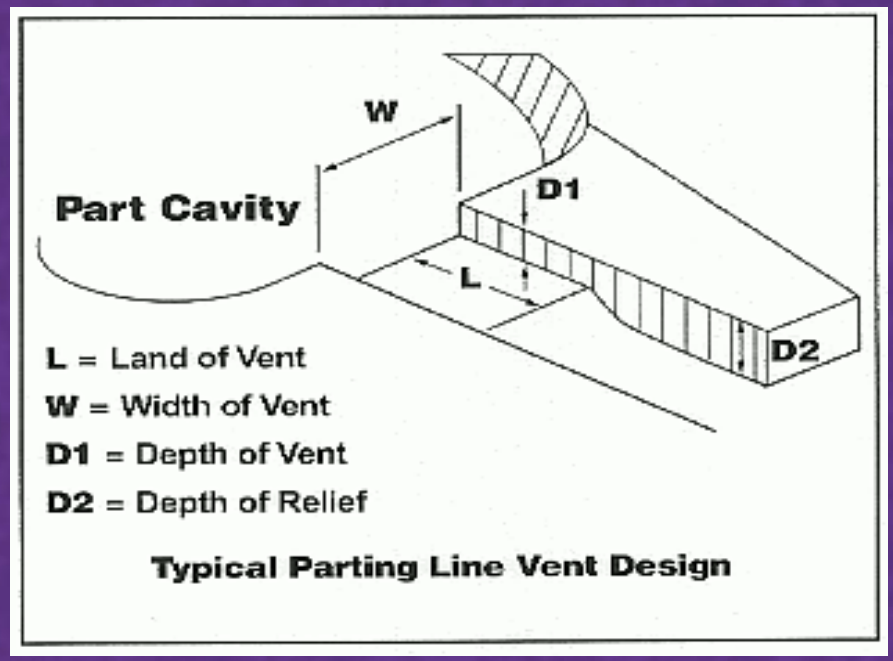
Escape of Air

Vent Depths for Various Resins	
Resin	Depth (inches)
ABS	0.0010 - 0.0015
Acetal	0.0005 - 0.0010
Acrylic	0.0015 - 0.0020
Nylon	0.0003 - 0.0005
PPO/PS (Noryl)	0.0010 - 0.0020
Polycarbonate	0.0015 - 0.0025
PET, PBT, Polyesters	0.0005 - 0.0007
Polysulfone	0.0010 - 0.0020
Polyethylene	0.0005 - 0.0012
Polypropylene	0.0005 - 0.0012
Polystyrene	0.0007 - 0.0010
T/P Elastomer	0.0005 - 0.0007



Typical Parting Line Vent Design

Venting Considerations:

The critical dimension on a vent is the depth or D1

Locate at last places to fill

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MFI & Material Lot Number

MFI & Material Lot Number

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MFI & Material Lot Number

- Viscosity Measurement - Melt Flow Index Test
- Rated in Grams/10 Minutes
- A simple test commonly used but it only has a limited value to the molder because it measures viscosity at a single, very low, flow rate - not anywhere near typical injection rates.
- Also over 80 melt flow test conditions
- High Melt Index Number = Low Viscosity
- Low Melt Index Number = High Viscosity

MFI & Material Lot Number

- Pull data from certification sheet
- Viscosity indication
- Future re-sampling?

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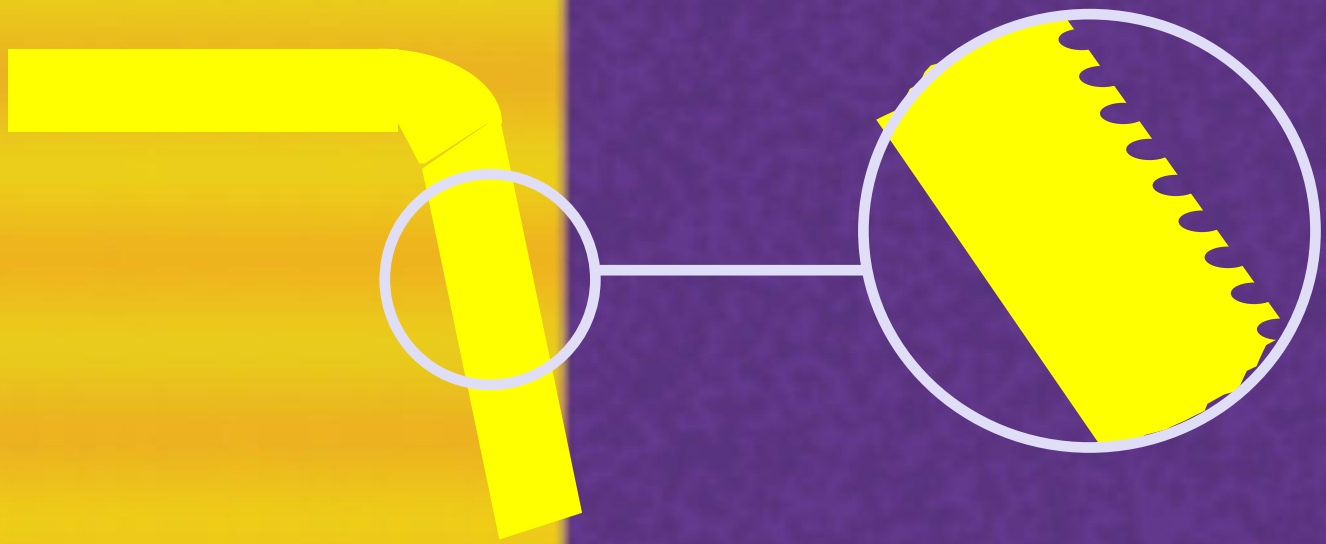
10

Textured Parts

Textured Parts

- Adequate draft angles exist?
- Part tearing & rolling
- Sampling before & after

Draft Textured Surfaces Produce Undercuts = Difficult to Eject



- Minimum: Draft 1°/Side + 1°/side/0.001 inches texture depth thus 0.002 in texture depth = 3° / side.
- Low shrinkage plastics do not shrink away from the cavity as much as high shrinkage plastics.
- Low shrinkage plastics are easier to eject from cores and harder to remove from cavities.

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11

Tool Tear Down & Inspection

Tool Tear Down & Inspection

- Develop tooling standards

- Develop mold checklist
  - Mold basics
  - Cooling system / waterlines
  - Air circuits
  - Hydraulic circuits
  - Mechanisms
  - Cavity & core inserts
  - Ejection
  - Electrical

Thank You

Paulson Training Programs
www.paulsontraining.com
spaulson@paulsontraining.com

Orbital Plastics Consulting
www.orbitalplastics.com
umberto@orbitalplastics.com