Moldflow Summit 2018

Moldflow vs. Moldfloor - Feeling The Pressure To Get It Right

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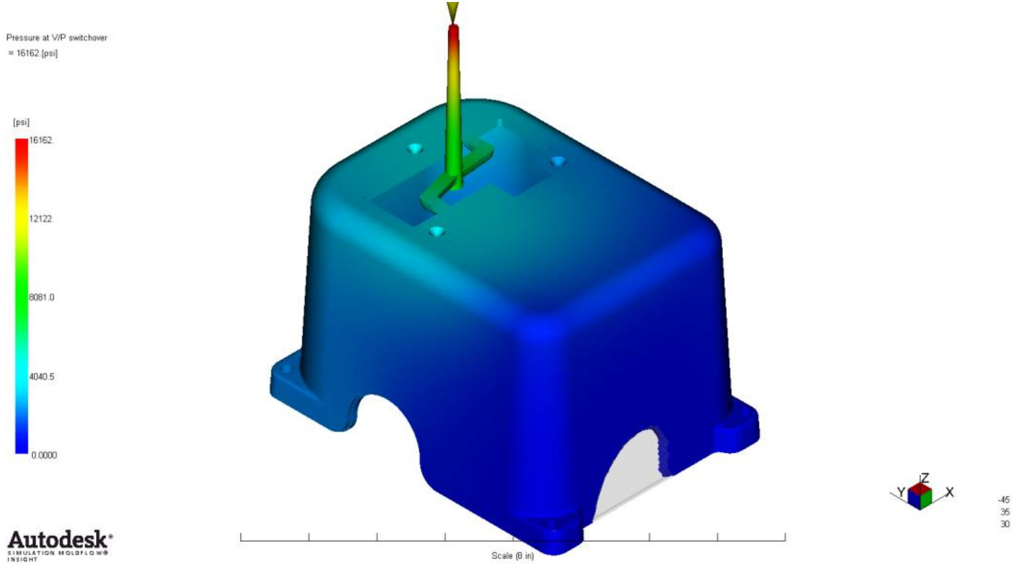
Moldflow vs. Moldfloor

Outputs	Moldflow Simulation, VP Switchover	Molding Process, Transfer Pressure
Pressure at V/P Switchover	16,162 psi	16,625 psi

Are these results close enough to consider the simulation a success?

What's missing from the simulation?



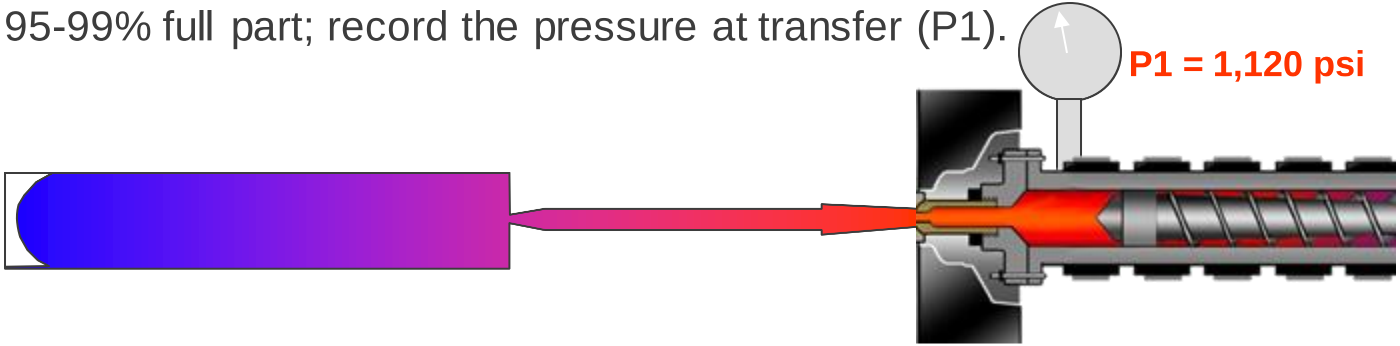
Moldflow vs. Moldfloor

What about the pressure allocations in the sprue, runner, gates & parts?

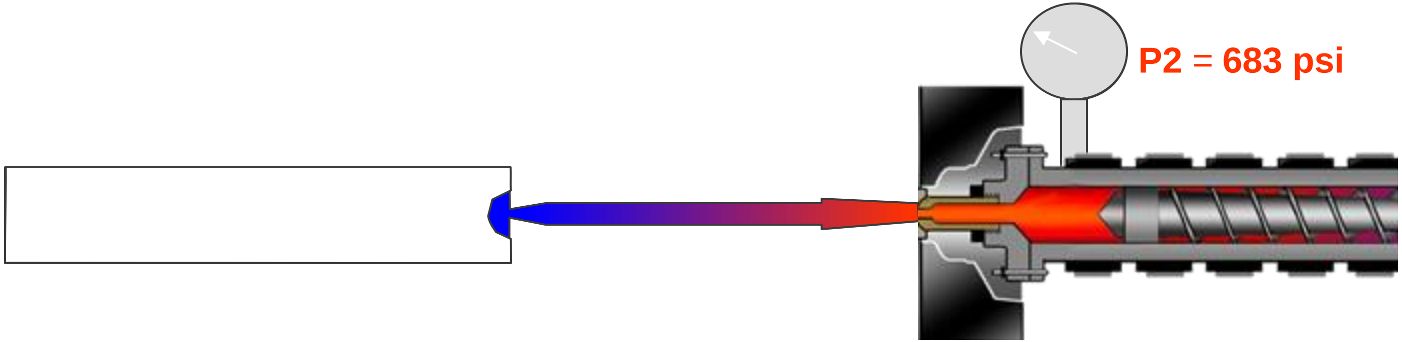
Moldfloor - Pressure Drop Study

Procedure

1. Make a 95-99% full part; record the pressure at transfer (P1).



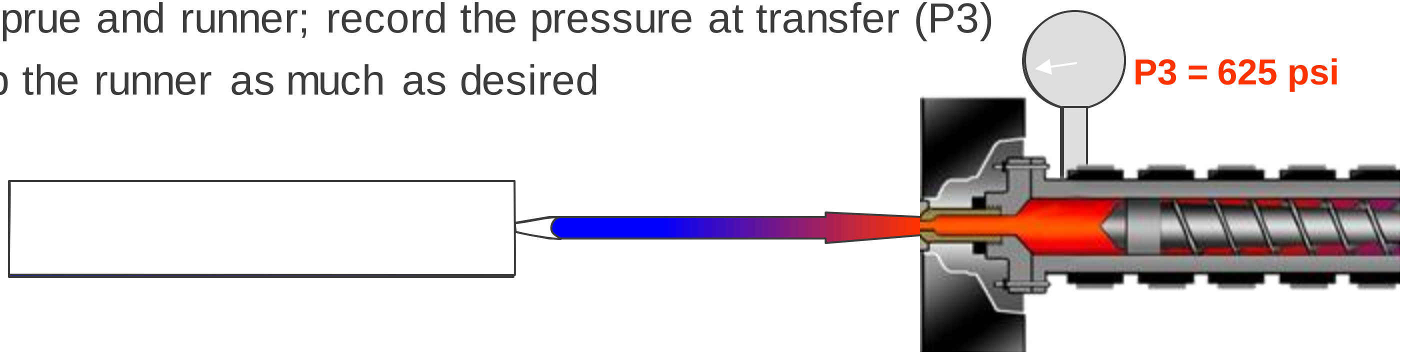
2. Make a nub after the gate; record the pressure at transfer (P2).



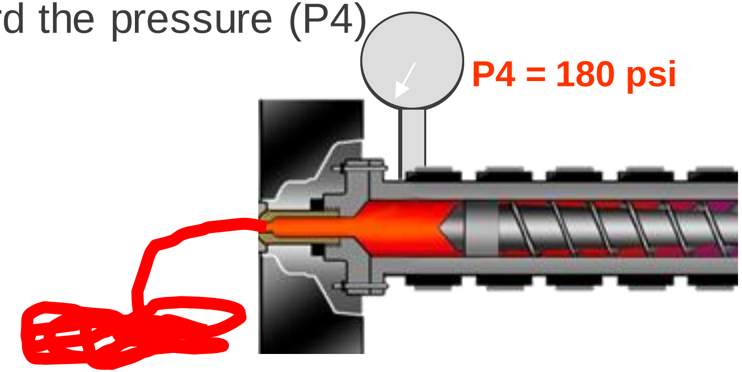
Moldfloor - Pressure Drop Study

Procedure

3. Make the sprue and runner; record the pressure at transfer (P3)
   - Break up the runner as much as desired



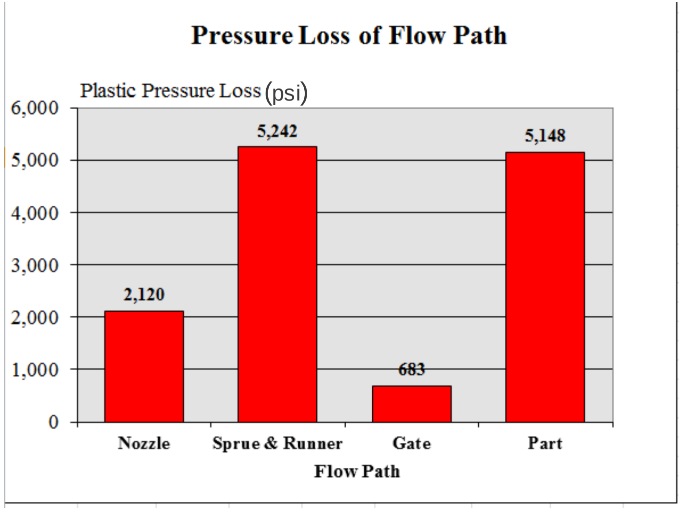
4. Make a purge shot at the same fill speed; record the pressure (P4)



Moldfloor - Pressure Drop Study

Pressure Location	Hydraulic Pressure (psi)	Intensification Ratio	Plastic Pressure (psi)
End of Cavity (P1)	1,120	11.78	13,194
After Gate (P2)	683		8,046
Sprue & Runner (P3)	625		7,363
Nozzle (P4)	180		2,120

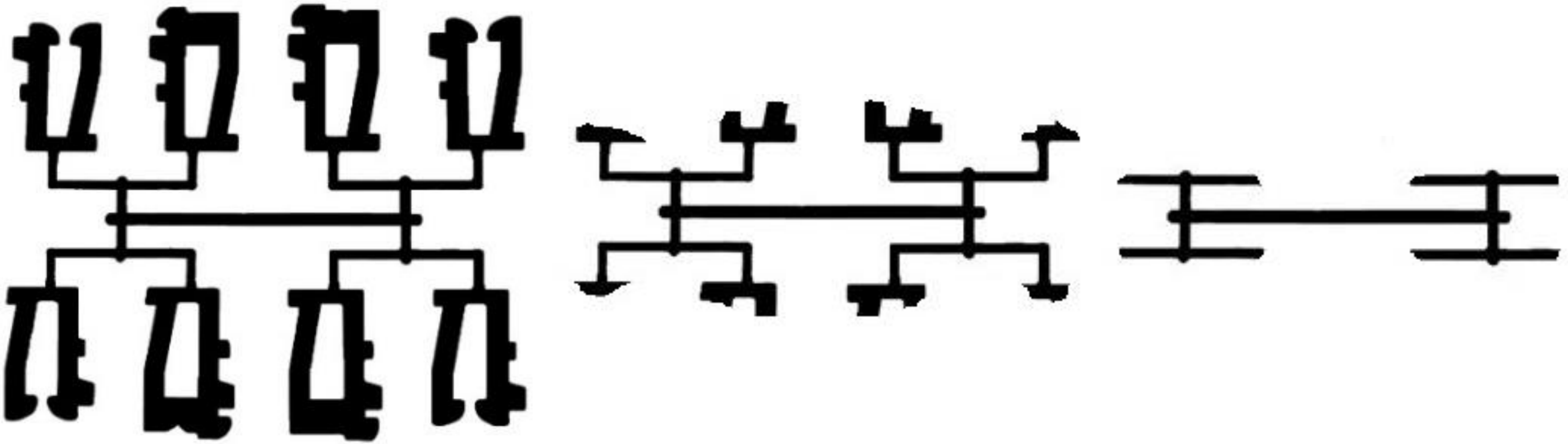
Mold Location	Pressure Drop (psi)
Part = (P1- P2)	5,148
Gate = (P2 – P3)	683
Sprue & Runner = (P3 – P4)	5,242
Nozzle = (P4)	2,120



Moldfloor - Pressure Drop Study

Purpose

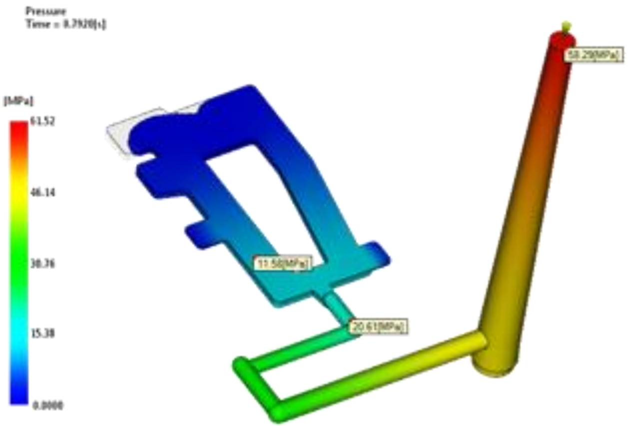
- Determine the pressure required to fill the mold during First Stage
- Identify what region(s) to modify if the pressure is too high



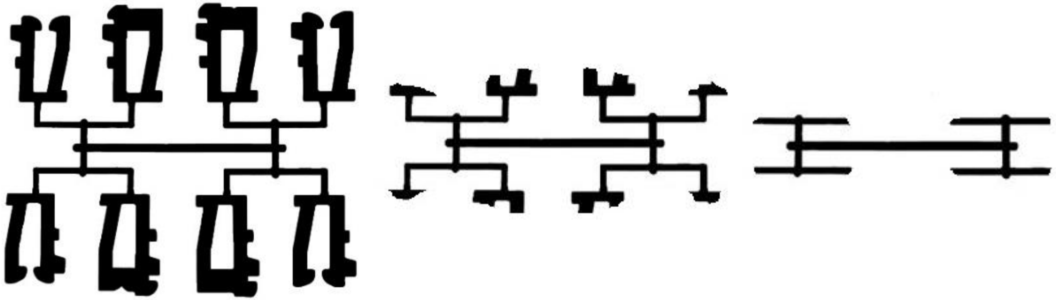
Moldflow vs. Moldfloor

Which method is more accurate in assessing pressure allocations?

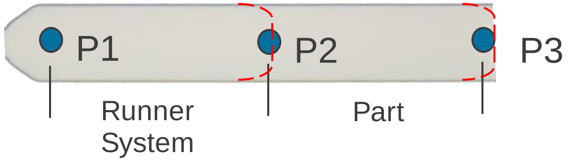
Moldflow



Moldfloor



Background & Theory



Example:
P1@P2 = 5.4 MPa
P1@P3 = 33.3 MPa
P2@P3 = 10MPa

<u>Conventional Method</u>

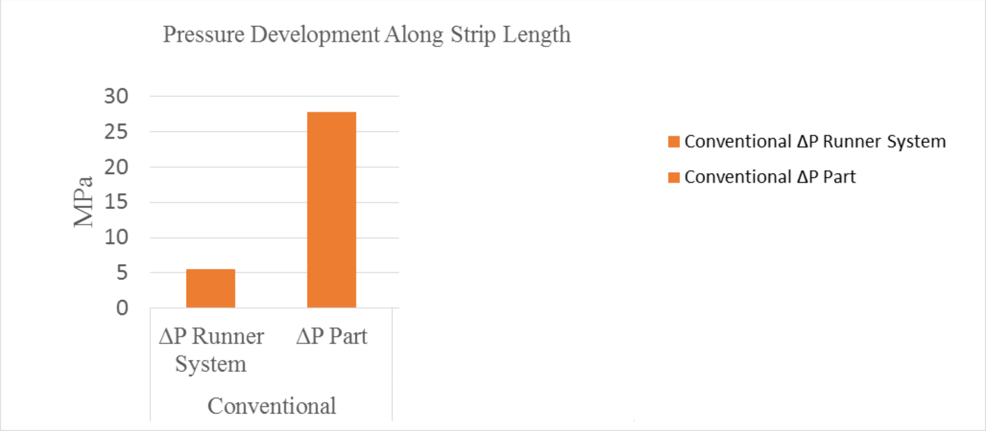
ΔP Part = P1@P3 – P1@P2
ΔP Runner System = P1@P2

ΔP Part = 27.9 MPa
ΔP Runner System = 5.4MPa

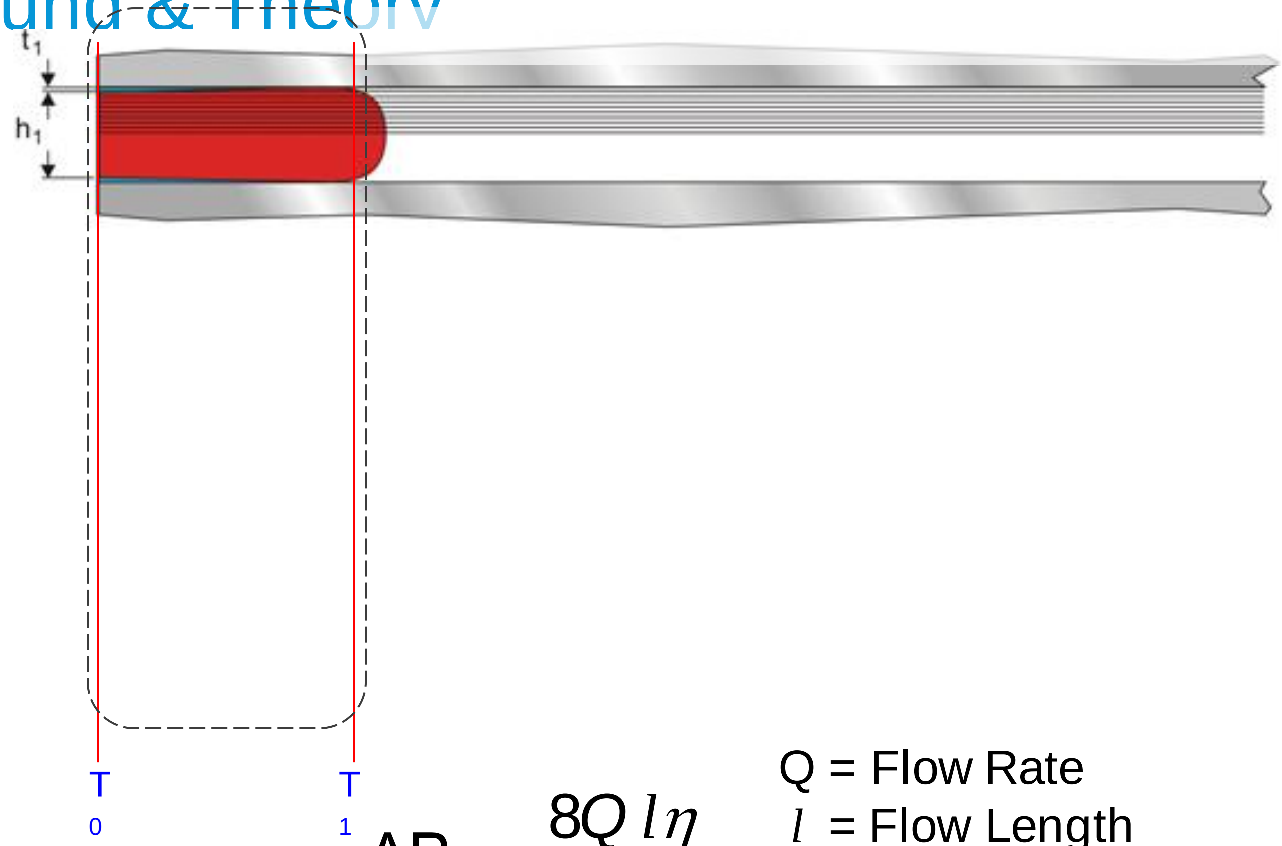
<u>Actual</u>

ΔP Part = P2@P3
ΔP Runner System = P1@P3 – P2@P3

ΔP Part = 10 MPa
ΔP Runner System = 23.3 MPa



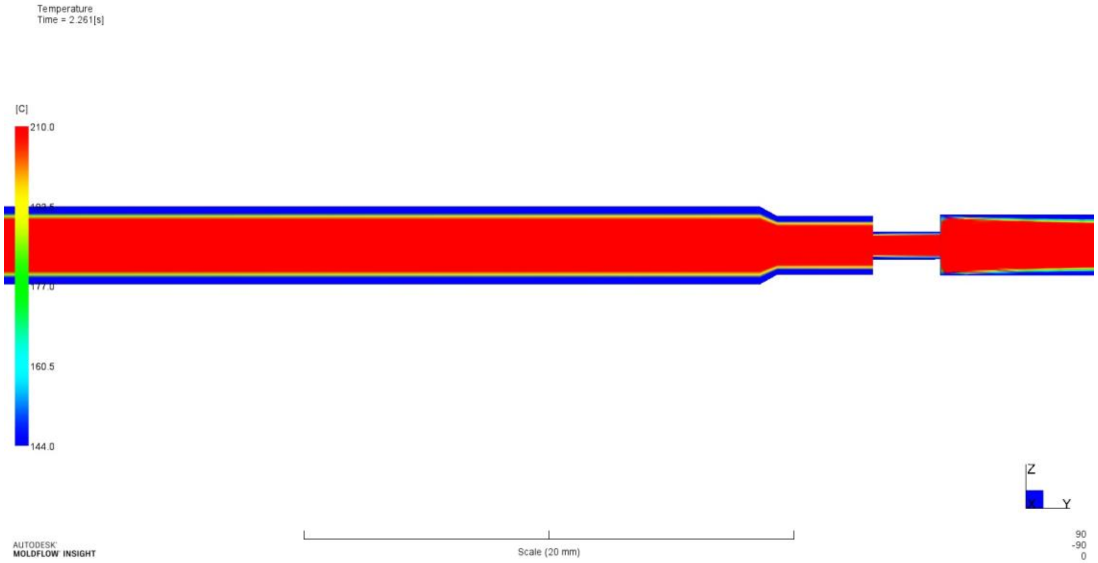
Background & Theory



$$\Delta P = \frac{8Q\, l\eta}{\pi r^4}$$

Q = Flow Rate
l = Flow Length
η = Viscosity
r = Radius

Effect of Frozen Layer During Continuous Flow



$$\Delta P = \frac{8Q\,l\eta}{\pi r^4}$$

Q = Flow Rate

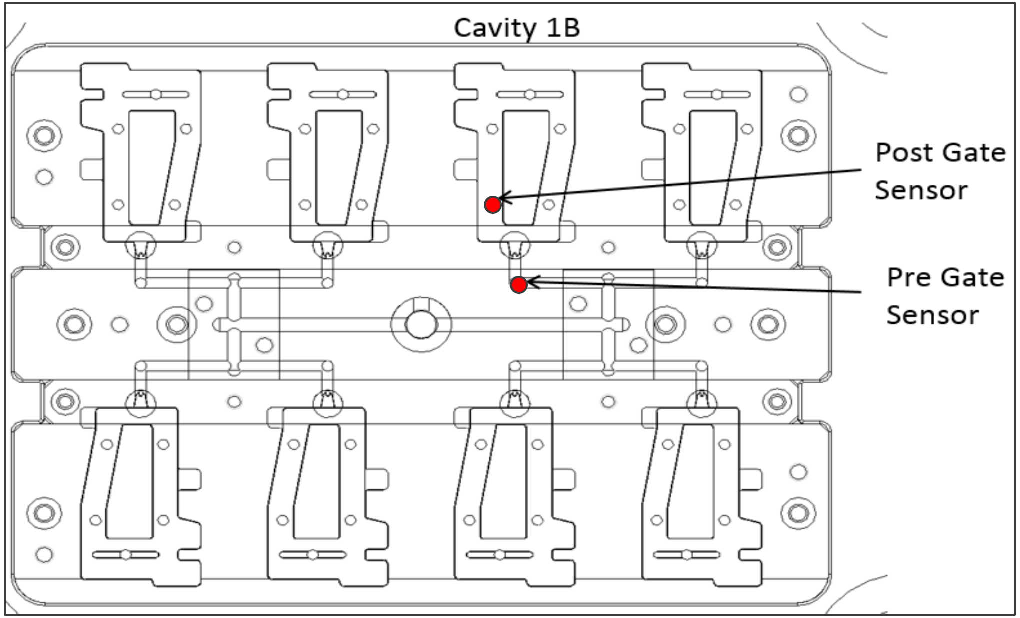
l = Flow Length

η = Viscosity

r = Radius

Equipment Used

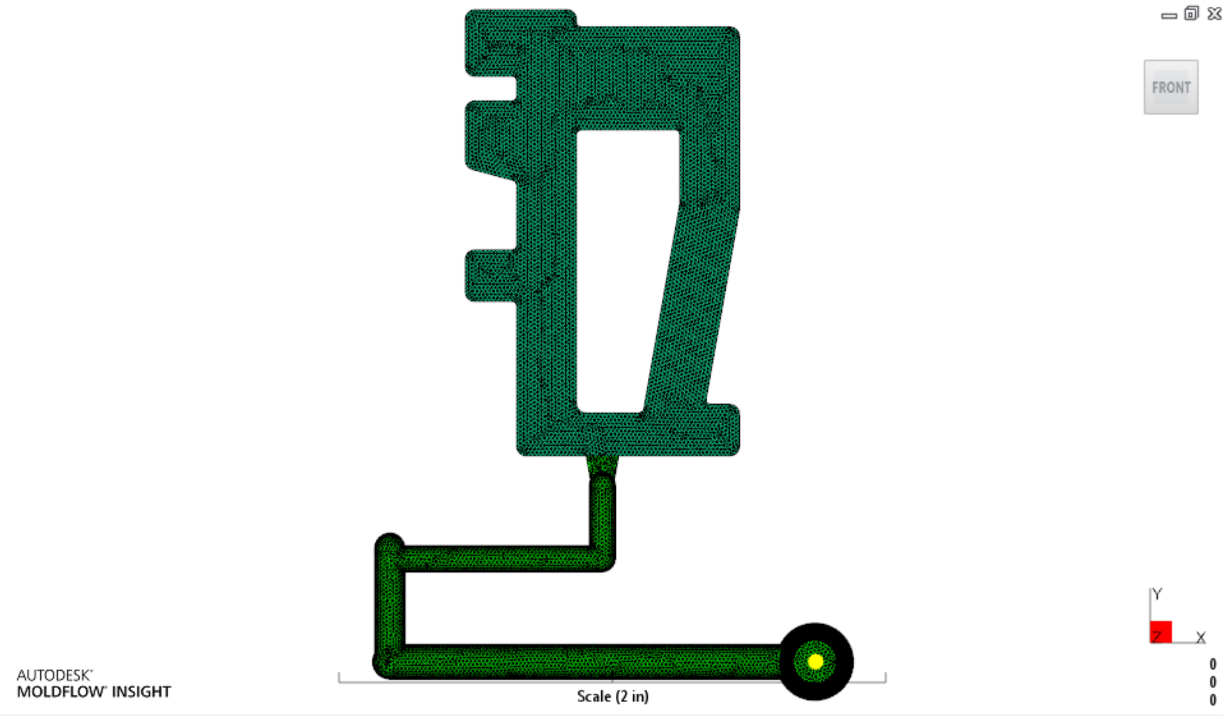
- Part Volume = 8.51cm^3 (1.49mm nominal wall thickness)
- Runner Volume = 3.32 cm^3 (sprue, runner, gates)
- Model 9211 force sensor (Kistler Instrument Corporation)



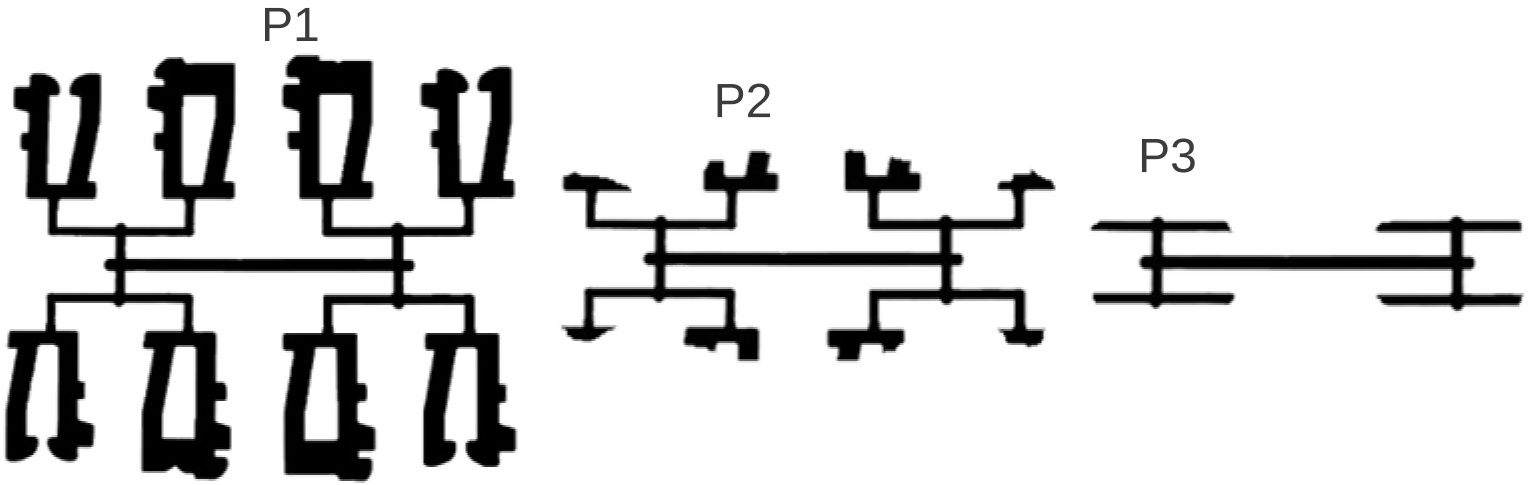
Equipment Used

Simulation Software

- Autodesk ® Moldflow® Plastics Insight, Version 2018

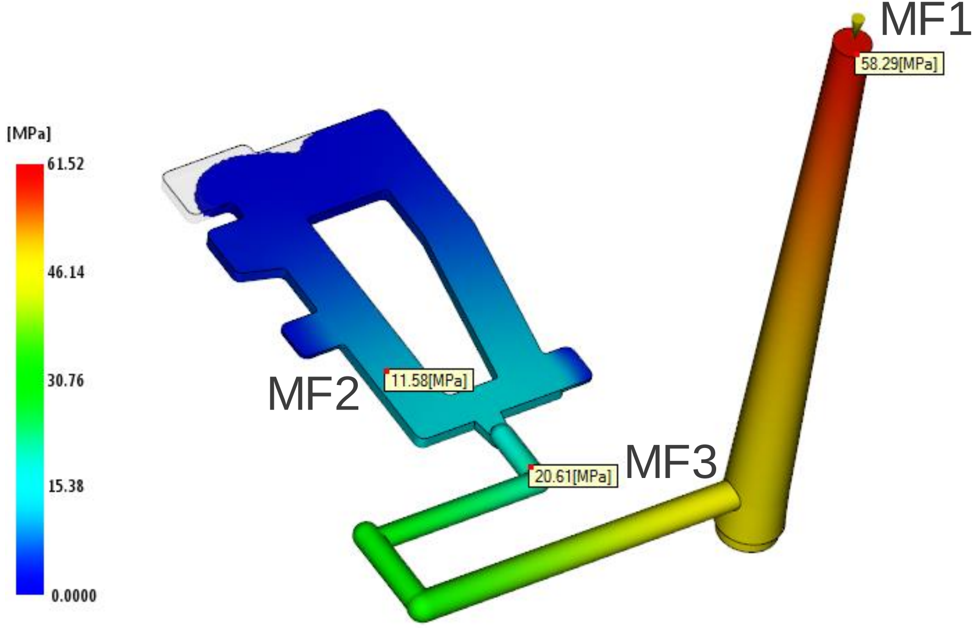


Method #1 - Moldfloor Pressure Drop Study



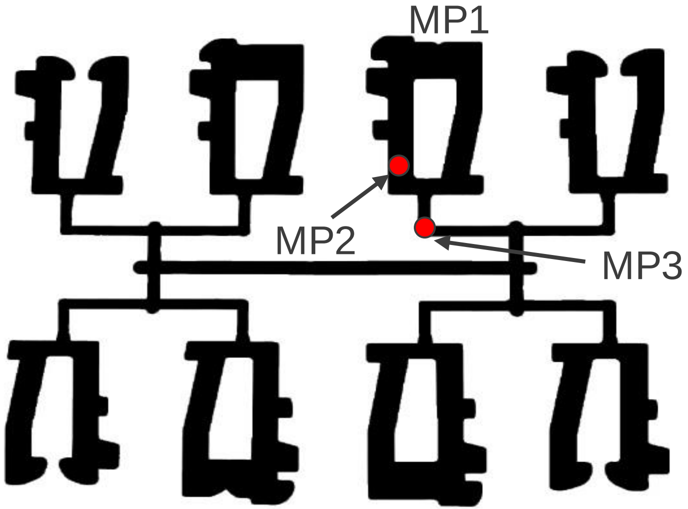
ΔP Machine Nozzle	= P4 (full shot at injection rate)
ΔP Part	= P1 - P2
ΔP Gate	= P2 - P3
ΔP Runner System	= P3 - P4

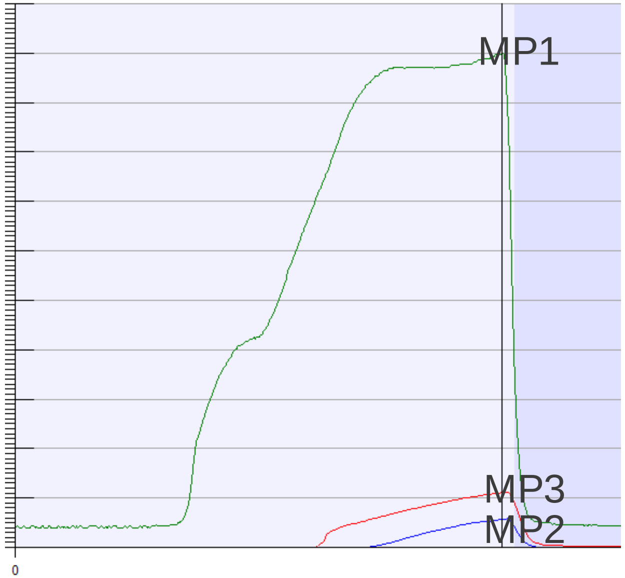
Method #2 - Moldflow Pressure Drop Study



ΔP Part = MF2
ΔP Gate = MF3 - MF2
ΔP Runner System = MF1 - MF3

Method #3 - Instrumented Mold

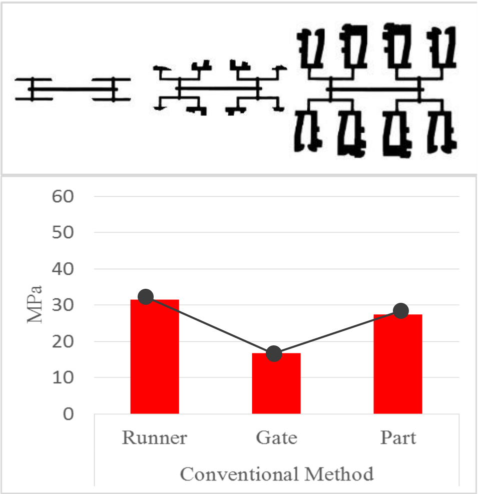




ΔP Nozzle	= MP4
ΔP Part	= MP2
ΔP Gate	= MP3 - MP2
ΔP Runner System	= MP1 - MP4 - MP3

Pressure Drop Study

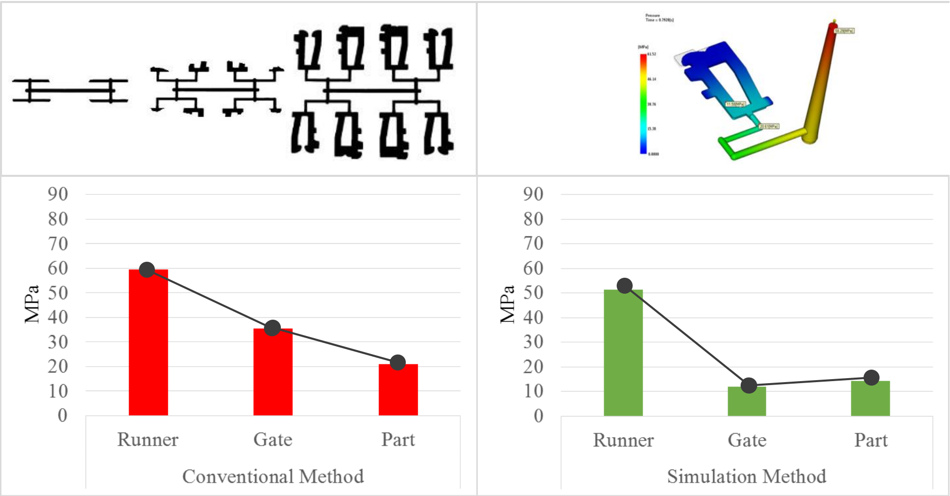
PP



$$\Delta P = \frac{8Q\, l\eta}{\pi\, r^4}$$

Pressure Drop Study

PC/ABS

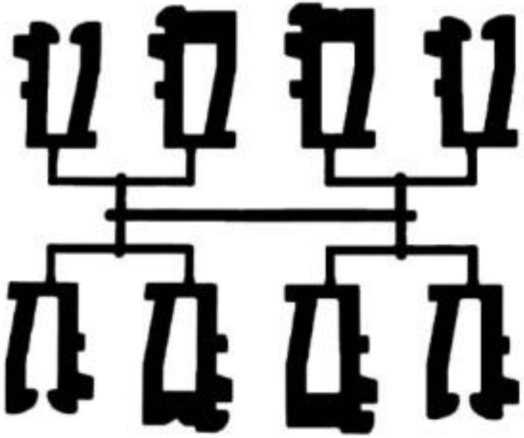


$$\Delta P = \frac{8Q\,l\eta}{\pi r^4}$$

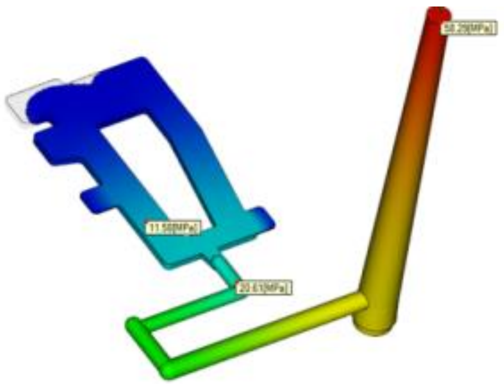
Pressure at V/P Switchover

Outputs	Moldflow	Moldfloor
Pressure at V/P Switchover	11,039 psi	16,074 psi

- What is another processing factor that would influence pressure predictions



$$\Delta P = \frac{8Q\, l\eta}{\pi\, r^4}$$



Measuring Melt Temp

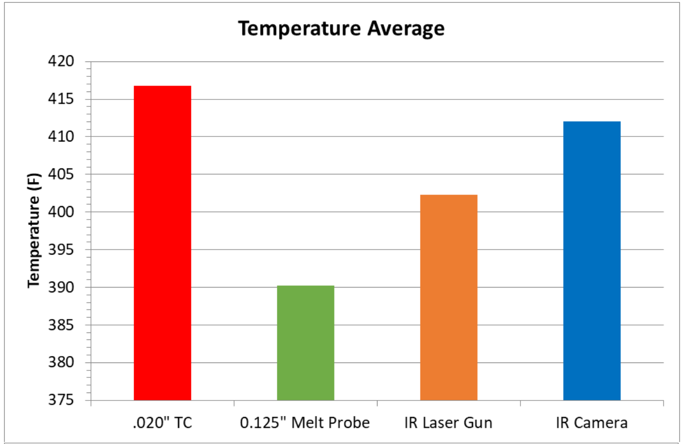
- IR Camera

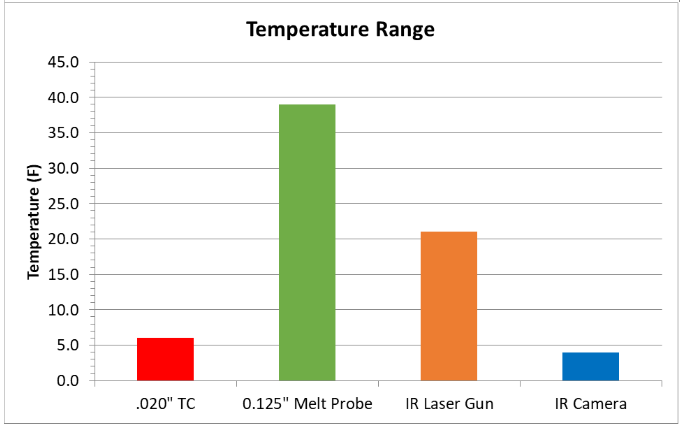
- IR Gun

- 0.125” Melt Probe

- 0.020” TC

Moldfloor - Measuring Melt Temp





Equipment Used

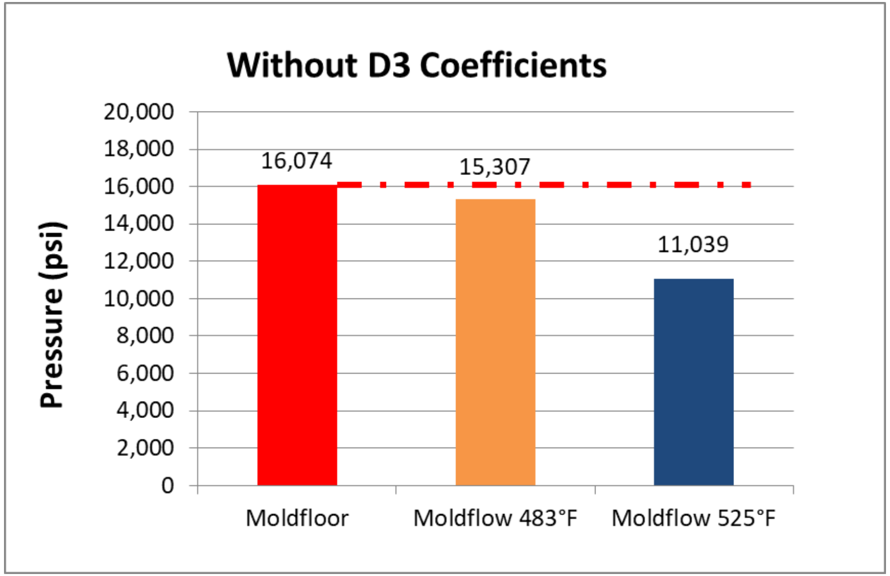
- Sodick LA60 injection molding machine
- 0.125” Melt Probe
- 0.020” Thermocouple
- PC/ABS
  - Original material characterization = Bronze
  - Revised material characterization = Gold
    - Tested by Beaumont Advanced Processing, March 2018
    - Material lot tested = Material lot processed

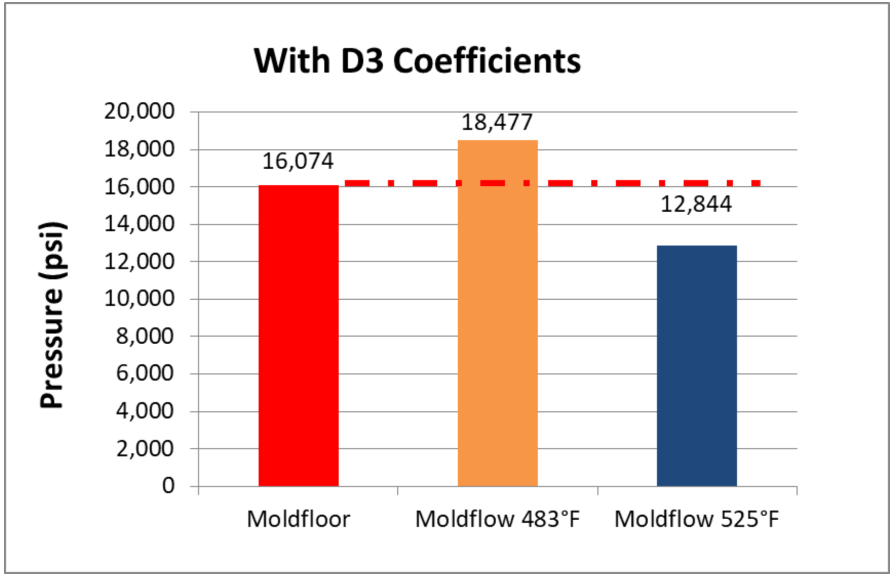
Pressure at V/P Switchover

- PC/ABS
- Sodick LA60 injection molding machine
- AIM Process Development methodology

Device	Measured Tm	Moldfloor TOTAL Pressure at VP Switchover	Moldfloor Pressure Loss From Nozzle	Moldfloor Pressure at VP Switchover
0.125” Melt Probe	483°F			
0.020” TC	525°F			

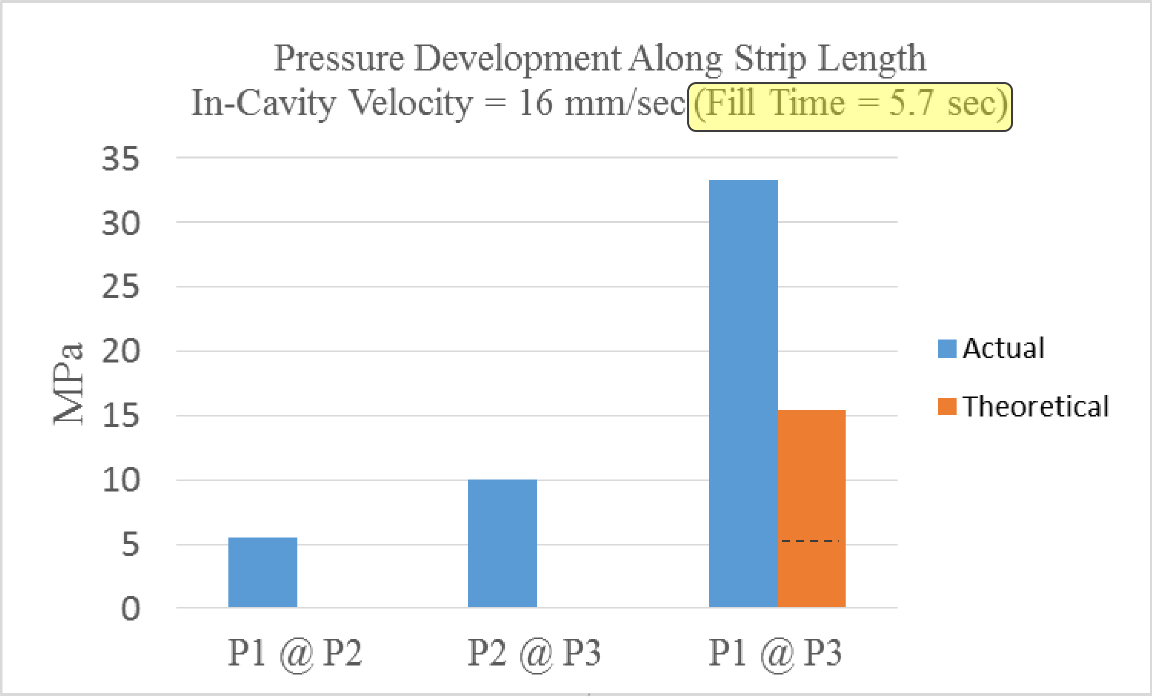
Pressure at V/P Switchover

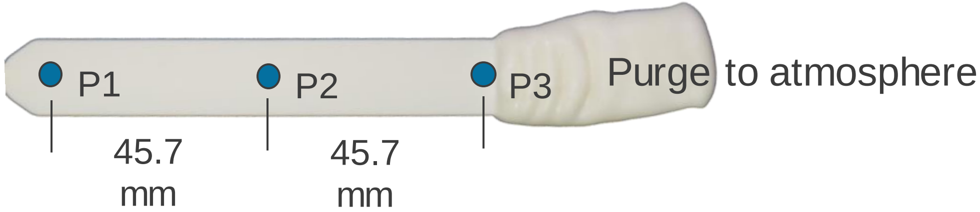




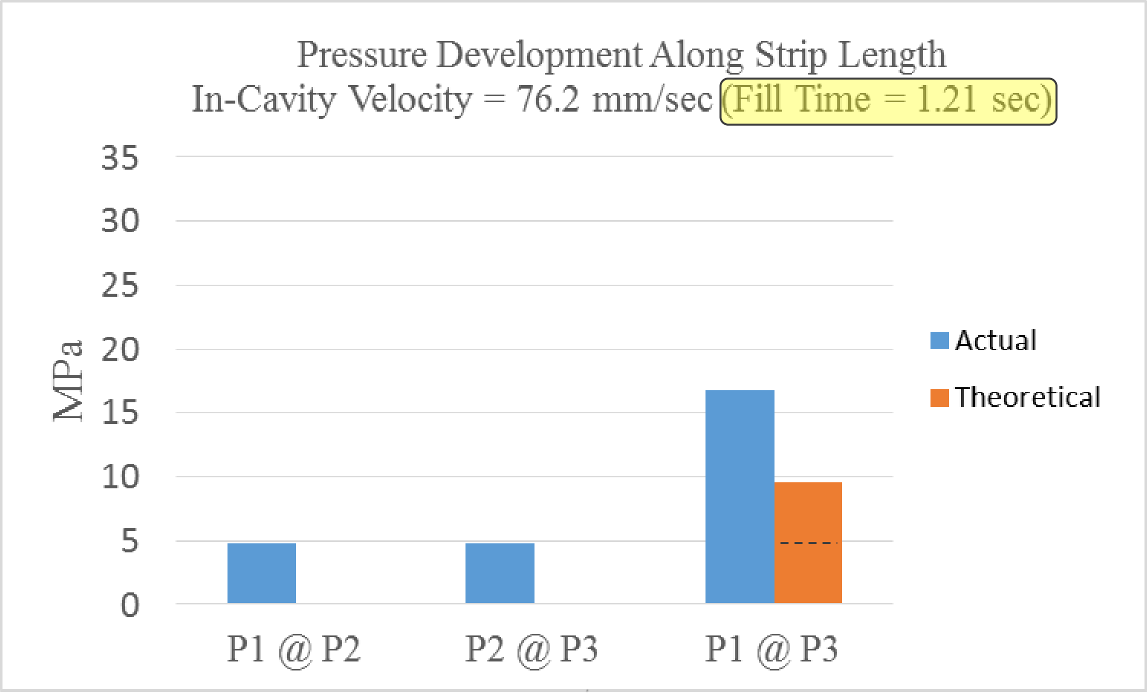
Other Influencing Factors

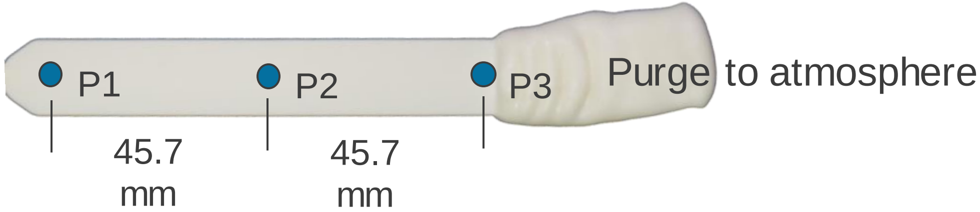
Other Influences - Injection Rate





Other Influences - Injection Rate





Other Influences - Screw Over-Travel

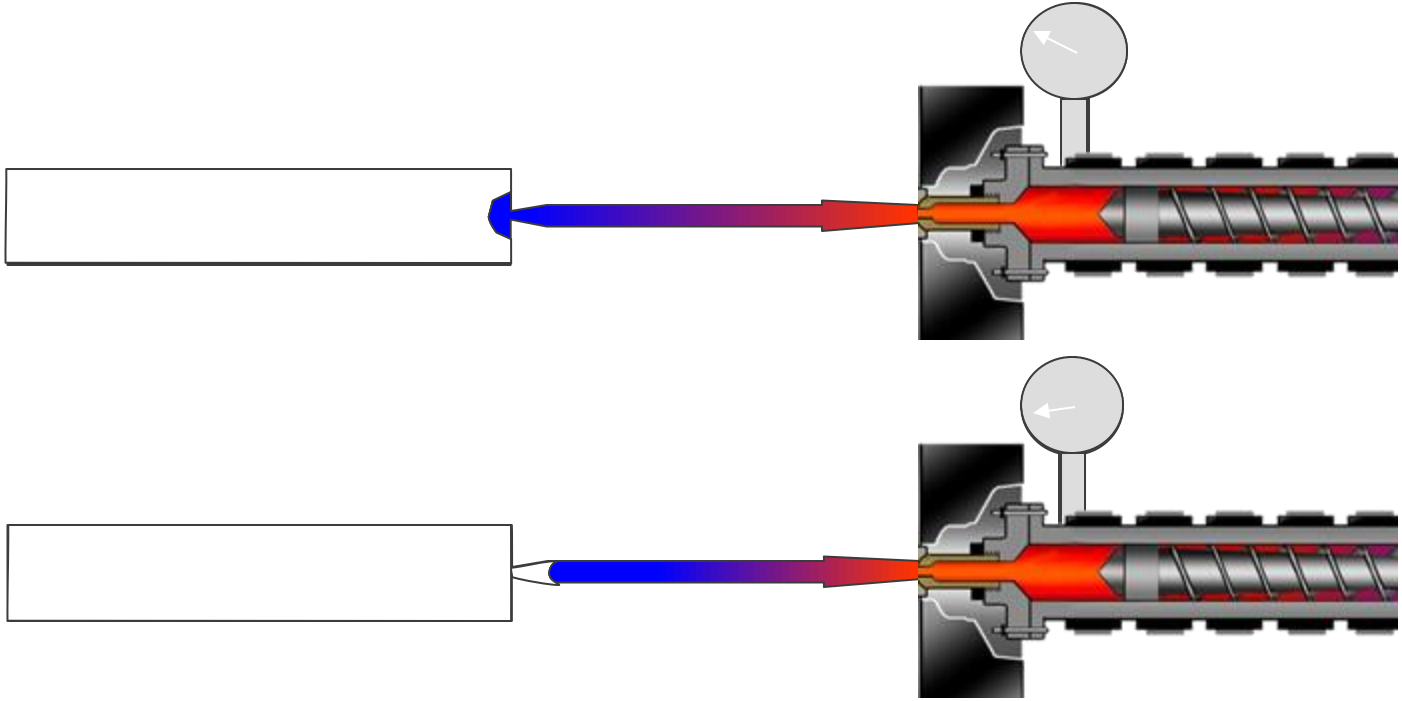
- Where was the shot actually stopped vs. what you see?

Faster

Slower

Other Influences - Screw Over-Travel

- Where was the shot actually stopped vs. what you see?



Other Influences

- Process velocity vs. purge velocity
- Material viscosity
  - Lot characterized vs. molded vs. equivalent material
  - Moisture content (if applicable)
- Frozen layer predictions

$$\gamma = \frac{4Q}{\pi r^3}$$

Shear Rate

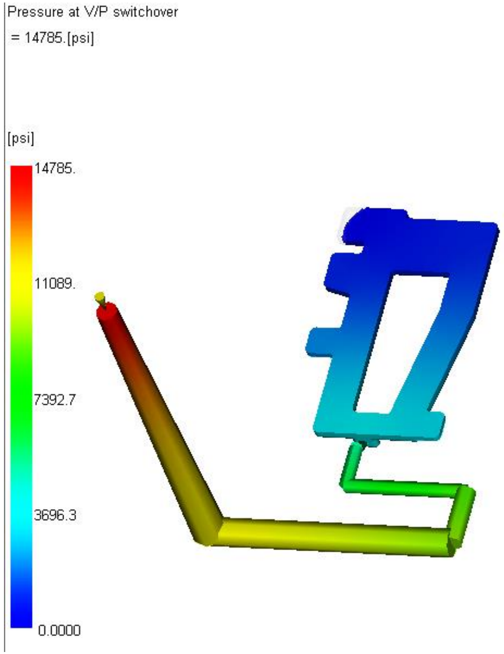
$$\Delta P = \frac{8Q l \eta}{\pi r^4}$$

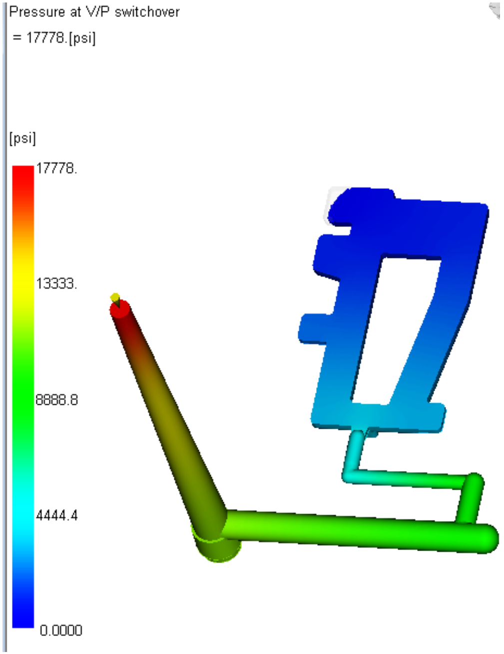
Pressure Drop

Q = Flow Rate
l = Flow Length
η = Viscosity
r = Radius

Other Influences

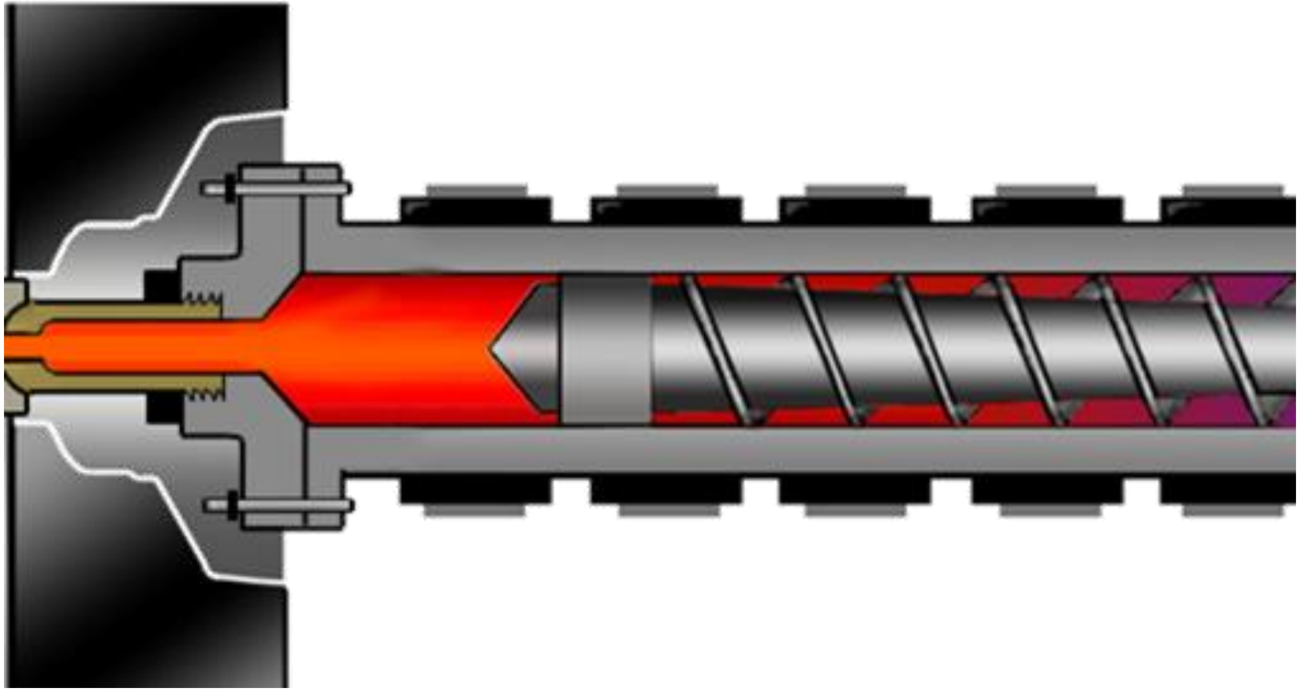
- Mesh Types
  - Beam vs. 3D runner designs





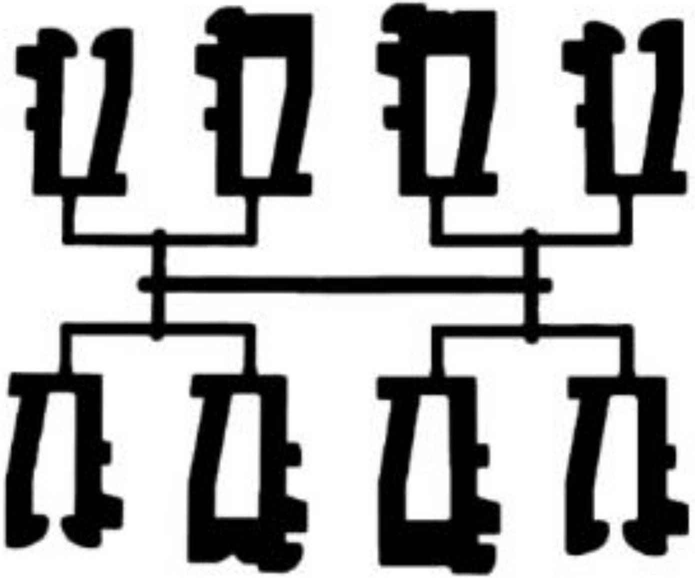
Other Influences

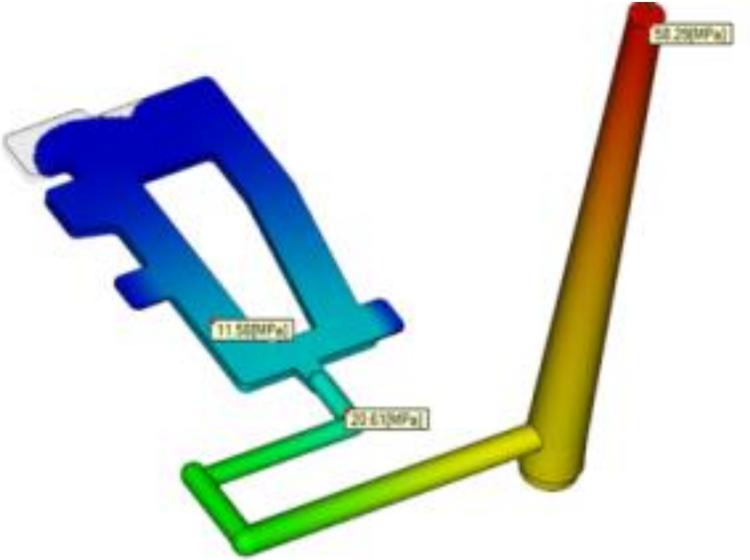
- Modeling the entire flow path, including the nozzle



Other Influences

- Shear imbalances
- Etc…





Another Point of Confusion

Moldflow®

Description	Recommended Processing	Rheological Properties

Mold surface temperature	158	F
Melt temperature	527	F
Mold temperature range (recommended)		
Minimum	140	F
Maximum	176	F
Melt temperature range (recommended)		
Minimum	491	F
Maximum	563	F

Moldfloor

CYCOLOY™ FR Resin C2950 - Americas
Polycarbonate + ABS
SABIC

Injection	Nominal Value (English)
Rear Temperature	428 to 491 °F
Middle Temperature	428 to 527 °F
Front Temperature	473 to 527 °F
Nozzle Temperature	473 to 527 °F
Processing (Melt) Temp	473 to 527 °F
Mold Temperature	140 to 176 °F

sabic

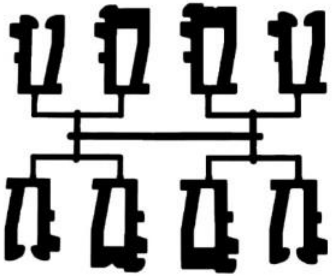
CYCOLOY™ FR RESIN C2950
REGION AMERICAS

Melt Temperature	245 – 275	°C
Nozzle Temperature	245 – 275	°C
Front - Zone 3 Temperature	245 – 275	°C
Middle - Zone 2 Temperature	220 – 275	°C
Rear - Zone 1 Temperature	220 – 255	°C
Mold Temperature	60 – 80	°C

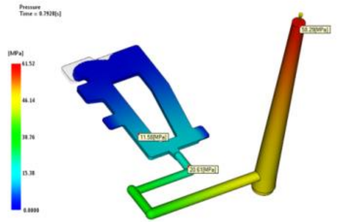
The company purchasing the characterization specifies the temperature range they want tested.
Suggestion: compare Moldflow® recommendations to material supplier data or online resources

Conclusions – Comparison of Pressure Loss Methods

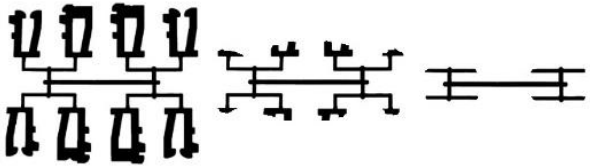
- Instrumented Mold Method
  - Best representation of pressure drop
  - Impractical



- Simulation Method
  - Best trend correlation with the Instrumented Mold

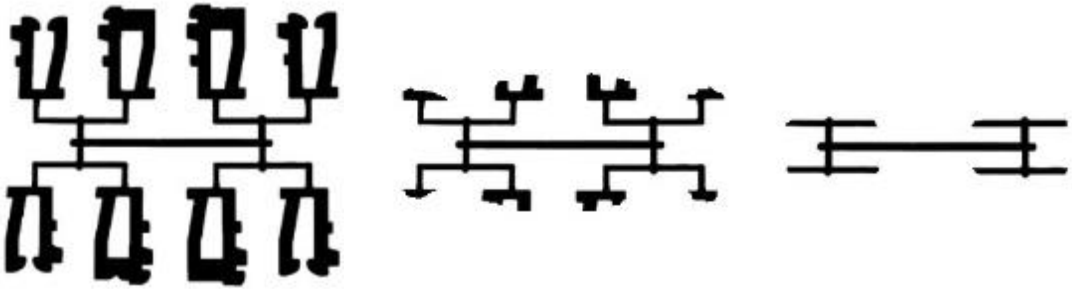


- Conventional Method
  - Frozen layer development influence
  - Appears to skew pressure allocation



Conclusions – Comparison of Pressure Loss Methods

- Caution must be used if you are comparing conventional pressure loss methods to simulation predictions



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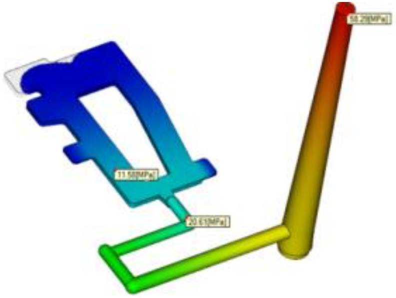
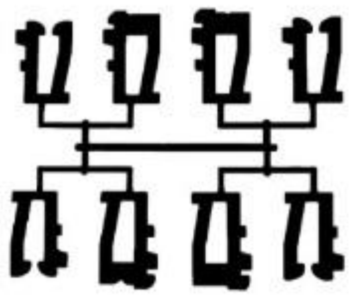


Conclusions – Pressure Predictions Overall

- OK to compare Process Transfer Pressure to Pressure @ VP-Switchover
  - Be sure to account for nozzle losses properly
  - Consider how the data was collected (pressure, melt temperature)
  - Be aware of other sources of variation discussed earlier
- Be practical when evaluating the results of Moldflow® vs. Moldfloor



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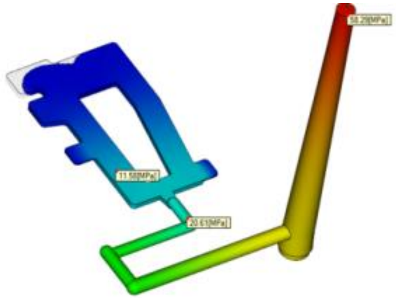

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Thank you for attending

What questions do you have?

Instructor: Jason Travitz, jtravitz@aim.institute, 814-899-6390

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