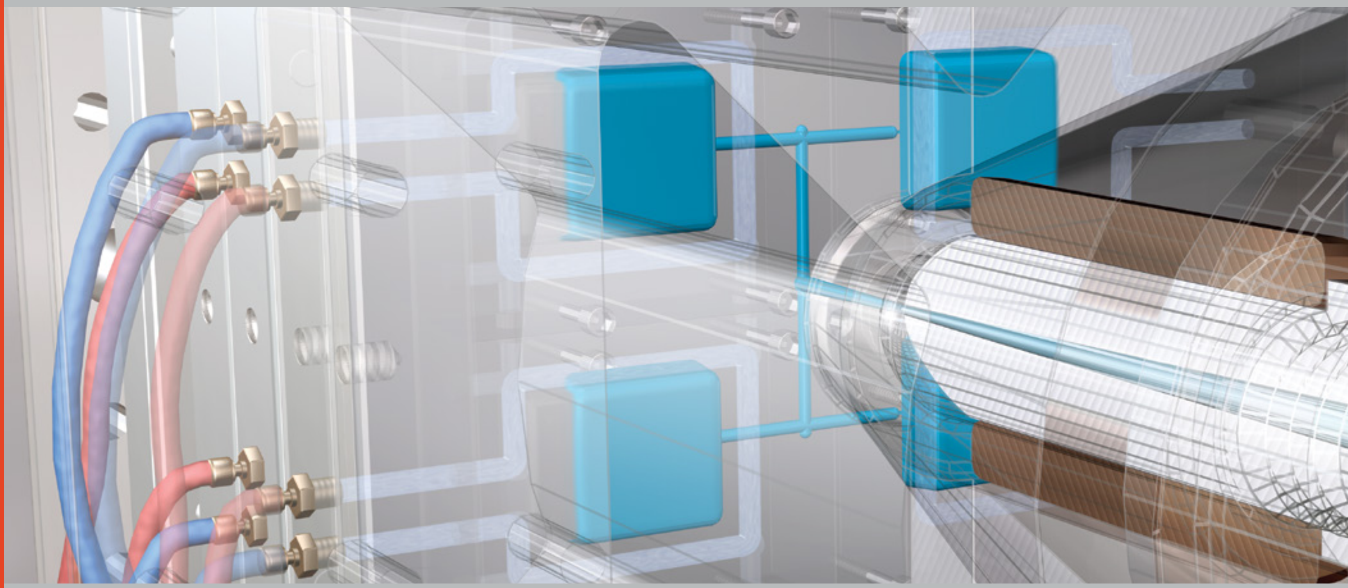
REFERENCE SERIES: DESIGN

Pressure Drop Calculations for Plastics Processing



nexeo plastics

Created exclusively for **Nexeo Plastics** by Routsis Training, this free guide contains excerpts from Routsis's ***Mold & Part Design Courses***.

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PRESSURE DROP

During mold filling, a great deal of pressure is required to force the polymer through the cavity. The high injection pressures are required because of the large Pressure Drop which occurs during filling.

This is a simplified example of a Pressure Drop calculation for a polymer flowing through a rectangular cavity. This formula assumes that the wall thickness is significantly less than the flow width.

The **ΔP** represents the Pressure Drop, **Q** represents the flow rate, while **μ** represents the material viscosity. **L** represents the flow length, **W** represents the flow width, and **H** represents the part thickness.

Pressure Drop
(for Simplified Flow through Rectangular Cavity)

$$\Delta P = \frac{12 \cdot Q \cdot \eta \cdot L}{W \cdot H^3}$$

Many designers make an effort to make parts lighter and less expensive by using stronger polymers and thinner part walls. Unfortunately, many high-strength polymers also have high viscosity.

The Pressure Drop calculation reveals that the Pressure Drop is directly proportionate to the Material Viscosity. This means that an increase in Material Viscosity directly increases the Pressure Drop in the mold cavity.

Since Pressure Drop is related to the inverse of the thickness cubed, a decrease in part thickness causes a significant increase in Pressure Drop. The Pressure Drop can be reduced by adding additional gates to lower the flow length. Unfortunately, using multiple gates can result in Weld and Meld Lines.

The pressure drop can also be lowered by using a material with a higher Flow Rate. Unfortunately, these materials typically have lower mechanical strength.

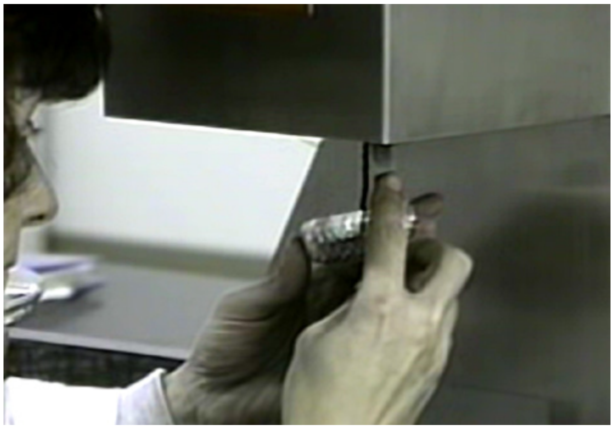
If such considerations are not made before processing, excessive pressures may be required. In such cases, the polymer can be over-stressed and ultimately fail due to the high pressures applied during processing. In addition, excessive pressures waste energy and money.

Material Viscosity

Material Viscosity is an important factor in plastic part design and the material selection process. Viscosity is a measure of a polymer's resistance to flow. There are many methods used to measure a polymer's viscosity. The most common forms of viscosity data are the Melt Flow Index, the Spiral Flow Index and Viscosity Curves.

Melt Flow Index

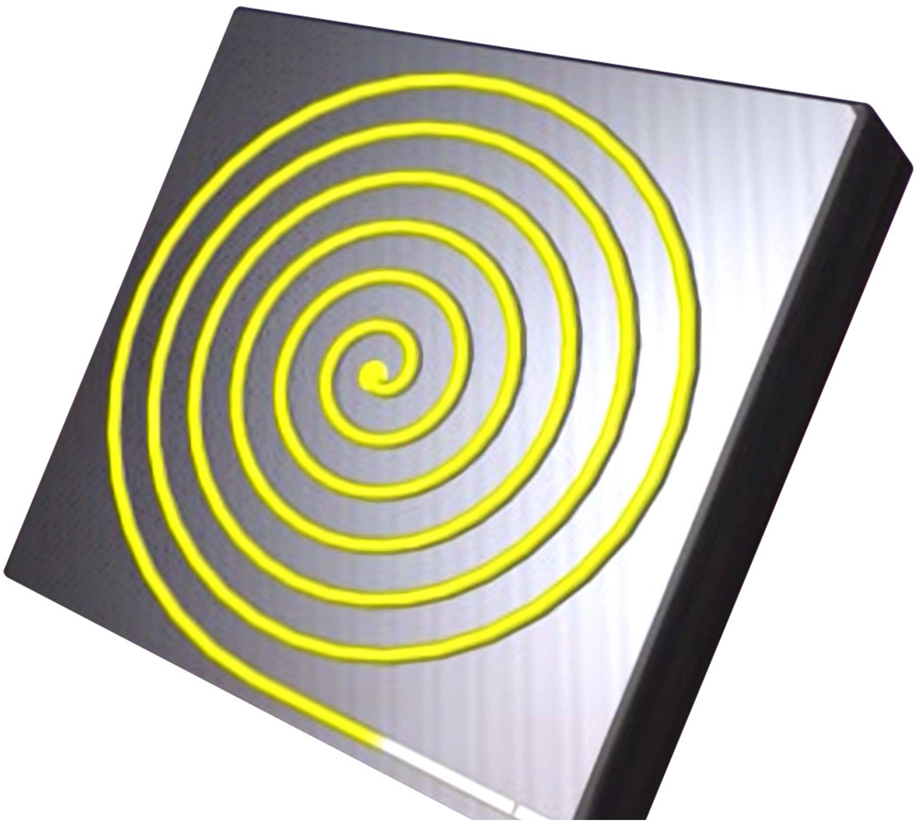
The Melt Flow Index test measures how many grams of material are forced out of a testing apparatus over a ten minute period. The Melt Flow Index has very little value to a part designer. The testing times, pressures and stresses are not similar to those used in injection molding. Such data should not be used for important Pressure Drop determinations.



Spiral Flow

The Spiral Flow test uses an actual injection mold to test the material. A mold with a long spiral cavity is filled at various temperatures and pressures to determine the flow length of the polymer before the polymer melt front freezes.

Spiral Flow test data can be a quite valuable during the part design process. If the part thickness and processing conditions are similar to those of the test, actual Flow Length limits can be easily determined.



Viscosity Curves

Material suppliers can often supply Viscosity Curves, which give specific Shear Rate and Viscosity information for each material. This information is provided from various tests, such as Capillary Rheometry. After calculating the Shear Rate of the polymer in the cavity, the viscosity can be easily determined. Viscosity Curves can be a quite informative, and a useful tool for Pressure Drop calculations.