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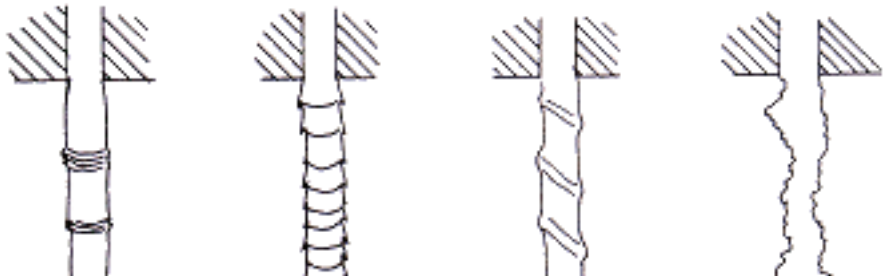

Examples of the appearance of melt fracture, a primary cause of extrusion instabilities.

Optimize Your Polymer Extrusion Process By Eliminating Instabilities

Strategies to Reduce or Eliminate Melt Fracture

At B&H Tool Company, we are committed to helping customers optimize their extrusion process. A major barrier to optimal performance is polymer extrusion instability, and the most common cause is a phenomenon known as melt fracture.

Instabilities can also result from improperly prepared feedstock, solids conveying issues, insufficient melting or mixing capacity, barrel temperature fluctuations, lack of uniformity in melt temperature or viscosity in the die region, improper screw design, and suboptimally designed or improperly operating ancillary equipment downstream.

Melt fracture is often signaled by surface roughness and/or surface irregularities in the extruded plastic involving a severe distortion of the extrudate. This occurs when shear stress imparted into the polymer exceeds the critical shear stress value of that polymer or slip-stick flow conditions occur in the die.

The following can help to reduce or eliminate melt fracture:

- **Reduce the haul-off rate or line speed.** Where high line speeds are not essential, small reductions in line speed may sufficiently reduce the amount of imparted shear into the extrudate and reduce surface defects.
- **Streamline the die head.** Flow can often be improved by reducing the entrance and exit angles.
- **Increase the melt temperature in the die region.** A small temperature increase may sufficiently reduce the polymer's viscosity, lowering the shear stress imparted in the extrudate.
- **Reduce the land lengths of the die, pin or mandrel.** This will decrease the shear stress in the extrudate, but it will increase the extrudate swell/die swell and decrease the molecular alignment along the direction of material flow.[1]
- **Reduce the entrance angle of the die and the angle of the pin or mandrel.** Larger length to diameter ratios (L/D) increase the uniformity of flow and decrease melt fracture.
- **Increase the Draw Down Ratio.** This will reduce the affect of melt fracture on product appearance but too large an increase in DDR can cause draw resonance, which is a cyclic pulsation in the product diameter.[2]
- **Use a polymer grade with a higher Melt Flow Index.** If it does not adversely affect the mechanical properties of the final product, switching to a higher MFI material allows higher throughput rates before melt fracture occurs.[1]
- **Decrease the elasticity of the resin.** This results in a higher critical shear stress value for the polymer.[2]
- **Incorporate low molecular weight additives into the base resin.** A small amount (5-10%) of a compatible low molecular weight additive will act as an internal lubricant, reducing shear stress, facilitating flow through the die. *Chemical compatibility is a must.* Typically, small amounts of additive will not cause adverse affects, but they can alter the mechanical or cosmetic properties of the final product.
- **Reduce slip-stick phenomena in the die region with coatings or impregnations.** Using materials such as nickel, Teflon™ or diamond can reduce the coefficient of friction and the imparted shear in the polymer. Coatings may alter the physical dimensions of the treated parts and must be chosen to withstand the operating temperature and chemical affects of the polymer.
- **Apply medium frequency (kHz) ultrasonics to the die region.** Using externally mounted transducers facilitates molecular alignment and reduces the degree of extrudate swell.[1]

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References:

1. *Hans Kramer: "Polymer Extrusion Instabilities", Applied Polymer Research, 1999.*

2. *Paul M. Hendess: "The Effect of Die Design on Extruded Product Quality", StreamLine Extrusion, Inc., 2002.*