Defining Screw Performance

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Defining screw performance requires the determination of a group of parameters for full understanding and to allow comparison of several screw designs. We communicate screw performance information routinely, but do not always include enough of the information to fully specify the screw's operation. The parameters that are necessary to fully define a screw's performance include:

Output rate, the easiest parameter to define, is one of the highest visibility items in an extrusion system specification. Pounds/hour, feet/minute, parts/minute are all well understood and are conveyed with good understanding and accuracy. Extruder output in pounds/hour/RPM is used as an output defining term, but some caution is required here, since this number is not always constant at different screw speeds (typically higher at low screw speeds). This parameter is sensitive to screw tip pressure level and possibly to early barrel zone temperature set tings.

Melt temperature is often the limiting parameter of an extrusion line and is the hardest to accurately measure. Pyrometer readings and immersed thermocouples near the center of the melt stream are believable. Flush thermocouples and those immersed only slightly into the melt stream (1/8" [3mm] or so) are still utilized and are of no practical use in achieving a meaningful melt temperature number. This parameter is sensitive to pressure levels at the screw tip and barrel temperature profiles utilized.

Melt quality is often the most difficult to define, since it can involve visual judgements or physical properties of the final extrusion product. Experience plays a major role in determining the "work" level of the screw to insure adequate quality. One indicator of the melt quality is the variation of the melt temperature near the middle of the melt stream. If the screw is not controlling this variation to acceptable levels, many processors consider static mixers while improved screw designs would be a more efficient means of improving melt quality. This parameter is sensitive to screw tip pressure and barrel temperature settings.

Extrusion stability involves the pumping consistency of the screw and relates directly to the tolerances of the part being extruded. Measuring output variation in real time is not practical unless a gauging system is employed. The best method to determine real time stability is to measure pressure consistency at the screw tip or in the die system. One note of caution, the typical production pressure reading is in the extruder flange and shows the screw flight pattern in the reading. Screw tip pressure stability is best analyzed on a chart recorder trace and not well analyzed with a digital pressure readout due to the slow update time between readings.

Energy usage is important for a few reasons, one is the sizing of the drive and the setting of the maximum screw speed to allow adequate torque to turn the screw. The other is the comparing of several designs as to the energy used per pound of product extruded. Typically, the deeper the screw design selected, the better the energy efficiency and the higher torque required. (Exceptions are in cast film and melt blown fiber operations, where high melt temperature levels are required.)

Different processes will require different levels for each of the parameters listed and these levels must be understood to allow accurate screw design selection and extruder sizing.

- Ed Steward

See also:

- Autogenetic screw operation
- Causes of surging
- Effect of temperature
- Extrusion evaluation through pressure and melt temperature analysis
- Interfacial instabilities during coextrusion of LDPEs
- Maximum rate of an extruder
- Pyrometers

- Stability on single screw extruders
- Thermocouple depth
- "Wave" pattern instability in multilayer coextrusion

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