Screw Cooling in Extrusion

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The cooling of extruder screws is practiced by many processors, particularly in the field of vinyl processing. It is a relatively easily installed mechanism, since most screws are supplied with a cooling bore when they are purchased. The installation, however, must be made with some precautions, if the desired results are to be realized.

Articles in various periodicals frequently make reference to screw cooling as a means to achieve certain results in the extrusion process:

The main objective of screw cooling in a plastics extruder is to enhance the ability of the screw to forward the solid plastic feed into the extruder at the steadiest possible rate. It accomplishes this by providing a more constant and lower coefficient of friction between the screw shank and the plastic granules. In so doing, the screw is able to rotate inside the mass of unmelted plastic solids while the forwarding of plastic melt takes place inside the barrel surface through the scraping action of the rotating screw flights.

In essence, the extrusion process is a complex heat transfer system in which the temperature in the various locations inside the barrel controls the friction coefficients between the various solids in those locations at any particular moment. It is this friction coefficient that enables the screw to forward plastic granules and plastic melt, and even more so, to create large amounts of heat through shear energy coming from the extruder drive motor. The latter is evidenced by the fact that an operating extruder is in the "cool" mode during most of its operating time when it is in production.

It is obvious that screw cooling is but a small factor in the extrusion process from the stand point of heat transfer, but it is a major factor in the performance of the screw insofar as the efficiency of the feed section of the screw is concerned. Melting begins in the feed section of the extruder, and control of the onset of melting is accomplished by "tuning" the barrel/screw temperatures to attain the optimum feed rate and uniformity. This entails gradual adjustment of the barrel and screw temperatures coupled with locating the correct depth of insertion of the screw cooling pipe. These conditions are unique to each different resin, depending on its physical properties. For this reason, it is advisable to note the settings for each type of plastic as the conditions are established.

In general, the best location for the initial penetration of the screw cooling pipe is at the point where the feed section of the screw ends. Often, only the first five or so flights are cooled. It is in this general area that the optimum penetration for most resins is found. From this point, the cooling pipe can be moved in either direction to arrive at the correct location. This is easily done using an adjustable assembly which can be moved in either direction "on the fly".

A good screw cooling installation will include, besides the in-screw assembly, a closed loop circulating system with the capability to maintain a temperature control of ± 1ºF at a flow rate of 15-25 gpm. At the very least, a valve and flow meter, and/or thermometer, should be installed.

The benefits to be derived from an engineered screw cooling system include:

- More uniform extrusion rates
- Increased output
- Improved mixing
- Lower melt temperature due to shorter residence time of the melt in the extruder barrel
- Reduced surging resulting in more uniform head pressure
- Fewer feed problems due to variable feed particle geometry and/or fines
- Improved physical properties in extruded parts

The benefits provided by an inexpensive screw cooling system will pay for the installation in a matter of weeks. It will even enhance the operation of computer controlled lines by reducing the inherent fluctuations which the computer is called on to rectify. In short, there are very few extruder enhancements that will give you more "bang

for the buck" than screw cooling.

— Michael Billings

See also:

- Autogenetic screw operation
- Causes of extruder surging
- Effect of temperature
- Flow surging
- Materials with feed stability problems
- Machinery installation
- Screw cooling length
- Screw installation and removal
- Screw maintenance

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