Ten Key Principles of Extrusion

Ten key principles of extrusion
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1. Screws for single-screw extruders are usually right-hand thread, and turn counter clockwise (looking from the rear) as if to unscrew themselves backward out of the material. The thrust bearing prevents them from doing so. Twins may turn in either direction, or both, but the principle is the same.

2. In most extrusions, most of the heat to melt comes from the motor, not the heaters. The exceptions are very small extruders, slow-moving twin-screws, high-temperature plastics, and coating.

3. Motor speeds must be reduced from 10:1 to 30:1 to get reasonable screw speeds, which are lowest for very small machines (need residence time) and very large machines (need to avoid excessive shear rates, which rise with diameter).

4. The entering material is really the major cooling agent in extrusion, as it absorbs the heat from the motor and heaters so it can melt. When the feed is stopped, the system equilibrates: the front end transfers heat to the rear (feed) end, and there is danger of sintering, bridging and sticking to the screw root.

5. Pellets must stick to the barrel and slip on the screw root (in the feed zone), and must stick to each other as much as possible, for maximum conveying through that zone. More is not always better, though, as some screws can "bite off" more than their front ends can "chew."

6. Material is by far the biggest component of manufacturing cost. Therefore, almost anything that saves material can be justified, and material management should be stressed, even at the expense of equipment development that does not have material-saving ends.

7. Energy is a very small proportion of manufacturing cost, as an extruder is an efficient machine. Moreover, excess energy would overheat the material and make it unextrudable, anyway.

8. Pressure at the screw tip is important, as it relates to thrust bearing wear, mixing efficiency, personal safety and screen contamination. This pressure is the cumulative demand of the head, from the screens to the die lips, and is not something generated in dependently by the extruder.

9. Production rate is the drag flow displacement of the last flights of the extruder, less the effect of resistance (pressure demand of the head), plus the effect of over bite at the feed end. Leakage over flights may also have an effect, sometimes in a positive direction if there is a pressure peak along the barrel.

10. Effective shear rates are around 100-500 rsec in single-screw extruders, as well as in most die lips, compared to values of from 1-10 in the typical ASTM melt index test. Proper comparison of materials demands at least two viscosities (not a ratio), with measurement or extrapolation into the practical (100-500) range.

— A. L. Griff

See also:

- Back to basics for profile extrusion
- Extrusion evaluation through pressure and melt temperature analysis
- How to buy a screw - Part II
- More on the drag flow equation
- Shear rate and what it means
- Thrust bearings

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