Extrusion dies

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As the extrusion industry matures, we find more and better theoretical presentations in the literature, ANTEC papers and such. This is good and helpful to those of us that deal in theory as well as practice. However, we sometimes lose sight of the fact that, ultimately, the objective is to extrude a good product efficiently, on a line run by someone who is not particularly theoretical.

As one wanders from plant floor to plant floor, the same errors, rooted in a lack of understanding of the basics, keep cropping up. The mistakes made on production lines haven’t changed much over the years.

A classic example is the over-adjusting of sheet and flat film dies. A flat die has one practical function and one only: to control transverse thickness uniformity.

It does not and can not:

1. Control average thickness: This is a relationship between extruder pumping rate and roll speed. Closing die lip opening has very little influence on extrusion rate and does not make the entire sheet thinner.

2. Correct surges: Variation of extrusion rate with time originates in the extruder and must be corrected there. This is probably the most common and most difficult to correct extrusion problem, as it has multiple sources. None of them, however, are in the die. A surge can result from inconsistent feed from hopper to barrel, varying frictional forces in the barrel feed zone, improper screw design, particularly in two stage screws, and a host of other sources.

3. Mix: Commercial thermoplastic resins, at commercial rates, in production scale equipment, are in laminar flow at any point downstream of the last moving part. Therefore, mixing cannot occur in the die. Poor additive dispersion and incomplete thermal homogenization must be corrected prior to the die.

4. Significantly effect melt temperature: Almost all thermoplastics are efficient insulators. At production rates, they are in a flat die for only a few seconds. These two factors combine to leave the die with little effect on melt temperature. It is possible to alter melt skin frictional effects and thereby distribution through changes in die temperature. The need to do this, however, usually indicates a homogenization problem in the extruder. Melt temperature targets are met and melt temperature uniformity achieved in the extruder.

5. Significantly influence extrusion rate: Lip opening, restrictor bar clearance, die temperature and overall die design have small to moderate effects on back pressure. Extrusion rate, however, is only slightly effected by substantial changes in back pressure. The combination of these factors makes opening the lip or increasing die temperature to increase rate an exercise in futility as well as an invitation to other problems. Yet one still sees it done.

In plant after plant we find operators, and sometimes foremen and supervisors, die wrench in hand, trying to make a flat die do all these things that it can’t do. The loss in time and materials, while the real source of the problem - usually in the extruder -continues without correction, can be extremely costly.

- David R. Hopkins

See also:

- Effect on temperature
- Feed screw temperature control in the single screw extruder
- Melt temperature measurement
- Process uniformity
- Using shape factors for extrusion die design

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