Operating Standards and Records

The overall performance of an extrusion line is strongly dependent upon selection of processing conditions and proper maintenance of extrusion hardware. Management should not expect to achieve a high-quality product at good production rates if extrusion equipment is not well maintained or if operating conditions are not well defined.

Too often extrusion lines are operative with poorly calibrated or broken instrumentation. Furthermore, operators are often expected to make any adjustments in processing conditions that they believe to be helpful. Operators usually need to be given some latitude, but only within well-defined limits, but only within well-defined limits. Otherwise, product quality may be severely affected, except possibly when only the product's physical appearance matters.

There are valid reasons to change operating conditions. Sometimes the same product must be made on two different extruders with two different screw designs, or sometimes with a different percentage of recycled regrind, or even with resin lots bought from different sources of supply. In such cases, several feedstock and hardware combinations can be standardized. Standard operating conditions can be determined for making good product at a good production rate.

Operating Conditions

Because minor lot-to-lot differences in both virgin resin and regrind do occur, operators often must be allowed to make minor deviations from standard operating conditions. However, any time a major change in operating conditions becomes necessary, the cause should be immediately investigated. The problem could be caused by either equipment or instrumentation malfunction, or a variation in feedstock characteristics, extrusion conditions, or hardware.

Some quality differences are readily observable in extruded structures or even in pellets made by extrusion compounding: color, transparency, surface roughness and so on.

However, unless standard operating conditions for extrusion yield similar results, hour after hour, we cannot be certain that other product characteristics are being well controlled. This is especially important, even when the product is visually acceptable, if extruder instrumentation shows a major shift in screw torque (proportional to amperage for a dc drive) or a major shift in melt temperature or head pressure (unless due to screen-pack buildup).

Passing standard quality control testing is good evidence that the product quality is normal if the product extrudes normally under standard extrusion conditions. However, routine testing may not be adequate if extrusion is significantly abnormal. Comprehensive characterization of a fabricated polymer product is extremely complex. For example, serious deviations from normal in the feedstock composition (in molecular configuration, molecular weight, additive content, heat stability and son on) may affect orientation, crystallization, and degradation during processing. All of these variables, in turn, affect tensile and impact properties (including low-temperature properties), flexural properties, creep under load, and other properties that may have significant effect on the performance of the product.

Record Keeping

How much extrusion record keeping is necessary? The need varies widely, but every operating shift should keep basic records of extruder performance, either hand-written or as a summary data-sheet computer printout. Without adequate records, neither repeat problems nor progressively worsening problems, nor sudden changes can be properly identified. In some cases, production plants keep extensive records of total daily output in such form that they may be useless to a process engineer attempting to evaluate extruder performance. He needs to know the instantaneous production rate while the screw is rotating at an accurately measured rpm.

He also needs to know the following:

- Barrel-temperature profile (settings and actual).
- Die-zone temperatures (settings and actual).
- Temperatures of die adapter, screen-changer (settings and actual).
- Extruder dc drive amps (used as a measurement of torque and horsepower).
- Pressure (and pressure stability) at screw tip and die entrance.
- Melt temperature.
- Output (pounds/hour) and specific output (pounds/hour/rpm).
- Date, time and operator.

In all situations, it is worthwhile to document the feed identity, including lot number. Also, records on end-product history and related quality-control information should be maintained for reference in handling customer complaints and in solving processing problems. Ideally, any data worth saving over an extended period of several months or years should be reviewed periodically to extract the key information in condensed form for easy reference.

It is important to know whether production conditions and feedstocks were approximately the same last year as this year and if they gave similar product properties. If not, why not? Both constructive and destructive changes may be taking place that merit evaluation. Examples of destructive changes could include screw and barrel wear and gradual loss of efficiency of feedstock predrying equipment.

The above list of items to record is by no means complete for all extrusion processes. For producing sheet, the die lip-gap setting and polishing-roll nip-gap setting should be recorded, along with roll temperatures, hauloff speed, and gauge (at least). However, for some well-standardized extrusion processes it may only be necessary to record significant deviations from thoroughly documented standard conditions.

The goal is to always make a product in the same manner unless there is some good reason to do otherwise.

The object is to know that each extruded product is always being made in the same manner unless there is some good reason to do otherwise. This not only helps to maintain uniformity of product quality but also helps to analyze production problems. In addition, good records allow measurement of results obtained by initiating process improvements, providing good maintenance, or installing new equipment.

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