Melt Blockage Problems - styrene extruders running at high output rates

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Solving melt-blockage (large loss of rate) problems is not always easy because there is no gauge on our extruder which directly tells us what is going on with regard to the location of the melting zone. We would like to know whether or not the onset of melting is moving toward the hopper or toward the die. There is an optimum location for this onset of melting which is thought to be 2 or 3 flights down the barrel. If melting starts much earlier than this, we are likely to encounter melt-blockage. If melting is delayed beyond this, the production rate and melt quality will be reduced.

The best way to solve these type problems and to avoid their onset is to think of the heat-balance in the rear of the extruder. Any extra heat input to this zone will move the melting zone back toward the hopper, and conversely, any extra cooling will move the zone away from the hopper. This line of thought assumes that the feed size is constant, more on this later.

The challenge is to recognize all of the heat inputs and cooling inputs which effect his heat balance. Obviously, the barrel zone controllers and the hopper throat coolers are important and we can determine whether or not their input is constant by the extruder's controllers. However, what about the fact that the screw itself is a conductor of heat from the hot zones downstream, especially the compression zone. This heating-effect is why an extruder may start-up well and run-well for several hours or several shifts, but then melt-block. It may have taken that long for heat generated in the transition-zone to conduct down the screw and increase the temperature enough in those critical rear flights to cause polymer to stick to the screw and cause melt-blockage. How do we counter this? Most often we do this by decreasing the rear zone controller temperatures: this is where the water-cooled sections have proven valuable. In more difficult situations, we may need to go to a different screw design such as one with another feed flight.

This brief will not exhaust all of the things which effect this rear zone heat-balance, but another sometimes overlooked input is polymer feed-temperature. The polymer feed-temperature can change from day to day or in some cases hour to hour. This has especially happened when regrind was part of the feed. For example, during hot summer days the regrind temperature has increased during the day due to the location of the hopper bin. Hotter feed obviously can be a significant heat input which causes earlier melting.

Consider a situation in which the heat-balance is maintained constant, but the feed-size or percentage or type of regrind changes. Smaller-pellets melt quicker and so does thin-regrind. This means the proportion of regrind to pellets is important. In the case of thin regrind, higher percentages of regrind will require more rear-zone cooling to pre vent blockage. If the percentage of fines in the regrind increases, earlier melting will occur. This sometimes happens due to the way hoppers tend to segregate different sizes of material and do not insure a uniform flow of sizes.

A last thought in this too brief commentary on a difficult problem area. It is indeed true that an extruder operates on friction. Again our extruder lacks friction measuring gauges, so we must think about things which effect friction. The polymer's temperature is normally the major controller of friction. Higher temperatures mean higher friction, but this is not a linear relationship: the friction increases sharply just below the glass transition point (softening point) of polystyrene. This means just a few degree increase in temperature of the polymer next to the screw in the critical zone can change a good extrusion situation to a bad one. On this note, we do need to recognize the other contributors to friction which may be in the polymer, for example: the mineral oil and stearates additives frequently used. If any of these change with a new lot of polymer, they can require a change in conditions or may make it difficult to operate at the high extrusion rates.

— Chuck Finch

See also:

- Feed screw temperature control in the single screw extruder
- Melt block problems
- Melt blockage due to false start up will cause dramatic rate drop
- Temperature control

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