Some Considerations in Drying

Recently a failure in pre-drying some Ultem before running it was brought to my attention. Some considerations in basic drying philosophy might be worth noting, particularly in view of the severe drying requirements of some of the new engineering plastics:

Our desiccant dryer was not insulated and we could not get the temperature up to the required 230 degrees (Fahrenheit) be cause of heat loss. Also, at that temperature we greatly reduced the capacity of the desiccant bed. We needed more insulation on the tank and lines and a cooler ahead of the desiccant bed.

This brings up a general philosophy in extruder design. We don't worry about heat losses and we tend to design for a wide spectrum of operating conditions. This is probably acceptable for small units where the extra cost may not be justified, but with larger units and with more specialized application we may have to take a closer look at some of these applications.

Particularly, in the drying of engineering plastics (and even this may be too generalized) we are generally confronted with high temperatures and very low moisture content. Two general principles should be observed: 1. The rate of migration of the water molecule to the surface of the plastic is dependent only on the temperature of the plastic. 2. Once at the surface, the drying air must have the capacity to carry it away. That capacity is generally measured as relative humidity or dew point.

The reverse is also true. A colder pellet will absorb moisture from a wetter air stream.

To increase the capacity of the drying system, it is often advantageous to preheat the pellet by direct contact heaters, rather than taking out the sensible heat of the air. The drying rate is controlled by the migration of the water to the surface of the pellet, which is controlled by the temperature of the pellet. Hence, faster drying.

Generally, the desiccant has only ½ the capacity at 250 degrees as it has at 150 degrees. However, since the amount of water is so small, the cycle time may be all right. Generally, the cycle time is about 4 hrs. (Ours wasn't, so we needed an extra cycle.)

Also, since the quantity of water to be removed is very small, the large amounts of air flow are not required to flush away the water brought to the surface. Again, there is no objection from the operating standpoint, but can be wasteful. In most dryers, the amount of air required is deter mined by the amount needed to heat the plastic, not by the amount needed to carry away the moisture.

The desiccant bed is generally a molecular sieve. It may be oversimplifying that this also works like a plastic pellet. It tends to admit the water molecule when cold and to discharge them when the desiccant pellet gets hot. Hence, the bed is more efficient when it is cooler. The temperature of the bed is controlling, not necessarily the temperature of the air.

Ideally, then, the plastic should be maintained at the highest possible temperature and the desiccant bed at the lowest temperature. Not an easy solution with a normal dryer. The air flow should be at a minimum necessary for complete contact and have a low enough dewpoint consistent with removal of the water brought to the surface.

The desiccant bed has the advantage that it will take a lot higher temperature than the plastic so that it can be "dried" by heating it to a high temperature. Also, the drying air can be much wetter. Again, the air needed to carry the moisture away from the regeneration bed just has to have a lower relative humidity than the equilibrium required at the interface.

Keeping these principles in mind might help in preparing your feedstock for extrusion. Keep the plastic as hot as you can, the desiccant as cold as you can.

We have already discussed the pros and cons of hot feed going to a PVC extruder. However, hot feed for engineering plastics should be more of a plus.

Oh yes, another word of warning. Use the extruder vent cautiously. Some of the additives (plasticizers, UV stabilizers, etc.) may be driven off along with the undesirable elements at the temperatures and absolute pressures encountered at the vent.

These generalities may not always be applicable For more detailed applications, contact your drier manufacturer or, of course, your consultant.

- Robert L. Miller

See also:

- Extrusion of nylon 66 simplified from melt rheology data
- Polycarbonate extrusion
- Polymer drying
- Rapid extrusion line start up

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