Blown Film Air Cooling

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Question No.2 reads as follows:

In blown tubular film, much controversy exists concerning the effect of air ring exit air velocity vs. air ring exit air volume on output. There is one camp which promotes high air velocities as the key to bubble stability and output. Another promotes high air volume coupled with moderate velocities as an output enhancer. Please comment on this controversy.

Answer To Question 2:

Mr. Rosenkranz has a good question about why the controversy has been around so long between high pressure, high velocity and low pressure, high volume air rings. In simple terms, it has been around this long because which appears to be better is a function of air ring design. Each manufacturer touts his own design as being best and he is continually improving design to prove it. Better and best are continually flip flopping from year to year.

If you go into the theory of it, certain principles hold regardless:

1. Velocity improves the heat transfer coefficient.

2. Effective high mass flow improves heat transfer. (Note I said effective mass flow because air improperly directed is of little value.)

3. High velocity at the exit will assist in carrying a faster moving air stream higher up on the bubble.

4. Air that moves faster than the bubble is a better cooler than air moving slower. (redundant #1)

5. Lower back pressures in an air ring result in cooler air and more effective cooling.

Some designs do not permit high velocity air because the bubble is torn loose and there may be excessive turbulence. This often led one toward designs having somewhat lower velocity, larger gaps, lower back pressures (on the order of 4—6" water) and higher mass flow. Properly done these did very well.

The other camp in the beginning used high pressures, swirls, screens, etc. to improve uniformity. Back pressures in the range 10-18" water. (Really it only requires a few inches to obtain 5-10,000. FPM.) Through development this group gradually improved uniformity, dropped pressures, directed the air flow properly, added in some cases two air exits, one above the other and presently appear to be on top.

In fact, if one starts to take pressure and velocity measurements, we begin to wonder if the two camps haven’t merged into one. Each must still, however, maintain the integrity of their product line.

Unfortunately it is seldom, if ever, possible to test two of the best designs in the same place, on the same die, at the same time, same resin and conditions. The optimum way to buy is on a trial basis and you can compare the two. The one month’s rent is worth it.

Mr. Rosenkranz’ remaining question reads as follows:

The European extruder manufacturers rely on positive feed extrusion as the preferred method. Conversely, the Domestic manufacturers rely on the conventional solid bed method of extrusion. I have observed both methods in commercial production. What are the fundamental principals of positive feed extrusion? What are the fundamental principles of positive extrusion? What are the advantages and disadvantages of both methods as they relate to blown tubular LDPE film?

Paul Limbach's answer is stated in the following paragraph.

The European Extruder manufacturers rely on positive feed extrusion (twin screw) as the preferred method while the domestic manufacturers rely on conventional solid bed methods (single screw). True but today there is getting to be a mixture of both because both have something to offer.

Europe has always been short of power. Twin screws consume considerably less power than single screws i.e. 25-50%. Twin screw machines have the capacity to plasticize a melt, homogenize it and deliver it at near enthalpy horsepower. Back pressures in general are kept lower: 1500-2500 psi.

Single screws were notoriously wasteful in that they generated excess heat which had to be pulled out as cooling and thrown away. This came about because they relied on solid bed shear to generate the plastication heat of plastication and once the plasticated depths had to be kept shallow enough to deliver it under pressure.

A twin screw machine has 50-75% more barrel surface area exposed to the screw. Hence more heat can be transferred. Pellets are trapped by the action of the intermeshing screws, compressed, sheared, positively moved forward and plasticated and delivered. Twin screws do not rely on shear between barrel wall and screw root to convey. As a result they can handle a wider range of lubricants, stabilizers, etc., without difficulty. Higher lubricants gives lower back pressures from a die. Their rpm is generally 25-50% lower and maintenance is high and more costly. Initial investment is higher. Their low temperature quality capabilities are exceptional.

New screw designs have narrowed the low temperature gap, but I believe the twin is still ahead. Single screws offer the advantages of higher output per unit investment, and lower maintenance. With high slip films, slip additives can pose a plasticization problem but most of these have been overcome. One other advantage of single screw is the addition of high shear mixing heads which can improve opticals.

Both routes are acceptable. Both can produce excellent film with good dies and temperature control.

- P. Limbach

See also:

- Blown film
- Blown film - cooling air parameters
- Centrifugal fans
- Internal bubble cooling
- The effects of molecular structure, rheology, morphology and orientation on polyethylene blown film properties

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