

Film and Sheet Pinning Techniques to Promote Heat Transfer to Cooling Rolls

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In a previous article, I discussed heat transfer as related to cooling rolls and water flow. Contact of the polymer with the cooling roll also has an effect of heat transfer. If contact is poor, throughput suffers and, in some cases, product quality is reduced. Product deficiencies show in the form of puckering, haze, surface defects and properties. This article is intended to describe various means of providing good polymer contact for different processes.

SHEET EXTRUSION

In the sheet extrusion process where the polymer thickness is in excess of 10 mils, good contact of the polymer to the chill roll is assured using two chill rolls, one on each side (i.e., top and bottom) of the web. The polymer is extruded between the rolls to completely fill the gap. Enough pressure is applied by the cooling rolls to provide good contact. A further benefit of two rolls is that heat is removed from both sides of the polymer (at the nip only), a necessity since the conduction through polymers is poor. Heat is also removed from the sheet as it continues around the center roll. During this time, good contact is maintained by adjusting the speed of the exiting (third) roll relative to the center roll. If no means exists to make this adjustment, it could reduce heat transfer rate and consequently throughput. Additional heat is removed (from the opposite side) using a third roll, but since the skin of the polymer is not molten, adhesion is nil; thus, contact is maintained though tension by using pull rolls.

EXTRUSION COATING

In the extrusion coating process, a rubber pressure roll assures good contact of the polymer with the cooling roll. Little heat transfer takes place in the other direction, i.e. through the substrate, because of the insulating properties of the polymer. As long as the pressure is adequate and the rubber is of the proper hardness, problems are not likely to develop.

FILM CASTING

Film casting poses the greatest challenge because of the fragile nature of the thin film. A second chill roll to exert pressure against the web as in sheet extrusion might seem to be a solution. It would also serve to remove additional heat. However, roll runout is usually greater than the allowable variability in the film thickness which is usually in the 1/2 to 2 mil range. A rubber roll, as is used in extrusion coating is usually unsatisfactory because it will affect the appearance of the film surface leaving an impression of the roll surface and dulling it. Furthermore, the surface of the rubber roll would have to be cooled, so other means has to be employed. The usual approach is to use either an air knife or a vacuum box. Most casting lines use an air knife, although it's not necessarily better than a vacuum box. The air knife blows a jet of air against the web to pin it the chill roll to assure good contact. It must do it uniformly and with sufficient force to prevent the entrainment of air between the web and the chill roll. The shortcoming is that an air knife can cause the web to flutter, can cool the die lips and cannot always be placed close enough to the die to pin the web at the optimum position for minimum drawdown distance, suitable properties and, in some cases, to prevent drew resonance. This is where a vacuum box is more suitable. A properly designed vacuum box provides a differential pressure across the web, i.e. from front side to back side which forces the web against the chill roll. If sealed properly, air flow is low approximating a static condition, thereby eliminating one of the shortcomings of the air knife.

CASTING/EMBOSSING

In the casting/embossing process, a rubber pressure roll assures good contact of the polymer with the chill roll. In fact, additional cooling is achieved with the pressure roll because the surface must be cooled with water which also prevents sticking of the polymer to the roll. Surface cooling is achieved using a water trough with circulating water. Removal of excess water requires properly designed equipment.

While it's relatively easy to put design parameters on paper, it's often necessary to analyze a situation if problems are occurring with an existing installation.

- William K. Foerster, P.E.

See also:

- Blown film versus the cast film process
- Cast film - air knives
- Continuous soy protein films by twin and single screw extruders
- Selection and maintenance of cooling rolls
- Upstack vs downstack
- Water cooling extruders

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