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Selection and maintenance of cooling rolls for film casting, extrusion coating and sheet extrusion
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Often throughput in film casting, extrusion coating and sheet extrusion is limited by the ability to cool the extrudate. When cooling rolls are new this may not be a problem, but over a period of time fouling can diminish their effectiveness. There are probably many cases, though, where the rolls and water circulating systems were not designed properly. Let’s take a look at what creates effective heat transfer (cooling) and what can be done to improve existing systems.

The heat to be removed from the polymer generally ranges from 300 Btu/lb to 400 Btu/ln for polyolefins and can be calculated using the specific heat of the polymer, heat of fusion, melt temperature and the desired product temperature when it exits from the cooling or chill roll. Required chill roll size is also dependent on the temperature of the cooling water which could range from 50°F to 85°F. Since the exiting web temperature might typically be 100°F to 120°F, temperature differentials will range from 15°F to as much as 70°F. This could result in a roll with a diameter five times larger in one case than in another. So you can see that establishment of operating conditions is very important to assure adequate processing rates as well as to prevent over-designing. More often than not, overdesign is non-existent. Instead rolls may be of poor design (not all spirally baffled rolls are alike) or may be undersize. Nevertheless, some problems relating to poor heat transfer can be easily corrected. The following is a list of factors relating to cooling efficiency, some of which will be discussed:

- Chill roll diameter
- Chill roll shell thickness
- Water temperature
- Water flow rate
- Chill roll fouling
- Chill roll baffle design
- Product contact with chill roll

The first item, chill roll diameter, is directly related to all of the other factors listed above. This makes it necessary when purchasing chill rolls to be familiar with the design. Most new rolls perform well because they are clean and water volume (hence velocity) is high, both of which promote good heat transfer. Lack of maintenance, resulting in fouling, coupled with poor" design, can substantially reduce heat transfer with time. With fouling, flow (thus, velocity) through the chill roll decreases. This "results" in reduced heat transfer because heat transfer rate is a function of velocity.

Depending upon the pump characteristics, it might not take much fouling to reduce the water flow to even half its intended value. Inadequately sized piping can have the same effect from the outset. In addition to a reduction in output, reduced water flow can increase the temperature differential across the surface of the roll with the result that product uniformity decreases. Unfortunately, most systems lack a flow meter to indicate the volume of water circulated. Nevertheless, water flow can still be determined if pressure gauges are installed at the inlet and outlet of the pump.

Treated soft water is necessary to maintain relatively clean rolls for optimum heat transfer. Untreated water can result in corrosion, and hard water will usually cause scaling. Although nickel plating of the interior roll will inhibit corrosion and minimize fouling, it will not prevent scaling.

By varying the pitch of the spirals in a chill roll, the heat transfer rate from one end of the roll to the other will change compensating for the increase in water temperature as the water passes through the chill roll. The result is a more uniform roll surface temperature. Further more, using this technique, the volume of water circulated can be reduced to conserve pumping energy. If an undersize pumping system exists, a properly designed roll with a varying pitch spiral will compensate for the water temperature rise.

Product contact with the chill roll, can have an effect especially in film casting where a pressure roll is not used. Means of improving contact, hence heat transfer, will be covered in another article.

See also:

- Cast film - air knives
- Casting of extruded semi-crystalline film and sheet
- Chrome plated steel casting drums
- Film and sheet pinning techniques to promote heat transfer to cooling rolls
- Sheet/film coextrusion grows
- Upstack vs downstack

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