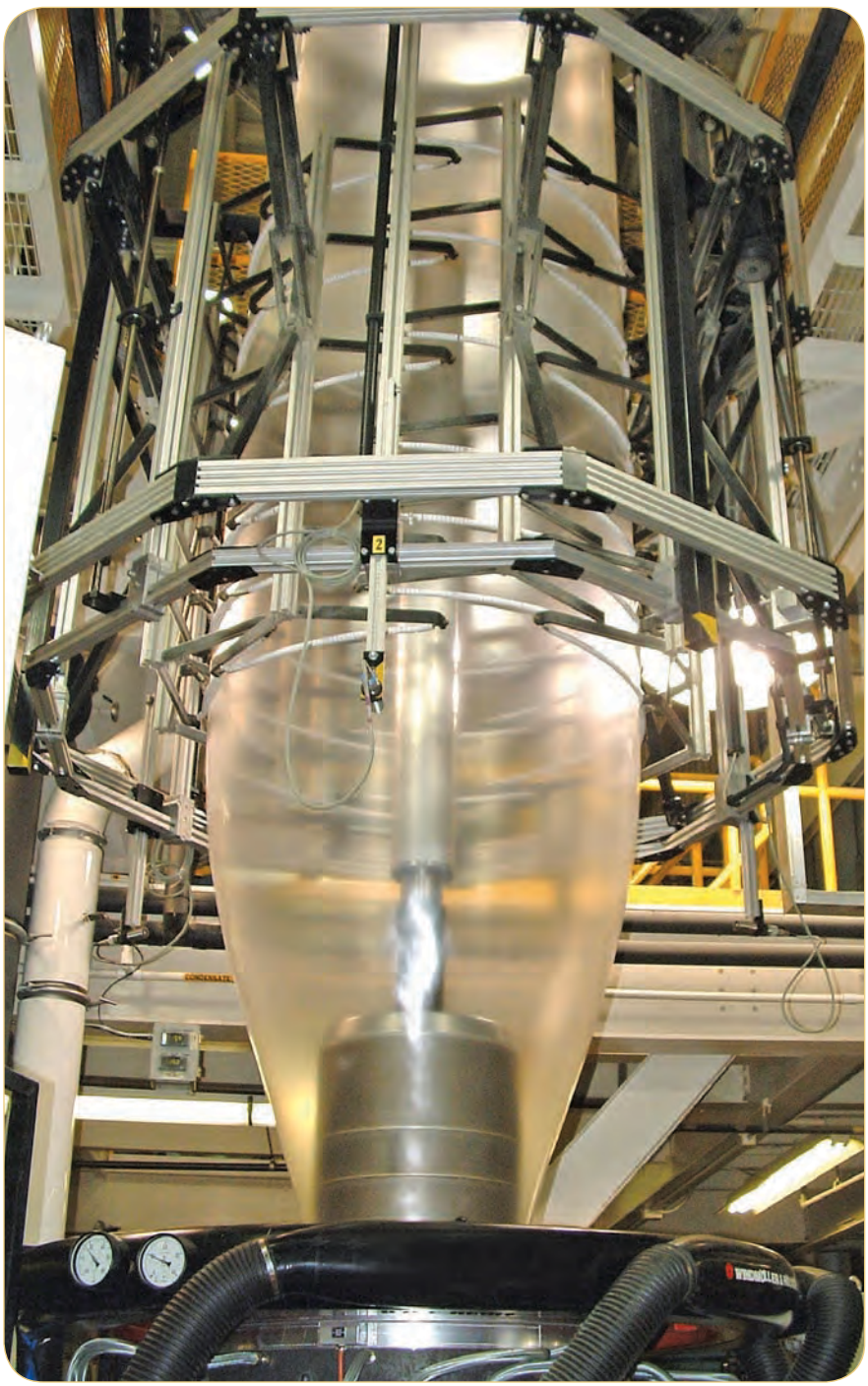
Seven Simple Steps to More Efficient Blown Film Extrusion



Keeping your banker happy is unusually difficult when credit is tight, sales are slow, and foreign competition is growing. Your plant is the engine that generates cash for your business. When business is good, you tend focus on increasing production rates. When business is slow, you need to focus on improving production efficiency. The most expensive component in film and sheet manufacturing is the raw material. The second most expensive cost component is energy.

There are two common sources of inefficient material usage in film processing. Scrap is product that cannot be sold. Excessive gauge or layflat variation results in lower yields. Here are some seven steps to improve raw-material and energy usage and make your operation more productive.

1) REDUCE PRODUCT CHANGEOVERS

When a factory is not working at maximum capacity, you have more options when scheduling production. It takes a long time to change products, particularly when that involves color changes. Make sure you know how long it takes to change colors on a line. It may be better to dedicate certain lines to specific colors, even if that means running slower than normal. Keep in mind that running slower often improves gauge consistency, as well as bubble and web stability.

In a slow economy, you have to focus more on production efficiency than on maximizing output. (Photo: Pechiney)

By Paul Waller, Plastics Touchpoint Group

2) MAINTAIN YOUR INSTRUMENTS

A typical problem as lines get older is that instruments break and are not replaced. This is a common occurrence for magnehelic pressure gauges on air rings and internal bubble cooling systems (IBC's), temperature gauges for air rings, barrel- and air-cooling coils, extruder motor amperage meters, haul-off nip-pressure gauges, and the like. These instruments allow operators to fine-tune production conditions to make product with consistent quality.

One diagnostic tool that is frequently ignored is a traversing melt-temperature probe. The probe is usually installed in the melt pipe between the screen changer and the die block. The correct procedure when using this instrument is to push the probe across the channel until it touches the opposite wall of the internal flow channel. Readings are taken at equal distances (usually each rotation of the thumbwheel) until the probe is in the full out position. This procedure lessens the risk of bending the probe if it is left in the melt stream for too long.

3) FOCUS ON HOUSEKEEPING

Dirt inside dies causes transverse-direction (TD) gauge variation. A common mistake is to strip the plastic off the die lips when the line is shut down. The plastic inside the die lips is then exposed to heat and oxygen during the start-up procedure. This plastic degrades into hard carbon, which is difficult to remove. The resulting die lines can often take 30 minutes to wear off. Leaving some plastic on the die lips during shutdown will minimize the formation of die lines. The plastic that is exposed to air will burn (carbonize) during start-up, but little oxygen will get into the hard-to-reach die gap.

Gradual build-up of dirt inside air rings and IBC stacks can also affect TD gauge variation. One common mistake is to spray silicone oil onto the air-ring lip set. Some of this oil can drip into the air ring gaps and freeze, resulting in uneven cooling around the bubble.

Surfaces that contact the film must be kept clean of sticky residue. Bubble-sizing cages will destabilize the bubble and force the operator to move the cage away from the bubble. Idler rollers in collapsing frames, towers and winders will cause transient web-tension pulsations that will create wrinkles in the web.

Dirt will build up gradually inside blower, cooling-coil, and motor cooling-fan filters. Build-up of oily residue inside IBC exhaust ducts will gradually reduce the air-exchange rate and cooling capacity of the IBC system. In extreme cases, it will be difficult to control bubble stability. Output capacity of most blown film lines is limited by the bubble-cooling capacity, so these blockages will reduce output capacity over time. Clean the air ducts at least once every six months.

Heat-exchange coils become encrusted with mineral deposits that reduce heat-exchange efficiency. The most common problems occur in extruder throats, water-cooled barrel heaters, and air-cooling coils. Monitor the outlet temperature and clean the circuit when required.

4) MONITOR ENERGY CONSUMPTION

Energy is expensive, so use it efficiently. Insulate long melt-adapter pipes and air-exchange pipes. Not only will this save energy, but it will reduce gauge variation. Uninsulated melt-adapter pipes may create melt-temperature variation that the die must randomize. Uninsulated air-ring hoses heat up the air before it reaches the air ring, even if unchilled air is used. Air-ring hoses should all be the same length and insulated. Make sure none are too close to hot metal components such as screen changers.

If you can feel differences in air temperature around the air-ring chamber, then the frost line will be uneven around the bubble. This will result in gradual changes in TD gauge. Check and seal the air ring and hoses for the air ring and IBC. Air leaks will reduce cooling effectiveness.

Screen changers are designed to reduce downtime. Preheat the breaker plate and screen before placing them into the slide plate. Cold breaker plates chill the melted polymer, producing unmelted gels that must be purged from the die before starting a new production roll. That can take 15 minutes.

One popular technique is to expose the breaker plate and screens, replace only the screens, and slide both the new screens and old breaker plate back into position. This method also reduces the risk of scoring the screen-changer flanges if the breaker plate is not seated correctly. It is advisable to change the breaker plate when changing colors because some pigment may get hung up in the breaker plate and take a long time to purge.

Moisture in resin can result in hollow gels, even with non-hygroscopic resins such as polyethylene and polypropylene. A common problem in winter is condensation when resin from unheated silos arrives at the feed throat. Let the resin warm up in a gaylord next to the extruder instead of using a dryer.

Extruder motors consume the largest amount of energy in an extrusion line. Make sure DC motors have brushes that are not worn out. Watch the motor amperage and make sure the motors are not overheating, especially at low speeds. Although some new lines have AC motors connected directly to the screw, most still use gearboxes to maximize the rotation speed range.

Other motors that turn chill rolls, nip rolls, or winder components also use gearboxes and belts or chains. Make sure these connections are not loose or worn out. Such conditions increase energy consumption and cause subtle variations in speed that will affect the machine-direction (MD) gauge variation. Remember to maintain gearboxes at the temperature recommended by the supplier. Gearboxes that are too hot will

accelerate gear wear. And if they're too cool, they will force the motor to expend more energy than necessary to maintain the correct speed.

Speed and temperature are typically maintained using PID (proportional-integral-derivative) controllers. These controllers must be tuned whenever a component is replaced, such as a thermocouple or heater band. Improperly tuned controllers will destabilize the process, and usually increase MD gauge variation.

5) TAKE ADVANTAGE OF SLOW TIME

Extruder screws and barrels wear over time. The symptoms of screw wear are well documented. Consider rebuilding a screw when you lose 15% of your pumping capacity or mixing is insufficient. Repairs could take two to three weeks, so schedule them when you have spare capacity, if possible. Shifting from a gradually rising barrel-temperature profile to a humped or reverse profile may compensate for small amounts of screw wear.

Idler rollers are a common source of web-tension fluctuations that can magnify small gauge variations into large wrinkles, edge wander, and deformed rolls. Start at the winder and follow the film back to the die. Look for positions where wrinkles appear and fix bent or misaligned rollers.

6) PLAN AHEAD

As a general rule, it makes economic sense to replace an air-ring lip set every five to seven years, even if it is undamaged. Compare the performance guarantee of a new lip set from the same manufacturer to your old one. Look at other suppliers, as well, before you decide to update or completely replace the air ring. Consider buying an air ring that can be upgraded to automatic gauge control if you plan to replace it. Automatic gauge control will reduce TD gauge variation by about 50%. You may not be able to justify it right now, but that could change later on.

The addition of a second air ring above the first one can increase bubble cooling capacity by 30%. It can also improve film properties if you choose the right extrusion conditions. In blown film extrusion, external haze tends to be reduced when the frost line is high. MD tear strength and dart impact can improve as well.

Gear pumps are becoming popular in film lines because they allow the extruder conditions to be optimized to melt and homogenize the formulation. A gear pump allows colder melt to be pushed through the die at competitive output rates. A more homogenous melt at the die lips results in better film quality and more output capacity.

Many options that were very expensive only a decade ago are now much more affordable. Three of the most popular upgrades are oscillating haul-off nip assemblies, carbon-fiber composite rollers on collapsing frames, and IBCs. A lot of used equipment may be available. Remember that maintenance is one of the first budgets to be cut back when cash flow is tight, so be prepared to spend time and money repairing used equipment if you buy it. Air rings and IBCs that are more than 10 years old are usually not competitive with new systems.

7) DON'T HESITATE TO ASK FOR HELP

Where do you begin? If you are not sure, consider an independent audit of your factory. Your equipment and material suppliers can often recommend someone who can help. Remember that equipment is only one part of the equation. If you do not have a formal in-house training program, consider looking to outside sources. Training is usually not expensive and well worth the effort. PT

ABOUT THE AUTHOR

Paul Waller consults on extrusion and packaging and heads Plastics Touchpoint Group Inc. in Toronto (plasticstouchpoint.com), which offers engineering, plant design, machine installation and operator training. He can be reached by e-mail at paul@plasticstouchpoint.com.