LyondellBasell Technical Tip

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Fundamentals and Troubleshooting for HMW-HDPE Blown Film Extrusion

High molecular weight high density polyethylene (HMW-HDPE) blown film is steadily growing in use as processors push their lines ever harder to attain greater throughputs. The higher the line speed the more critical it is to heed and understand line performance. Any film problems can generate huge amounts of scrap if not caught and remedied quickly.

The optimal extrusion equipment for HMW-HDPE is a grooved feed extruder. The grooved feed section ensures a positive “bite” of the solid pellet against a barrel wall and prevents this non-tacky material from rolling around on itself. This is the entire theory behind a grooved feed system.

To ensure optimal bite and provide consistent throughput, the grooved feed systems is shrouded in a cooling jacket. The jacket is expected to have between 3-5 gallons of water at between 60° -85°F circulated through it per minute. If the jacket is kept cooler bridging problems can occur during idle time (i.e., screen changes). If the jacket is kept hotter, melting into the grooved feed section can begin prematurely, reducing feed which results in a loss of throughput.

There is no standard heat profile. The heats can be optimized by setting them as cold as you can without producing overrides or high pressures. For an unknown HMW-HDPE resin it is recommended that a straight profile of 400°F be set across the entire system. Once a mT (melt temperature) has been established, set the feed zone at mT-30°F, the second zone at mT-20°F and the rest of the barrel at mT. Always set the die slightly hotter to aid in a smooth flow through the die without creating additional pressure.

For an extruder with limited cooling, an offset reverse of 390°, 400°, 390°, 395° may be used in order to keep the cooling fan on. Remember that zones are adjustable and meant to be changed. Adjust zones based on what you see (i.e. melt fracture, mT changes, etc.). Always run as cold as possible to gain maximum efficiency from the grooved feed and allow the largest rate limiting area (cooling) to be more efficient.

For HMW-HDPE the typical blow up ratios (BUR) are 3.5-4.5:1. BURs may be varied depending on the film properties desired for the product being produced. The larger the BUR, the higher the machine direction tear. The lower the BUR, the higher the transverse direction tear value. The neck height (long stalk) for most resins is six to nine times the die diameter. This height is needed to allow relaxation of the polymer chains and maximize the inherent strengths of the resin. The neck height may be varied, same as the BUR may be varied, depending on the film properties desired. The higher the neck the higher the machine direction tear value and the lower the transverse direction tear value. The reverse is also true. One caveat is that you may increase the MD tear value from 6 grams to 9 grams, because of the morphology of HMW-HDPE, much like raw spaghetti, its polymer chains are basically in a straight line in the machine direction.

For those extruders that depend on a contact stabilizer for orientation, some of these rules may or may not apply. Whether you have experience in this art or are just beginning, there are fundamental steps that need to be followed to maximize this system. The chart on Page 2 describes some of the steps necessary to troubleshoot this type of system.

Make sure all main indicators are accurate, especially the mT and mP probes (melt pressure), temperature gauges, screw and primary nip speeds. Without a road map of the process, you won’t know which way to steer the extruder. The result of these devices not working properly is downtime, scrap and the safety of you and those around you.

There is a distinct relationship between heat and pressure. Whenever there is a need to make an adjustment, be sure of the direction and the result you expect to achieve based on the heat/pressure relationship.

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Problems	Possible Causes	Comments
In Barrel & Screw Zone Overrides	Overshear in one or more zones	Raise heat zones above override. Check controllers
Throughput Loss	Cooling Jacket	▪ Insure there is adequate flow (3-5 gal/min) ▪ Insure water temperature is within guidelines of the OEM
	Bridge in Feed Section of Screw	▪ Make sure cooling jacket is not too cold to freeze resin. ▪ Check material entering feed throat
	First Screw Flight out of Grooved Feed Section is Worn	Accompanied by increase in mT and decrease in mP
In Die: Port Flow	Melt temperature may be too low	▪ Raise die temps in 5 degree increments until lines disappear. ▪ If flow is too high through the ports raise die center and lower die exit. ▪ Check controllers and heater bands
Die Lip Buildup	Burned polymer or low molecular weight wax	▪ Lower die temperatures if possible ▪ Check heat stability of polymer
	Catalyst Residue in Polymer	▪ Contact resin supplier
In the Bubble Gauge Variations	Die not Adjusted Properly	1. Stop Rotation/Oscillation 2. Loosen Belly 3. Tighten Flat Side 4. Take Another Sample 5. Finger Tighten Loose Bolts when Finished
	Drafts Around Bubble	High stalk bubbles are especially sensitive to air currents
	Too Much Torque to Move Adjusting Bolts	1. Shut Extruder Down 2. Remove Die Pin 3. Remove and Clean Adjusting Ring 4. Anti-Seize Bottom of Adjusting Ring 5. Lower onto die proper and wait 20 minutes 6. Rotate 180 degrees & retorque to proper nm 7. Reinstall Die Pin and Retorque

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Problems	Possible Causes	Comments
In the Bubble Gauge Variations ***(Continued)***	Drive or Control Cabinet Overheating	▪ Measure to assure consistent voltages ▪ Consider air conditioning cabinets
	Running High Speed Line at Slow Speeds	Variation specifications are exacerbated at low speeds
	Variable Additions of Regrind	Pellet cuts or flakes alter feed zone bulk and blending percentages
Surging in Machine Direction	Too Much Tension Overdriving Primary Nip	Check nip motor for surging; check nip roll pressure. Ensure slaved units are within trip speeds
	Poor Drive Speed Regulation	Too Large a window presents gauge variation, especially in conjunction with slow speeds
	Partially Seized Bearings	Ensure bearings are lubricated and all rollers spin freely
	Loose Sprockets	Slippage will not keep constant tension across film width
Surging In Transverse Direction	Die Problems	1. Check Die Adjustment 2. Center die under nips when hot 3. Level die under nips when hot 4. Check for excessive degradation on die and/lips
	Air Ring Problems	1. Air ring not centered 2. Air ring not level 3. Air ring dirty 4. Poor air ring design 5. Air leaks through hoses, connections, etc. 6. Uneven hose lengths
	Environmental Problems	▪ Heat from surroundings, i.e. cooling fans, blowers, compressors, lights, etc. ▪ Drafts on stalk from open doors, windows, air conditioning vents
Bubble Breaks	Clear Gels	Lower feed zone temp to increase shear and raise barrel exit slowly until gels disappear
	Burned Gels	▪ May not be able to avoid die cleaning ▪ Try raising die heats to flow over burned, hard particulates ▪ Check for runaway die heats ▪ Check heat profile ▪ Don't allow extruder to sit for long periods of time without turning the screw

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Problems	Possible Causes	Comments
Bubble Breaks ***(Continued)***	Low Melt Strength	▪ If breaks occur without an assignable cause, check antioxidant content ▪ Have your resin package checked by your material supplier
	Extrudate Looks Cold	▪ Ensure die heater bands are not lined up, causing cold spots ▪ Ensure controllers and heater bands are in proper working condition
In Take Off: Uneven Roll	Rotation/Oscillation Issue	▪ Ensure bubble guiding cage, collapsing frame and tower are aligned and trammed ▪ Guide HMW-HDPE, squeezing it may cause wrinkles
	Tower Height	Check if film is too hot or too cold at primary nip
	Collapsing Frame	▪ Check alignments; ensure rollers spin freely. Use styles that offer the lowest COF for films being produced ▪ Stabilizer bars and bubble cages must be symmetrical without vibration ▪ Ensure no air entrapment through primary nip
	Dryer Heat	▪ Is one side of the web hotter than the other? If so, elongation will occur.

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