Botox for Blown Film

Wrinkles in blown film applications occur for two major reasons: Bubble instability causes web movement as the bubble is collapsed; and uneven tension across the web overcomes the modulus (stiffness) of the web, resulting in permanent deformations in the film. Here's how to prevent both.

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1. Transverse direction wrinkles

Side to side bubble motion will create transverse direction (TD) wrinkles. Wrinkles tend to form and disappear in a cyclical pattern at the edge folds, and pleated wrinkles form when the bubble passes through the primary nip. Helical instability causes baggy film, which causes TD wrinkles to move around the web. Rotating or oscillating dies or misaligned collapsing frames in oscillating nips will cause the same pattern, but the cycle will be much slower.

Baggy film is usually caused by bubble instability, variations in drag resistance within the collapsing frame, or temperature gradients in the upper regions of the tower. These changes in tension form pleats that are ironed into the web as it passes through the primary nips. Watch to see if the pattern moves or remains in the same position over time. Moving patterns often indicate an alignment problem within the tower. An example of helical instability and the corresponding wrinkle patterns are illustrated in Figure 1.

If the angle of the collapsing frame is too large, symmetrical edge wrinkles will form in the film and won't move around the web. Operators rarely optimize the position of the collapsing frame because it changes when the film gauge, layflat width or formulation is changed. Wrinkles can begin to appear in the middle of a production run because the air temperature in the tower changes during the day.

Viscosity variation inside the die can cause TD gauge variation and a tilted frost line. The asymmetrical bubble will produce diagonal wrinkles when it passes through the primary nip rollers.

Baggy film causes asymmetrical wrinkles at the edge or center of the web. These wrinkles will move as the bubble moves from side to side.

Roller misalignment wrinkles are diagonal wrinkles that tend to move from one side of the web to the other, as shown in Figure 2. The severity of the wrinkles depends on the degree of misalignment.

Strategies to eliminate these wrinkles are increasing or reducing web tension, decreasing traction on the rollers, increasing line speed, making the film stiffer by increasing gauge or bypassing the problem roller.

Summary of solutions:

Raw Material	• Adjust viscosity to minimize TD gauge variation • Increase modulus (density) of film. • Increase film gauge.
Processing conditions	• Stabilize the bubble. • Adjust collapsing frame angle. • Maintain film tension between 10 to 25 percent of ultimate tensile strength). • Increase line speed.
Equipment	• Align and level tower components (die, cage, collapsing frame). • Align rollers (maximum misalignment 0.001"/12" 25 microns/24 cm face width). • Increase span between rollers. • Decrease friction (traction) on rollers.

2. Machine direction wrinkles

The pattern of machine direction (MD) — see Figure 3 — wrinkles and the speed at which they appear and disappear provide useful clues about the cause. Slight variations in gauge can result in permanent deformation when the film is deformed (stretched) beyond its yield strength. Excessive web tension often causes this phenomenon. Keep in mind that the yield strength is affected by web temperature, so temperature gradients can increase the permanent distortions in the film when web tension is too high.

Bubble instability that increases and decreases the thickness of the film will produce this symptom. Slow changes in web tension are usually caused by gradual frost line height oscillation. Faster web tension pulsations may be caused by bubble breathing. Very fast web tension pulsations are usually caused be cyclical changes in traction (friction) on idler rollers.

Symmetrical wrinkles that do not move, but just appear and disappear are usually due to TD gauge variation that is magnified by MD gauge variation or unstable web tension. The most common causes are port line effects inside the die or water absorption that causes web expansion, such as with nylon. Symmetrical bubble instability (frost line height oscillation or bubble breath-

Transverse Direction Wrinkle Patterns

Figure 1

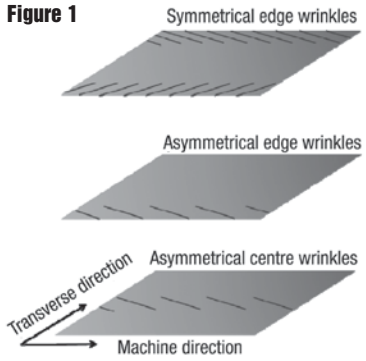
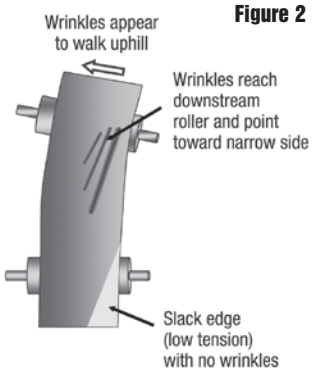
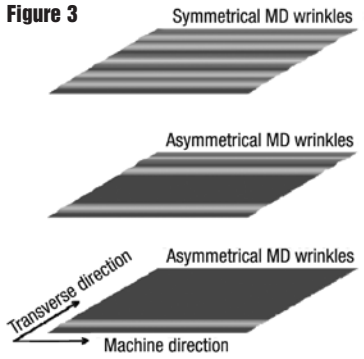


Figure 2



Machine Direction Wrinkle Patterns

Figure 3



ing) will result in MD gauge variation. Surging from the extruder is a less common cause for these symptoms.

Asymmetrical wrinkles are usually caused by unstable traction (friction) between rollers. Common causes for web tension pulsations from idler rollers are dirty surfaces, bent rollers and wobbling bearings.

A popular technique to compensate for baggy film is to use spreader rollers. Keep in mind that the web must be in the middle of the spreader roller to work properly, otherwise diagonal wrinkles and excessive edge wander will be created by the spreader roller. Fixed bowed rollers will work well only if the baggy web does not move from side to side. Elastic expander and grooved spiral rollers work better with unstable baggy film. Adjustment of the angle is critical. A minimum 30˚ wrap is required for bowed rollers to work effectively. Non-driven bowed rollers often create more wrinkles because the drag resistance is too high. Elastic expander and spiral grooved spreader rollers require more wrap around the roller to work effectively.

Summary of solutions:

Raw material	• Improve mixing inside die. • Change formulation to increase modulus (density) of film Increase film gauge.
Processing conditions	• Reduce web tension. • Reduce film temperature. • Reduce air currents.
Equipment	• Reduce drag resistance in collapsing frame. • Match rotation speed of rollers to line speed. • Reduce width of spreader roller grooves. • Adjust position of spreader roller. • Reduce idler roller deflection. • Reduce drag resistance across idler rollers.

Summary

The best way to diagnose and fix wrinkling problems is to look for clues in the rolls and web tension fluctuations that result in changes in reflection of light from the web. Work your way upstream until the changes in tension are no longer significant. This will help you isolate bubble from web transport problems. **CPL**

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