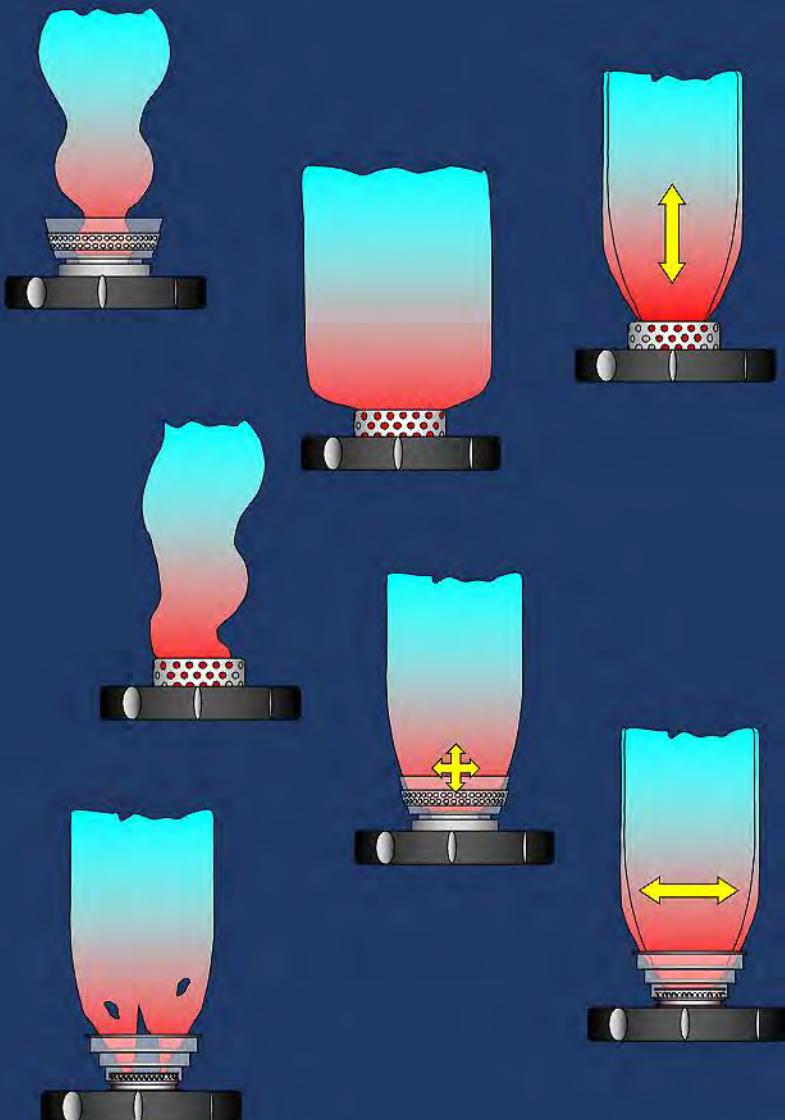


# Blown Film Processing and Troubleshooting



**2<sup>nd</sup> Edition**

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## 1.0 Four Strategies to Improve Profitability

Profitability can be maximized by focusing on four strategies:

1. Decrease scrap rates
2. Improve quality and consistency
3. Increase production rate
4. Adapt modern technology to add value to your product

The extrusion process involves producing the most output of an evenly mixed (homogeneous) melted blend. The key variables that operators use to control the process are temperature, pressure, output rate and quality or consistency of the melt. Shaping the melt into its final form involves another set of challenges that will be described later in this book.

## 1.1 Film Property Relationships

The fundamental relationships that control blown film processes are slightly different and are summarized in Figure 1.1.

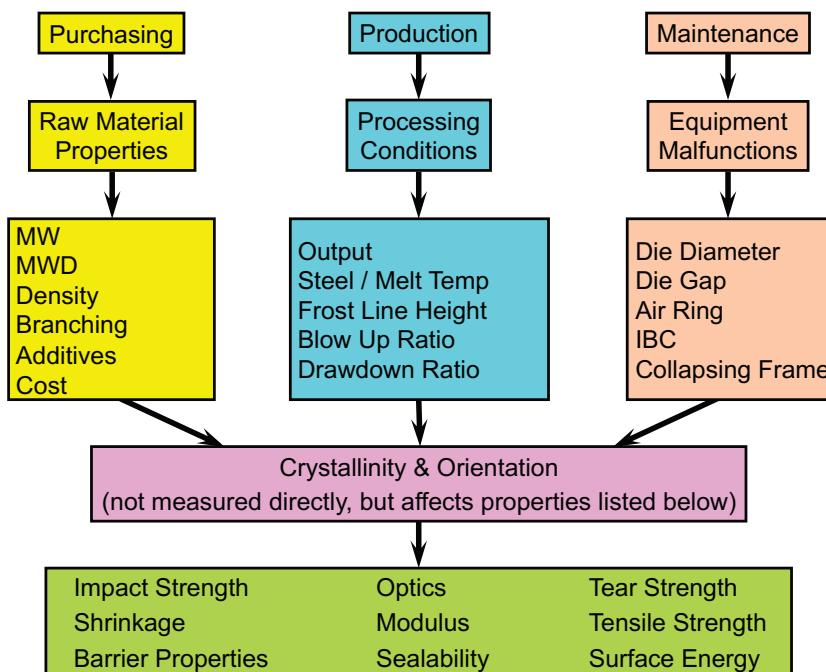


Figure 1.1 Blown film property relationships

The purchasing department selects the raw materials. The production department is responsible for selecting the processing conditions. The maintenance department is responsible for selecting and maintaining the production equipment. All three factors control the ultimate crystallinity and orientation of the molecules in the film structure.

The recommended adjustments in Figure 4.36 illustrate how barrel temperatures can reduce the magnitude of this problem.

### Adjustments to Prevent Melt Conveying Surging Caused by large differences in melt temperature

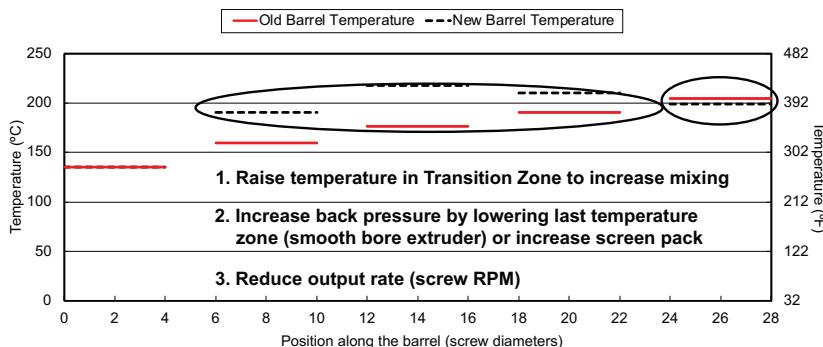


Figure 4.36 Barrel temperatures to prevent unstable melt flow in metering zone

#### 4.6.5 Test to Detect Surging with Blown Film Lines

Operators rarely have time to stand and watch blown film lines long enough to confirm the problem is surging. Attempts to stabilize the bubble are often the preferred strategy, even though this will not eliminate the problem. A simple test to verify that changes in layflat width are caused by surging is illustrated in Figure 4.37.

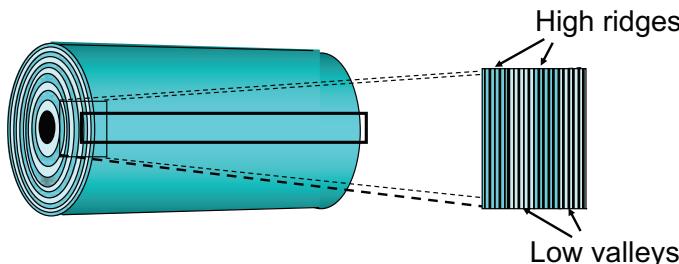


Figure 4.37 Sampling technique to distinguish surging from bubble breathing

Cut 2 sets of 5 layers across roll at peak and valley of exactly the same width.

If the weight of the film samples is the same = NOT surging

If the weight of the film samples is different = surging

#### 4.7 Strategies to Reduce Melt Temperature

The best strategy to reduce melt temperature is to modify the extruder temperature profile and set the last barrel zone below the target temperature. The molten polymer will come in contact with the cooler barrel surface and heat will be extracted via conduction. Recirculating

will be at a minimum in the center of the flow channels. Refer to Figure 5.25 for details.

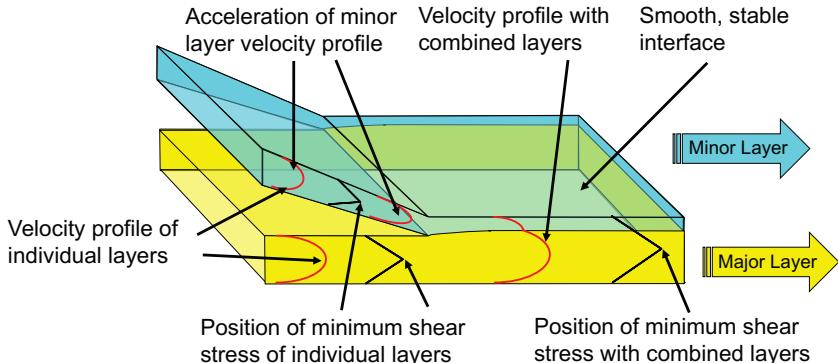


Figure 5.25 Melt flow patterns with good layer convergence in coextrusion die

### 5.5.2.1 Zig Zag Pattern Interfacial Instability

Zig zag interfacial instability occurs when shear stress at the interface between adjacent layers exceeds critical values. It can be predicted by measuring the shear viscosity of adjacent layers. Refer to Figure 5.26 for an example and Figure 5.27 for an illustration of the root cause. The watch is included to show the scale of the pattern.



Figure 5.26 Zig Zag interfacial instability pattern

Photograph courtesy of Compuplast North America

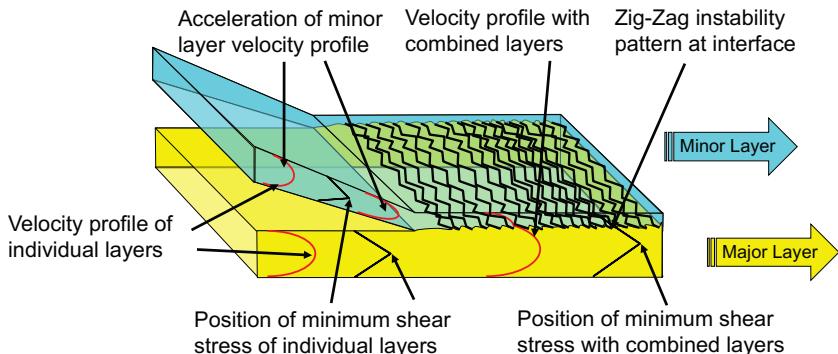


Figure 5.27 Root cause of Zig Zag interfacial instability pattern

#### 5.5.2.1.1 Strategies to Prevent Zig Zag Interfacial Instability

Raw Material

- Modify formulation to minimize shear viscosity differences of adjacent layers
- Change layer ratio to shift layer interface towards the center of the merged flow channel where shear stress is minimized

### 6.3 Air Ring Adjustment Principles

We can flip the surfaces vertically and now have the general principle that controls air rings. Bubbles that are not locked securely into the air ring will wobble or “dance”, causing severe gauge variation. Most air rings have two or three components where adjustments can lower pressure between the bubble and the metal surfaces, forcing the bubble to lock into position. Refer to Figure 6.3 for details.

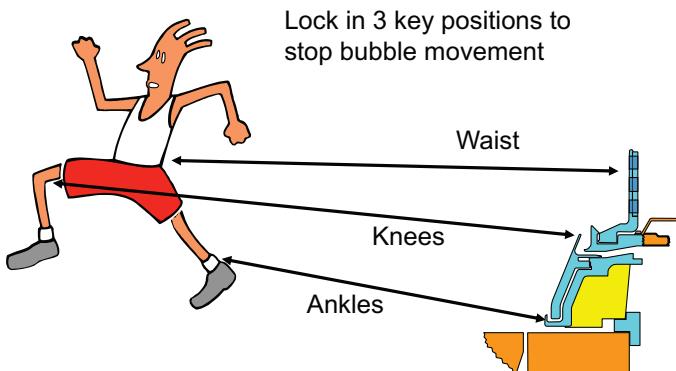


Figure 6.3 Air velocity and pressure stabilize bubbles

#### 6.3.1 Air Ring Adjustment Rules

Operators need only remember the 3 rules illustrated in Figure 6.4 to adjust all brands of air rings.

1. Velocity CONTROLS  
(Venturi Effect)



2. Volume COOLS  
(Controls frost line height)



3. “CLIMB THE STAIRS”  
Start at the bottom and work your way up.

Figure 6.4 Air ring adjustment rules

### 6.3.2 Air Ring Control (Locking) Points

One style of single lip and three distinct styles of dual lip air rings are commonly available. The Venturi effect between the bubble and the air ring surfaces can be adjusted by changing air velocity at specific points. Figure 6.5 illustrates the “control” or “locking” point positions as circles on the cross sections of these styles of air rings.

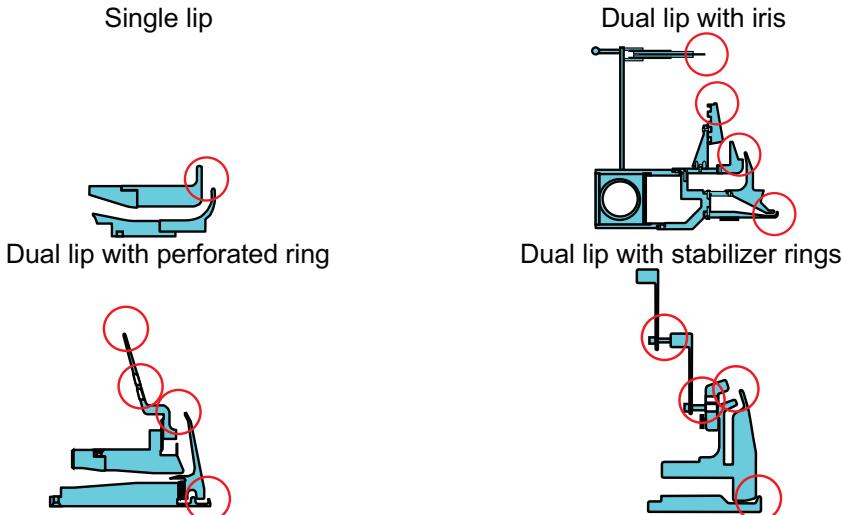


Figure 6.5 Air ring control (locking) points

### 6.3.3 Manipulation of Air Ring Control (Locking) Points

Adjustments and the effect of air volume delivered by the air ring or Internal Bubble Cooling (IBC), if available, are illustrated in Figure 6.6.

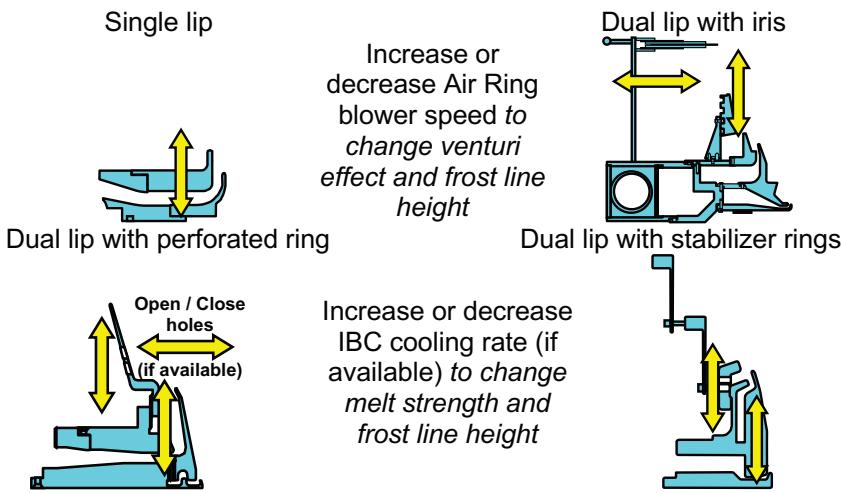


Figure 6.6 Manipulation of air ring (locking) points

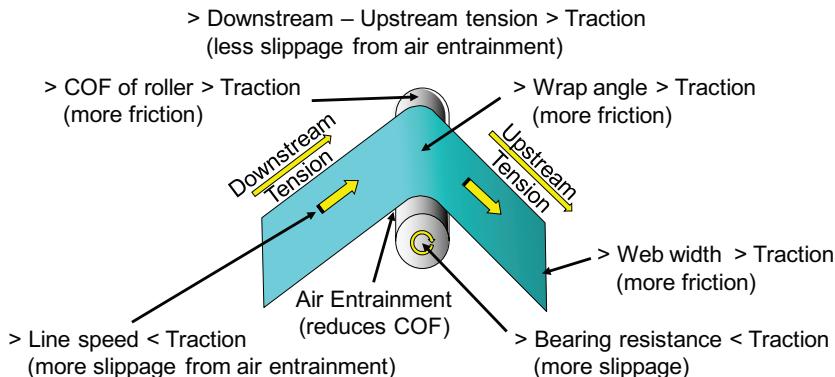


Figure 7.9 Factors controlling roller traction

#### 7.4.4 Soft Wrinkles vs. Creases

##### 7.4.4.1 Soft Wrinkles or Troughs

Soft wrinkles are troughs that form in the web as it buckles in the span between adjacent rollers. Soft wrinkles usually do not travel past the downstream roller. Refer to Figure 7.10 for details.

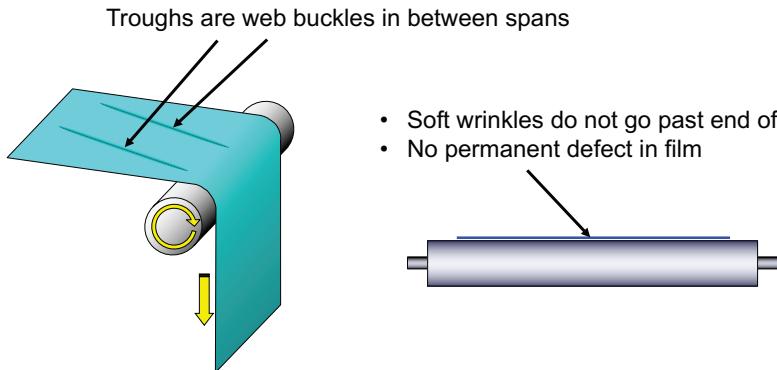


Figure 7.10 Soft wrinkles in web

##### 7.4.4.2 Creases

Creases, often referred to as wrinkles, are also troughs that form in the web as it buckles in the span between adjacent rollers. Creases usually travel past the downstream roller and produce permanent deformations in the film. Refer to Figure 7.11 for details.

The two most common web tension isolating techniques are nip rollers and S-wrap rollers. In all cases, web tension is always controlled by the speed of the downstream puller. Nipped pull rollers isolate tension ‘waves’, but often compress wrinkles into permanent creases. Refer to Figure 7.22 for details.

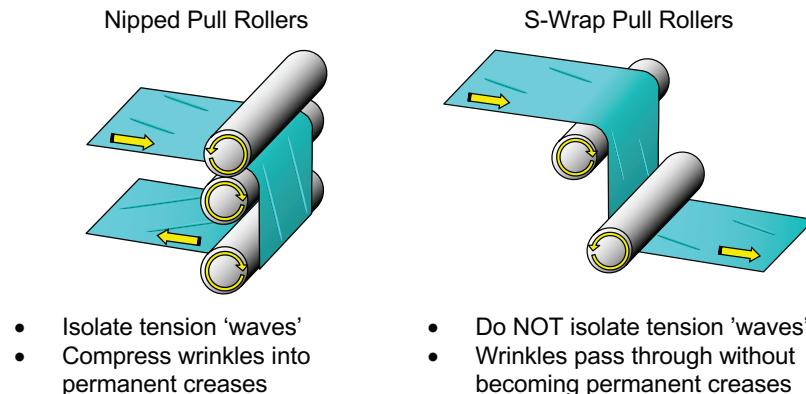


Figure 7.22 Nipped as S-wrap pull rollers

### 7.4.7.3 Change Web Tension

Lateral stresses cause diagonal wrinkles to form in a transient pattern, so they appear to travel towards the higher tension side of the web. At the same time, slack edges appear on the low-tension side closest to the upstream roller. Refer to Figure 7.23 for details. Decreasing web tension reduces friction and roller traction, allowing the web to relieve stress by sliding sideways along the downstream roller. Increasing web tension stiffens the web so that it can resist buckling that forms wrinkles. A graph showing how web tension changes film from flat to wrinkled as a function of roller misalignment angle is shown in Figure 7.24.

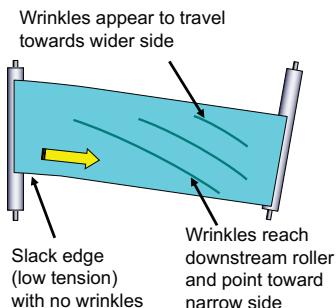


Figure 7.23 Symptoms of roller misalignment

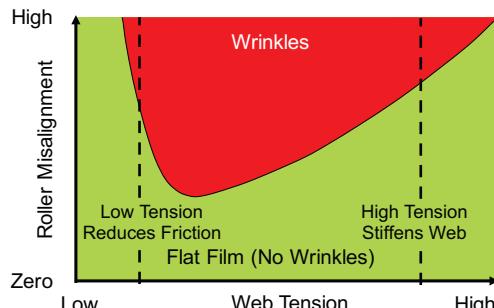


Figure 7.24 Web tension effects roller misalignment wrinkles

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## Chapter 9 – Troubleshooting Techniques

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## Process Instability Troubleshooting Guide

Problem	Type	Causes	Zone	Solutions
Wrinkles – Tracking (Symmetrical Diagonal and MD)	M	Film modulus (stiffness) is too low.	1	Reformulate with stiffer resins (lower MFR, higher density).
		Film modulus (stiffness) is too high.	1	Reformulate with limper resins (higher MFR, lower density).
	P	Film modulus (stiffness) is too low.	4	Decrease casting drum temperature in 5°C (10°F) increments. Check dimensional stability and adjust as required.
		Too much traction on roller downstream from where wrinkles first appear.	13	Reduce traction by increasing output and line speed to increase air entrainment between film and roller.
			14	Increase downstream film tension.
			15	
			13	Clean or refinish roller surface.
			14	
			15	
	E	Too much traction on roller downstream from where wrinkles first appear.	13	Lubricate or replace roller bearings.
			14	Change web path to reduce wrap angle on roller.
			15	
		Film span is too long to support film.	13	Increase lateral slippage by stopping rotation of roller.
			14	
			15	
		Excessive TD gauge variation.	3	Decrease span between rollers to stiffen film so that it can resist lateral buckling forces.
			7	Check autogauging system. Recalibrate and adjust die gap if necessary.