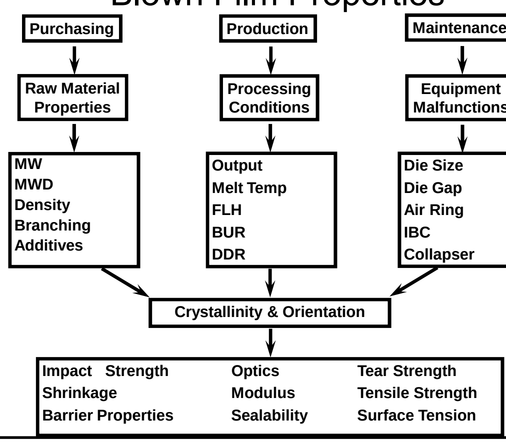
2009 Flexible Packaging Summit
Consumer Packaging Solutions for Barrier Performance Course

Blown Film Processes and Troubleshooting

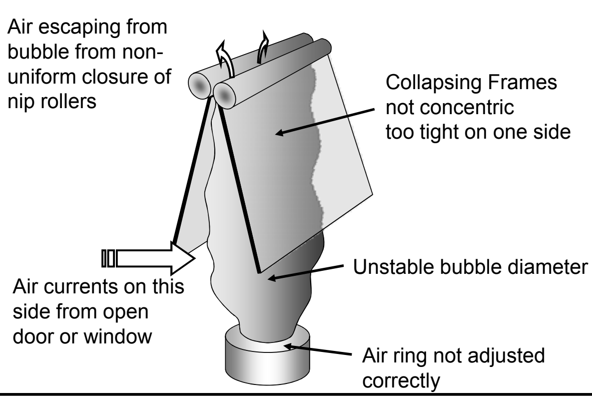
The Ultimate Quality Control Tool

Presented by:
Paul Waller
President
Plastics Touchpoint Group, Inc.

Blown Film Properties



Bubble in the Real World



Reading the Signs

1. Look at the finished roll
2. Follow the web path backwards to identify causes of defects
3. Be patient…some changes take longer than others

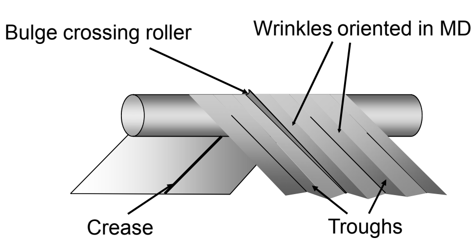
Wrinkle Patterns

MD Wrinkles
- Fixed position

TD Wrinkles
- Repeating patterns
- Transient patterns
- Edge patterns

MD Wrinkles

Compression in the Transverse Direction



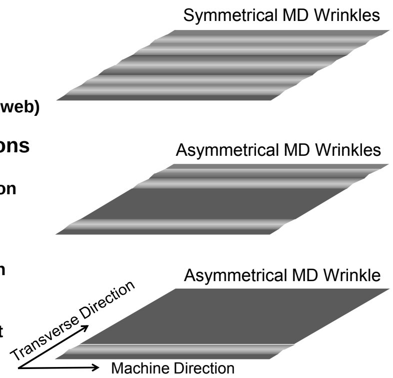
Max. roller deflection < 0.015% of roller width

Causes of Common MD Wrinkle Patterns

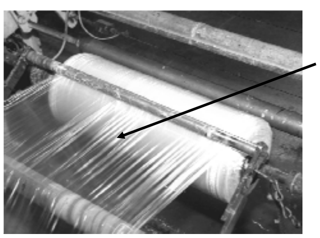
Raw Material
- viscosity variation (port line affect)
- water absorption (causes expansion of web)

Processing Conditions
- TD gauge variation
- insufficient web tension between idler rollers

Equipment
- insufficient traction on idler rollers
- bent idler rollers
- idler roller bearing not rotating properly



Film Tension Bands

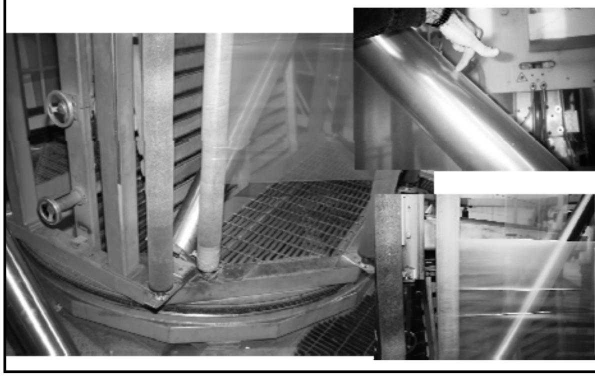


May be caused by
- Too much film tension
- MD gauge bands
- Too much drag resistance from idler rollers

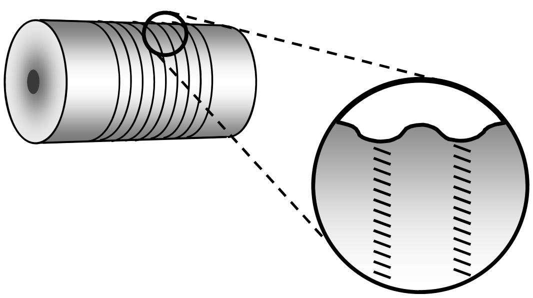
Locking Rollers Causes Problems

BGE Traversanip®

Wrinkles occur when air turning bar pressure is too high



"Tin Canning"



Solutions for Tin Canning

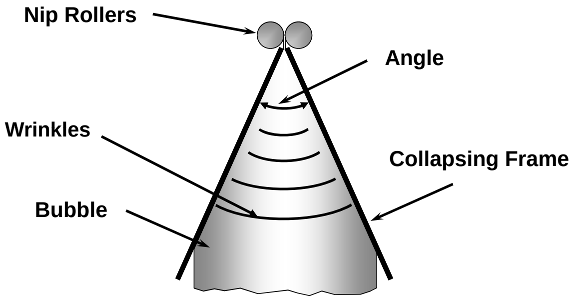
Material
- Improve mixing inside die
- Increase modulus (density) of film
- Increase film gauge

Process
- Reduce film tension
- Reduce film temperature
- Eliminate affect of air currents

Equipment
- Reduce drag resistance in collapsing frame
- Reduce drag resistance in bubble cage
- 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

Optimizing Collapsing Angle

Side View



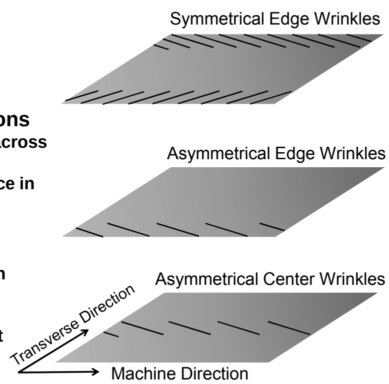
Wrinkles form if Angle is too large

Causes of Common Diagonal Wrinkle Patterns

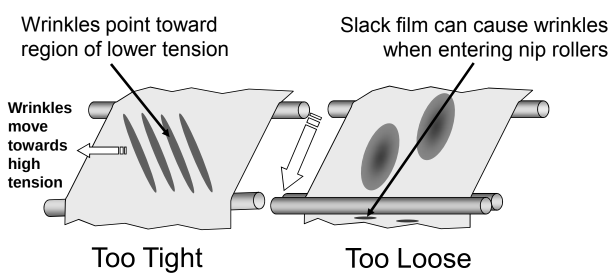
Raw Material
- viscosity variation (melt channelling)

Processing Conditions
- Uneven web tension across the web
- Uneven drag resistance in collapsing frame

Equipment
- insufficient traction on idler rollers
- bent idler rollers
- idler roller bearing not rotating properly



Tension and Elastic Modulus



- Amount of force (stress) that plastic can withstand and still return to it original dimensions
- Winding tension must never exceed this value

Spiral Wrinkle Pattern

Web Pattern

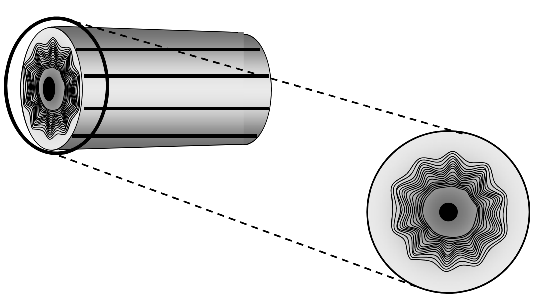
Roll Pattern

Calculating Film Tension
with Air Loaded Dancer

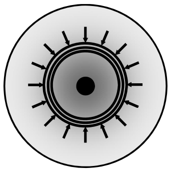
$$\text{Tension} = \frac{\text{Total Pressure} - \text{Pressure to raise dancer}}{\text{Gauge x Width x Layers}}$$

Total Pressure	= pressure reading on gauge (Kg, psig)
Pressure to raise dancer	= pressure to make dancer float (Kg, psig)
Gauge	= film gauge (microns, mils)
Width	= width of film (mm, inches)
Layers	= 1 for sheeting 2 for tubing

Starred or Spoked Rolls

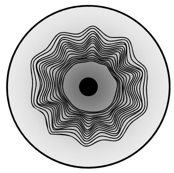


Starred or Spoked Roll Deformation Mechanism



Pressure from outside layers compresses inner layers

Roll deforms into star or spoked pattern because layers buckle when compression is too high



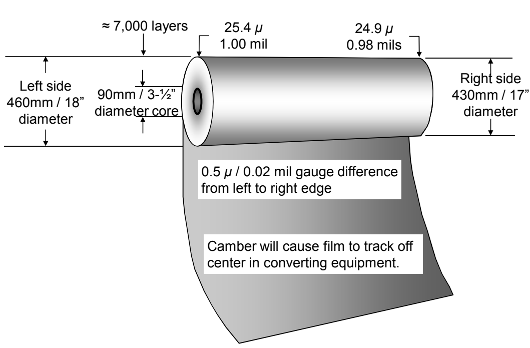
Solutions for Starred or Spoked Rolls

Material
- Reduce density difference between layers (co-ex)
- Change layer ratio to avoid curling (co-ex)

Process
- Adjust melt temp. to bring frost lines closer together (co-ex)
- Reduce film temperature
- Reduce film tension at winder
- Reduce lay-on pressure at winder

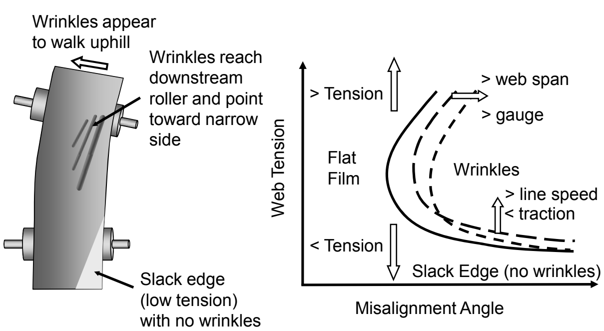
Equipment
- Improve winding tension control (watch movement of dancers)

Affect of Tapered Gauge Variation



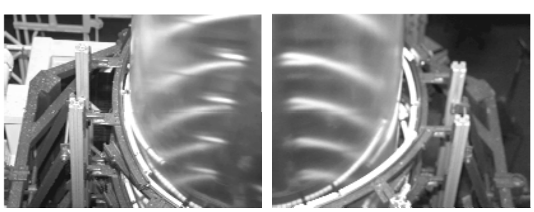
Roller Misalignment Patterns

Roller Misalignment Patterns



Bubble Misalignment

Bubble touches cage | Bubble does not touch cage

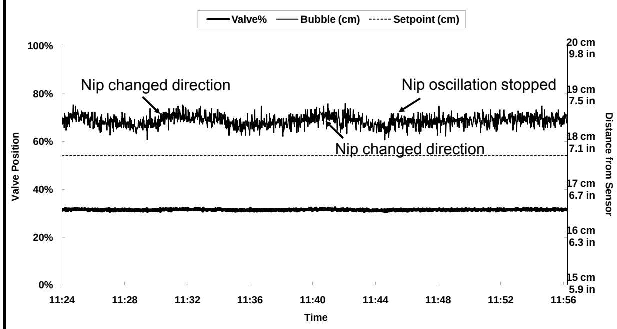


Moves with oscillating nip?

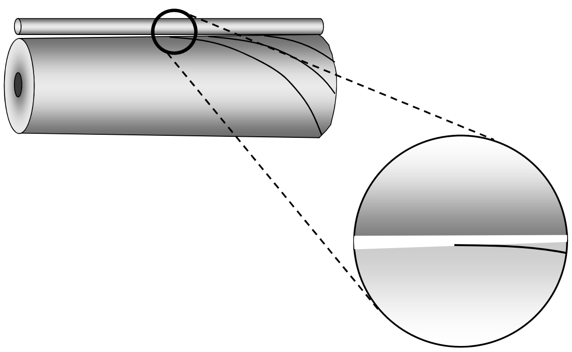
Yes Realign collapsing frame and side stabilizers

No Problem caused below collapsing frame

Evidence of Misaligned Collapsing Frame



Tapered Rolls

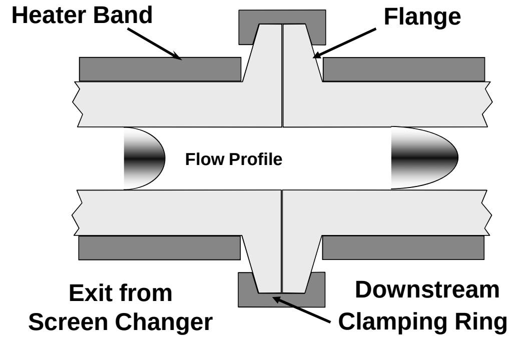


Solutions for Tapered Rolls

Process
- Reduce melt temperature variation (melt channeling)
- Eliminate air drafts across bubble

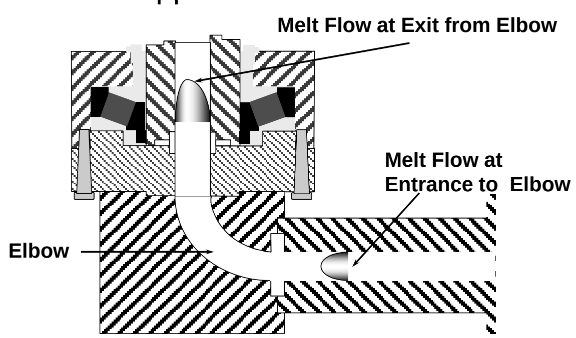
Equipment
- Align die
- Align air ring
- Align cage
- Align collapsing frame
- Align haul-off nip

Affect of Transfer Pipes on Flow Profiles

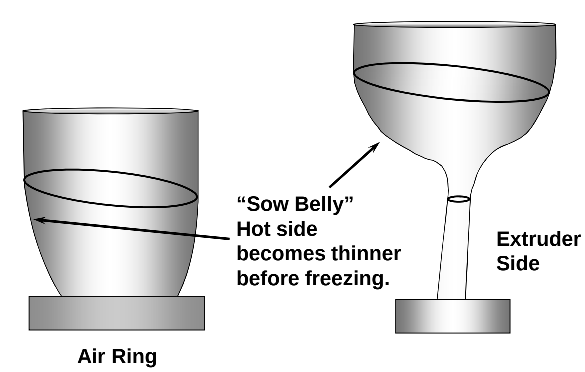


Melt Channeling

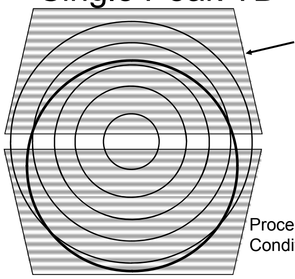
Side Opposite Extruder is Hotter



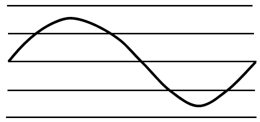
Affect of Melt Channeling



Single Peak TD Gauge Variation



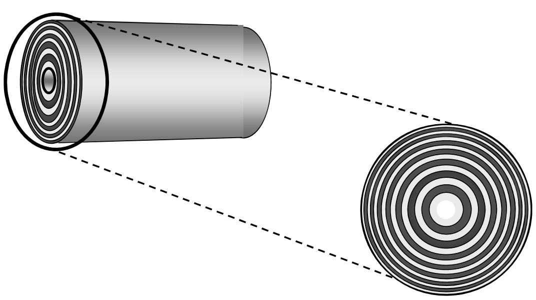
Polar Plot



Linear Plot

Processing Conditions	Uneven melt flow inside die (melt channeling) Hot air rising from extruder or other air currents inside the factory
Equipment	Die lip not centered Air ring or IBC stack not centered Tilted die ,air ring or IBC stack

Ringed Rolls



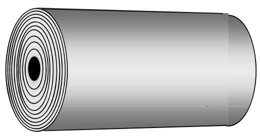
Solutions for Ringed Rolls

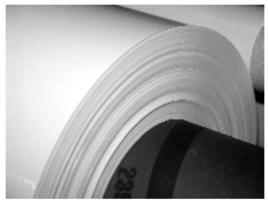
Material
- Reduce film COF (add slip)

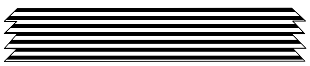
Process
- Keep film tension between 1% and 25% of ultimate tensile strength
- Eliminate web tension pulsations

Equipment
- Repair worn haul-off nips (slippage)
- Realign die, idlers, cage, collapsing frame
- Replace dull slitting blades
- Clean dirty rollers

Edge Variation

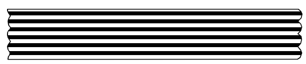






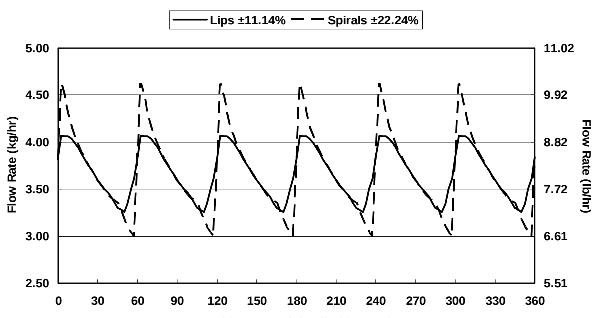
Sawtooth
• slippage in nip
• tension variation at slitters

Oscillation from side to side
• misaligned die, cage, collapsing frame



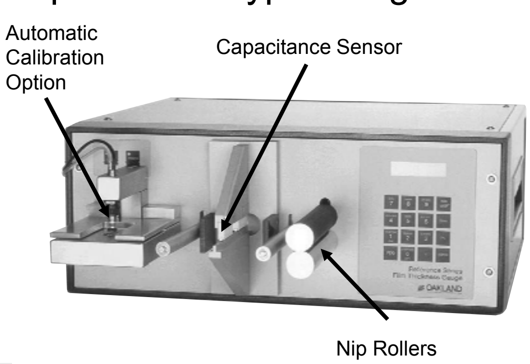
Gauge Variation at Die Lips

1 MI LDPE in HDPE Die at 200ºC (395ºF) Melt Temperature
6 Ports, 6 Port Overlap, 2 mm (80 mils) Die Gap, 200 kg/hr (485 lb/hr)



Flow2000 Simulation

Capacitance Type Gauge Profiler



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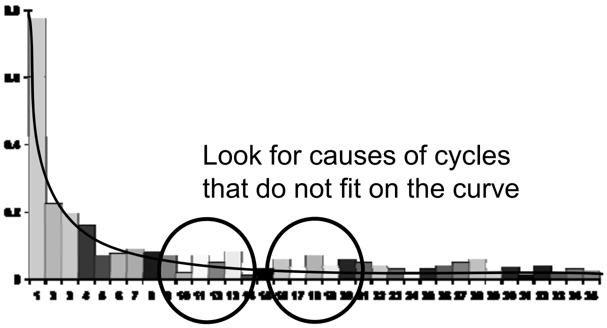
Fourier Analysis



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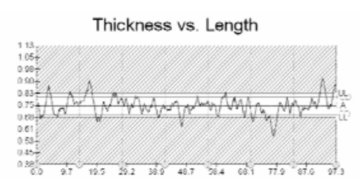
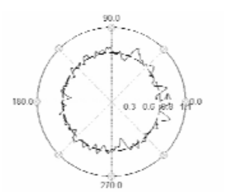
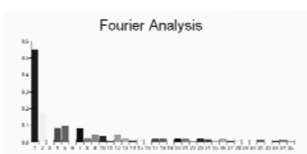
Before Air Ring Adjustment

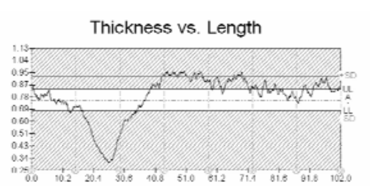


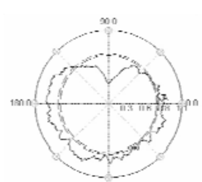


Target	0.750 mils
Average	0.752 mils
Range	+23% / -25%
Std Dev	7.2%



After Air Ring Adjustment

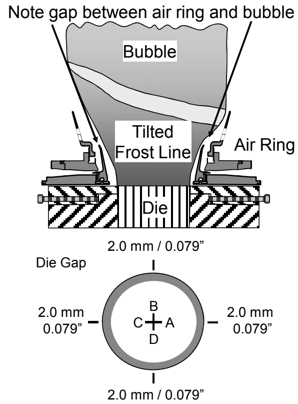




Target	0.750 mils
Average	0.776 mils
Range	+29% / -59%
Std Dev	21%

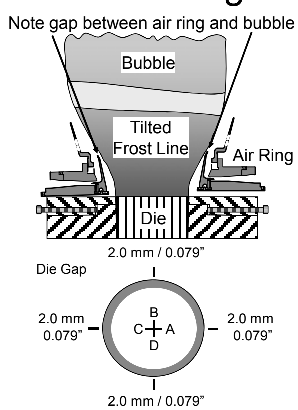
Affect of Misaligned Air Ring

Die Position	Gauge Profile
A	41.9 μ / 1.65 mils
	41.4 μ / 1.63 mils
	40.4 μ / 1.59 mils
B	38.9 μ / 1.53 mils
	38.9 μ / 1.50 mils
	34.3 μ / 1.35 mils
C	33.0 μ / 1.30 mils
	34.8 μ / 1.37 mils
	37.3 μ / 1.47 mils
D	38.4 μ / 1.51 mils
	39.9 μ / 1.57 mils
	41.1 μ / 1.62 mils
A	41.9 μ / 1.65 mils



Affect of Tilted Air Ring

Die Position	Gauge Profile
A	40.1 μ / 1.58 mils
	40.4 μ / 1.59 mils
	39.4 μ / 1.55 mils
B	40.1 μ / 1.58 mils
	38.9 μ / 1.53 mils
	37.8 μ / 1.49 mils
C	40.1 μ / 1.48 mils
	38.1 μ / 1.50 mils
	38.4 μ / 1.51 mils
D	38.6 μ / 1.52 mils
	39.9 μ / 1.57 mils
	39.6 μ / 1.56 mils
A	40.1 μ / 1.58 mils



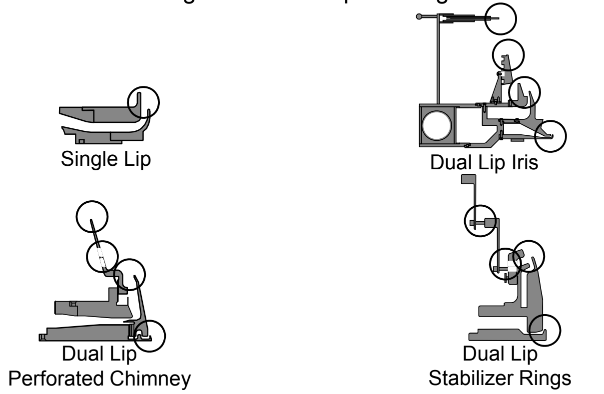
Key Air Ring Adjustments

Velocity CONTROLS

Volume COOLS

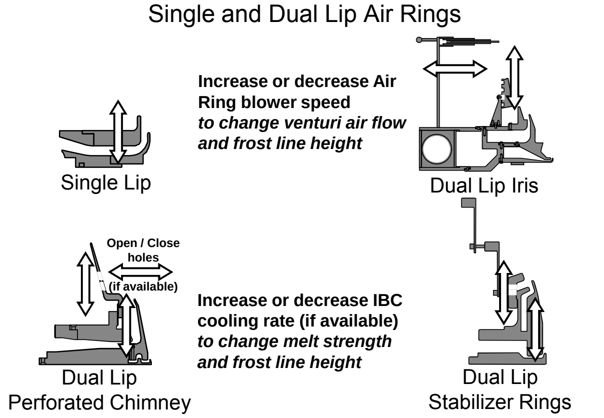
Air Ring Control Points

Single and Dual Lip Air Rings



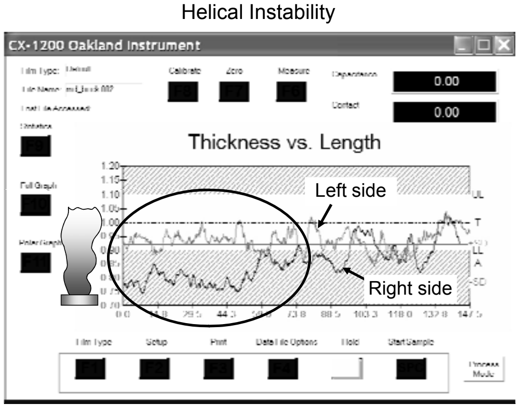
Air Ring Control Points

Single and Dual Lip Air Rings

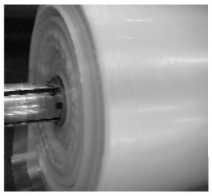


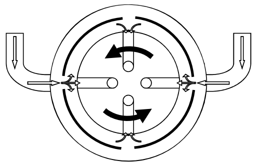
MD Gauge Variation

Helical Instability

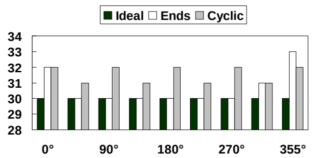


Ultrasonic Sensor Mounting Position



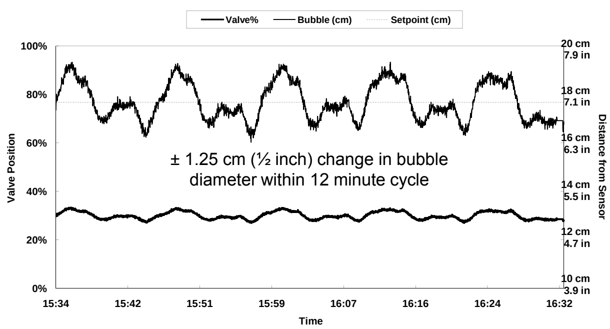


- **Uneven pressure distribution in oscillating die air plenums**
- **Static pressure changes either in cyclic pattern or when rotation changes**

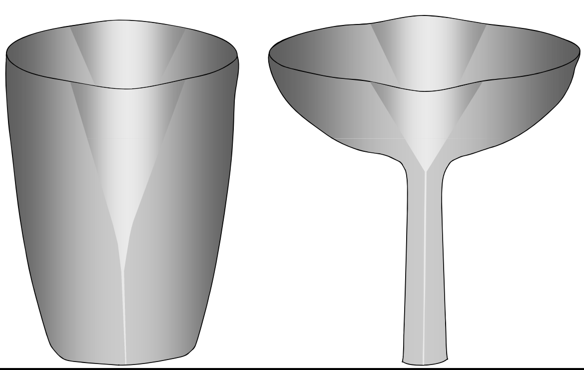


Source: D.R. Joseph, Inc.

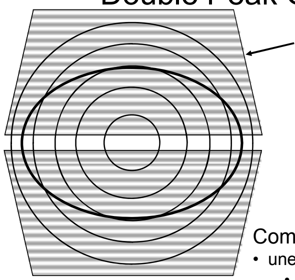
Evidence of Leaking IBC Air Plenums



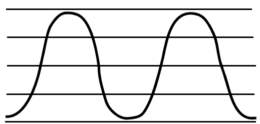
TD Gauge Variation
Oval Bubble with Thin Bands



TD Gauge Variation
Double Peak Gauge Profile



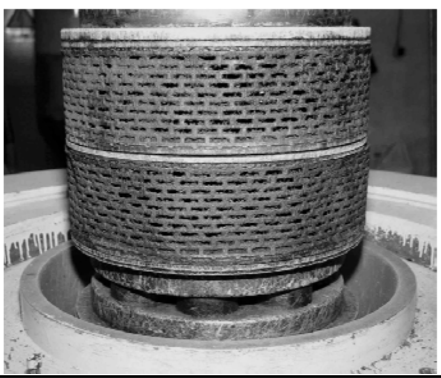
Polar Plot



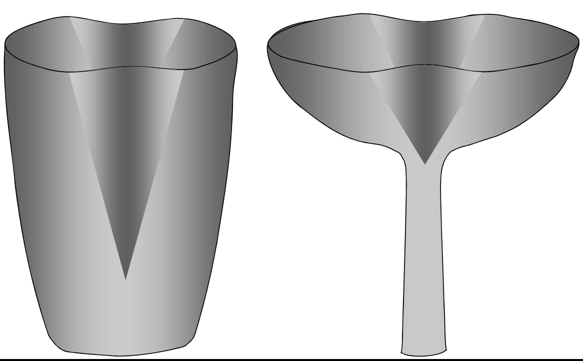
Linear Plot

Common Causes
- uneven melt flow inside die
  - die too cold (10 to 20ºC / 20 to 40ºF)
  - back pressure too high
  - dirty screens
- plugged air ring or IBC stack
- too much drag resistance in collapsing frame

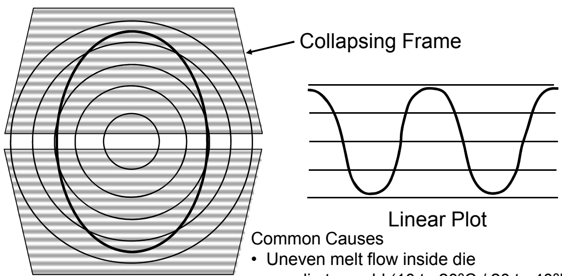
Dirty IBC Stack



TD Gauge Variation
Oval Bubble with Thick Bands

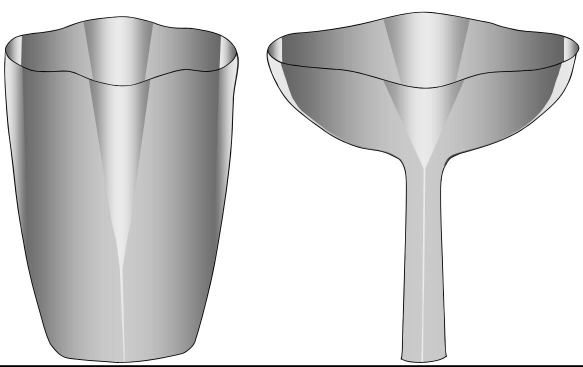


TD Gauge Variation
Double Peak Gauge Profile

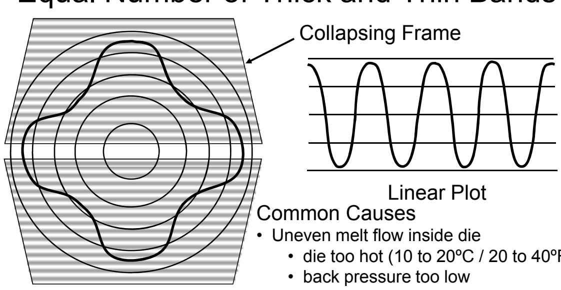


Common Causes
- Uneven melt flow inside die
  - die too cold (10 to 20ºC / 20 to 40ºF)
  - back pressure too high
  - dirty screens
- Plugged air ring or IBC stack

TD Gauge Variation
Equal Number of Thick and Thin Bands

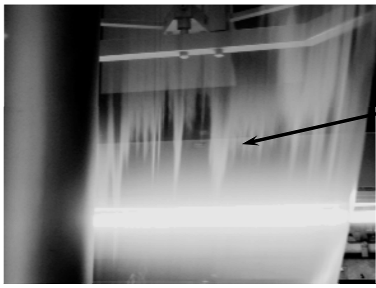


TD Gauge Variation
Equal Number of Thick and Thin Bands



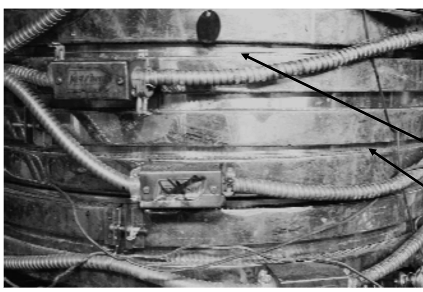
Common Causes
- Uneven melt flow inside die
  - die too hot (10 to 20ºC / 20 to 40ºF)
  - back pressure too low
  - dirty screens
  - melt temperature variation too large (worn screw)
  - too much output
- Plugged air ring or IBC stack

Bottom of Die is Too Cold



Jagged
Frost
Line

Loose Die Heater Bands



Compare
heater
position to:

parting line

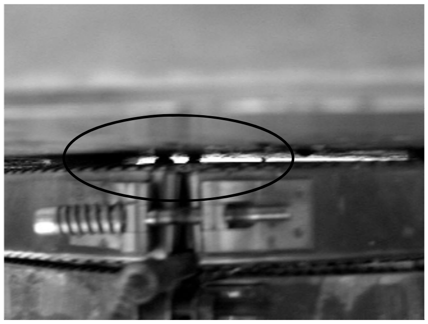
other heater
bands

Cold Spots in Die

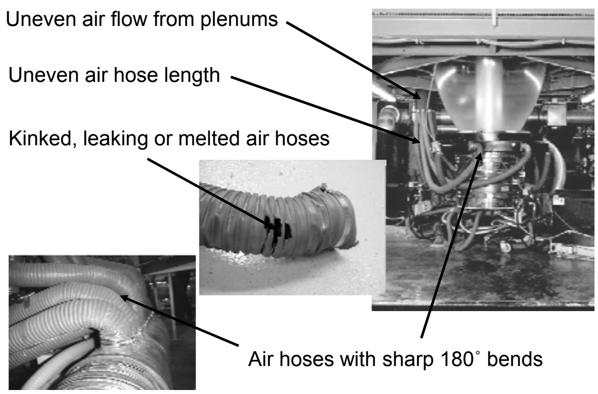
Heater clamps should not be lined up.

No heat supplied in this area.

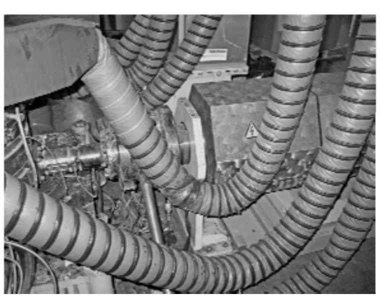
Dirt Between Die and Air Ring



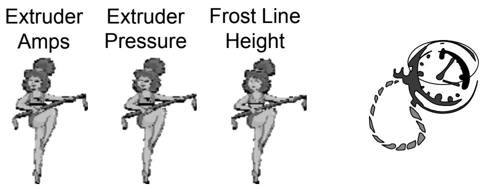
Common Air Distribution Problems



Air Hoses Too Close to Hot Spots



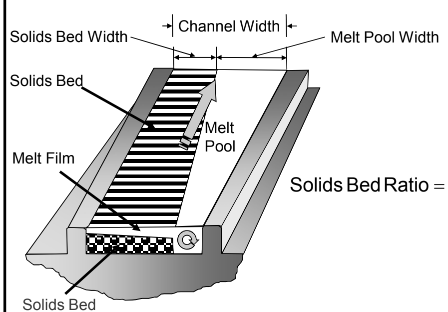
Surging
Watch the Chorus Line



- All 3 parameters move up and down together
- Look for speed of cycle compared to screw speed

Solids Bed Ratio

Indicates Melting Capacity of the Screw

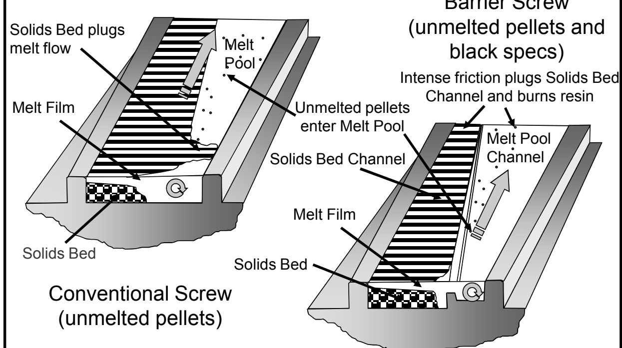


$$\text{Solids Bed Ratio} = \frac{\text{Solids Bed Width}}{\text{Channel Width}}$$

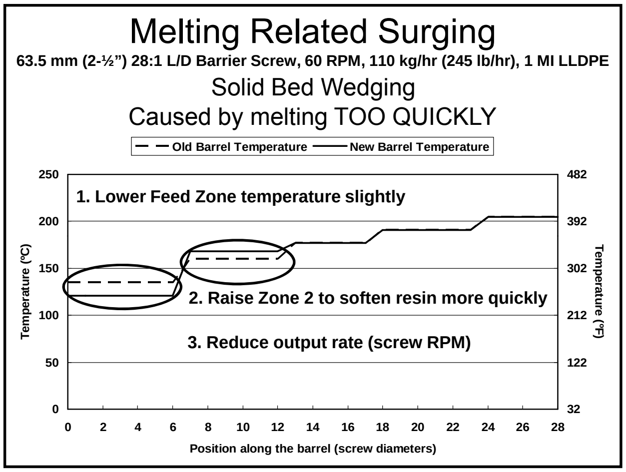
Conventional Screw

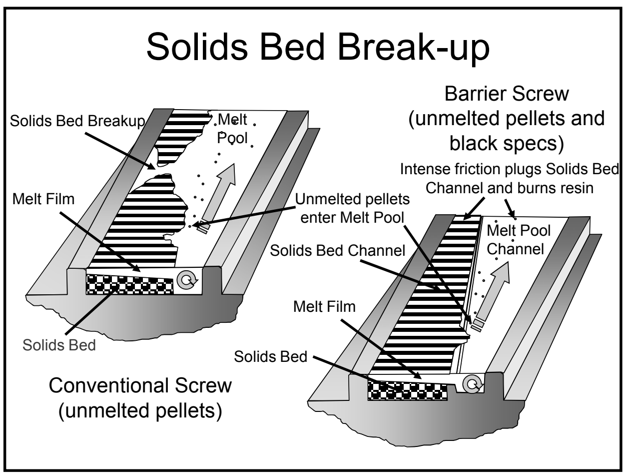
Solids Bed Wedging

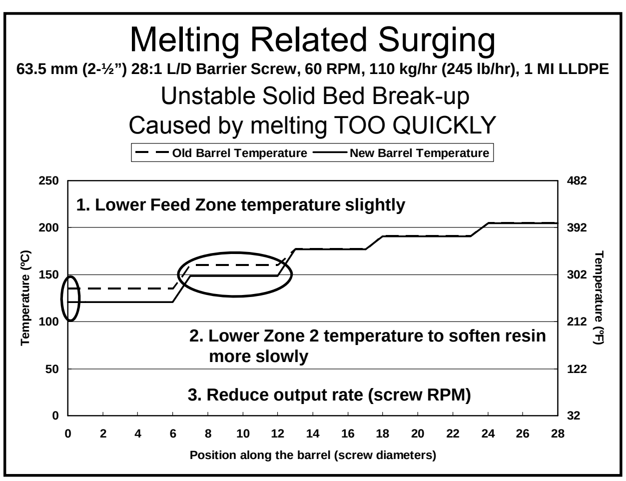
Barrier Screw (unmelted pellets and black specs)



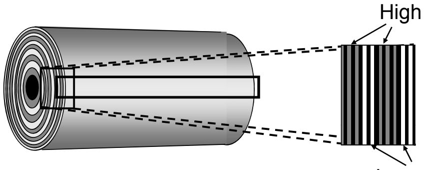
Conventional Screw (unmelted pellets)


Melting Related Surging
63.5 mm (2-½") 28:1 L/D Barrier Screw, 60 RPM, 110 kg/hr (245 lb/hr), 1 MI LLDPE
Solid Bed Wedging
Caused by melting TOO QUICKLY
Old Barrel Temperature
New Barrel Temperature
1. Lower Feed Zone temperature slightly
2. Raise Zone 2 to soften resin more quickly
3. Reduce output rate (screw RPM)
Temperature (°C)
Temperature (°F)
Position along the barrel (screw diameters)


Solids Bed Break-up
Solids Bed Breakup
Melt Pool
Melt Film
Unmelted pellets enter Melt Pool
Solids Bed
Conventional Screw (unmelted pellets)
Barrier Screw (unmelted pellets and black specs)
Intense friction plugs Solids Bed Channel and burns resin
Melt Pool Channel
Solids Bed Channel
Melt Film
Solids Bed


Melting Related Surging
63.5 mm (2-½") 28:1 L/D Barrier Screw, 60 RPM, 110 kg/hr (245 lb/hr), 1 MI LLDPE
Unstable Solid Bed Break-up
Caused by melting TOO QUICKLY
Old Barrel Temperature
New Barrel Temperature
1. Lower Feed Zone temperature slightly
2. Lower Zone 2 temperature to soften resin more slowly
3. Reduce output rate (screw RPM)
Temperature (°C)
Temperature (°F)
Position along the barrel (screw diameters)

Test for Surging



Cut 2 sets of 5 layers across roll at peak and valley exactly the same width
Weight is the same = NOT surging
Weight is different = surging

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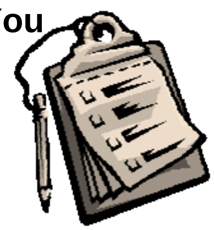
Consumer Packaging Solutions for Barrier Performance Course

Thank You



PRESENTED BY
Paul Waller
President
Plastics Touchpoint Group, Inc.
paul@plasticstouchpoint.com
www.plasticstouchpoint.com

Please remember to turn in your evaluation sheet...