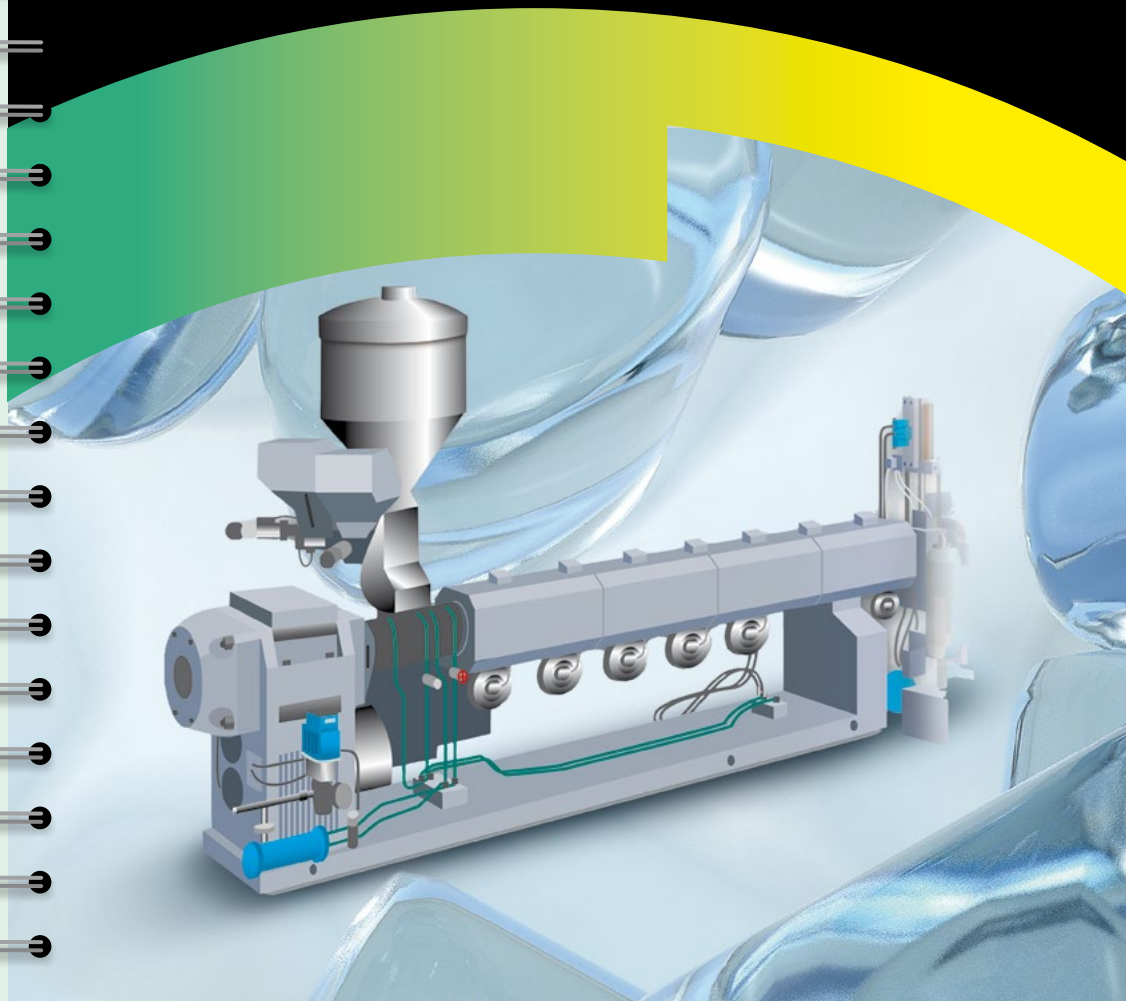
Tips for Defect-Free Extrusion of TPU



Covestro Deutschland AG
CHEMPARK Dormagen
Alte Heerstraße
Building F29
41538 Dormagen
e-mail: info@covestro.com

desmopan.com

Edition: 2016 · Order-No.: COV00080667 · Printed in Germany

1. Tips for defect-free extrusion of TPU

Various problems can arise when extruding thermoplastics – and that goes for TPU, too. We have compiled an extensive list of possible defects, explained their causes and described preventive measures. To help you find them more easily, we have divided the defects into groups, such as "Defects caused by moisture" or "Defects commonly associated with blown films". Please do not hesitate to contact us if this list does not help you solve your problem.

We would be grateful for any hints, suggestions and illustrations you could submit to make this catalogue of defects more complete.

covestro Desmopan® covestro Texin® covestro Utechllan®

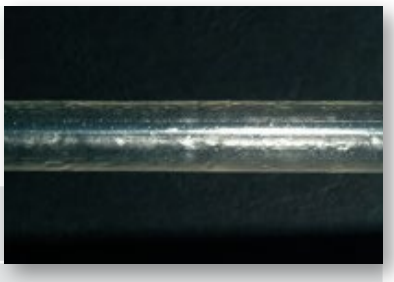
1.1 General defects

Contaminated extrudate

Description: Specks and spots on extrudate

Causes:	Remedies:
Dryer dirty	Check dryer for foreign material, clean
Dryer filter system defective	Check and repair system
Wear debris from conveyor	Check and repair system
Excessive dust formation in material preparation or extrusion areas	Keep all material containers tightly sealed until needed
Foreign material in extruder	Rinse or mechanically clean extruder and mold

Gel matter in extrudate



Description: Specks and spots on extrudate

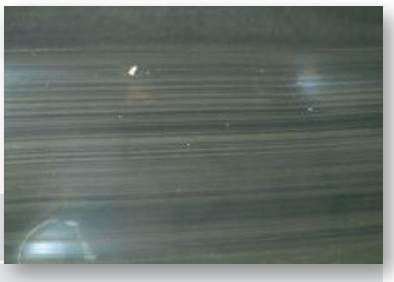
Causes:	Remedies:
Incorrect temperature profile	Adjust temperatures
Poor mixing	Increase counterpressure. Increase number or density of screening stack. Use static mixer
Throughput too fast	Reduce screw speed

White flakes in extrudate

Description: Hard flakes, usually white, of different sizes are flushed out at irregular intervals

Causes:	Remedies:
Dwell time too long	Increase throughput
Screw at a standstill	Allow screw to continue rotating slowly. Purge with Desmopan® 385 / Texin™ 285 and then shut down
Dead spots in mold / adapter	Optimize mold and adapter

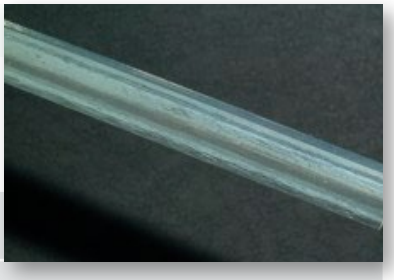
Streaks and blisters on the surface



Description: Streaks and blisters on the surface

Causes:	Remedies:
Thermal degradation	Optimize mold and adapter. Reduce melt temperature. Reduce dwell time. Reduce friction. Clean or clear dead spots more frequently
Moisture	See “Moisture-related defects”

Non-homogeneous melting



Description: Extrudate has irregular structure

Causes:	Remedies:
Foreign material in extruder making material incompatible	Purge or mechanically clean extruder and mold
Incompatibility with additive batches	Use appropriate additive batches
Different viscosities making materials incompatible	Do not mix different batches of same material
Temperature too high (degradation)	Reduce temperature
Poor homogenization	Adjust temperature profile. Increase pressure in front of die. Check screw profile and use more suitable screw if necessary. Adjust material throughput to extruder capacity

Discolored material

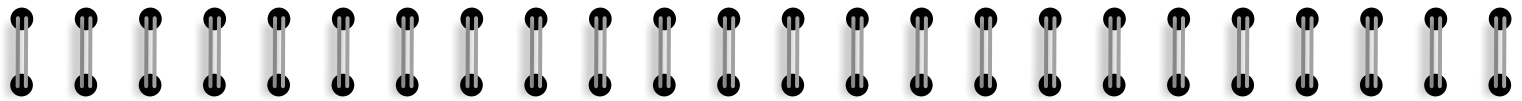
Description: Dark or silvery areas visible on material

Causes:	Remedies:
Thermal degradation of material. Dwell time in cylinder or mold too long. Melt temperature too high	Reduce melt temperature. Reduce dwell time in cylinder or mold Reduce shear Check all controllers and heating bands

Unusual smell

Description: Stronger than usual odors (typical or atypical of material)

Causes:	Remedies:
Material thermally damaged. Dwell time in cylinder or mold too long. Melt temperature too high	Reduce thermal load on melt. Reduce dwell time in cylinder or mold. Reduce melt temperature Reduce shear



Pulsing

Description: Highly fluctuating output of melt

Causes:	Remedies:
Bridging in hopper (defective conveyance)	Reduce temperature of feed zone (check cooling)
Unsuitable screw design	Use another material or a different screw Use a grooved feed bush
Back pressure in screw	Adjust temperature profile or use reversed temperature profile

Poor feed-in

Description: Extruder shows insufficient throughput rate

Causes:	Remedies:
Bridging in hopper	Reduce temperature of feed zone
Feed zone too hot	Reduce temperature of feed zone
No grooved bushing in feed zone	Change feed zone

1.2 Moisture-related defects

Surface streaks

Description: Extrudate has silver-colored streaks in direction of flow

Causes:	Remedies:
Material or pigment paste too moist	Check dryer and conveyor system. Cover hopper

Blisters on surface

Description: Extrudate exhibits small blisters and streaks

Causes:	Remedies:
Material or pigment paste too moist	Check dryer and conveyor system. Cover hopper

Voids in thick-walled extrudates

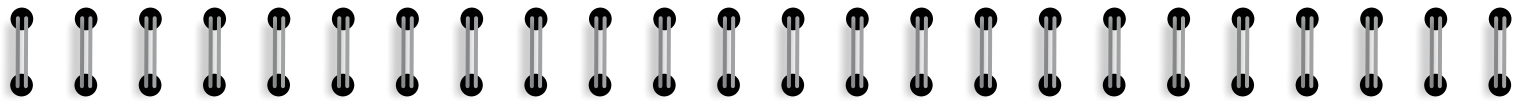
Description: The extrudate exhibits sink marks and cavities

Causes:	Remedies:
Material or pigment paste too moist	Check dryer and conveyor system. Cover hopper

Rough surface

Description: Surface of extrudate is rough and uneven

Causes:	Remedies:
Material or pigment paste too moist	Check dryer and conveyor system. Cover hopper



Dimensional variations

Description: Extrudate dimensions cannot be accurately set; dimensions vary continually

Causes:	Remedies:
Too much moisture in material or pigment paste causing fluctuations in viscosity.	Check dryer and conveyor system. Cover hopper

1.3 Defects affecting cast and flat films

Chatter marks

Description: Marks or lateral streaking on film surface

Causes:	Remedies:
Stretch ratio too high	Reduce size of die slot. Increase throughput
Temperatures too high	Reduce melt temperature
Film adheres to the roll	Increase amount of release agent Change roll temperature

Torn edges

Description: Edges of film are torn at irregular intervals, at right angles to direction of extrusion

Causes:	Remedies:
Stretch ratio too high	Reduce size of die slot. Increase throughput
Temperature in last heating zone too low	Increase temperature in last heating zone

Streaking on film surface

Description: Marks on film in direction of flow

Causes:	Remedies:
Mold dirty	Clean inside of mold and die lip
Mold incorrectly adjusted	Adjust pressure screws
Temperature variations	Check temperature control
Temperature too high	Reduce temperatures

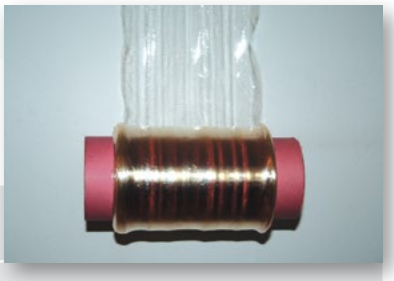
Holes

Description: Surface of coating exhibits small “craters” and holes

Causes:	Remedies:
Roughness of substrate layer	Increase layer thickness. Change substrate material

1.4 Defects affecting blown films

Blocking of film



Description: Film is difficult to unwind or wind around

Causes:	Remedies:
Insufficient quantity of anti-block additive or incorrect anti-block additive used	Check quantity and type of anti-block additive
Winding tension too high	Adjust winding tension. Fit deflecting rollers with own drive
Insufficient cooling and / or ambient temperature too high	Reduce output. Extend cooling section. Use cooled air for cooling

Chattering in film or bubble

Description: Bubble does not pass smoothly through collapsing boards

Causes:	Remedies:
Air speed from cooling ring too high	Reduce air throughput
Lip opening of cooling ring too small	Enlarge lip opening
Friction in collapsing boards	Modify surface of collapsing boards to reduce friction. Reduce melt temperature

Poor film transparency

Description: Film is milky or cloudy

Causes:	Remedies:
Incorrect material type	Use correct material
Extrusion temperature too high or too low	Adjust temperature profile
Insufficient film cooling	Check cooling system
Film too thick	Reduce film thickness
Poor mixing due to lack of shear in extruder and mold	Check extruder and mold. Increase counterpressure

Marks or droplets on bubble

Description: Film exhibits streaking in direction of flow

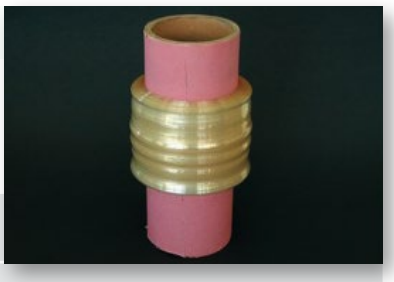
Causes:	Remedies:
Deposits on lip of die	Clean lip of die. Apply thin coating of silicone grease to lip of die
Hard particles or foreign material in mold	Clean blow mandrel and upper section of mold. Clean conduit area below die
Insufficient mixing of melt flows	Increase counterpressure in extruder. Increase temperature of adapter and mold. Use finer screen to increase counterpressure

Sagging film edges

Description: Film edges are wavy and sagging

Causes:	Remedies:
Film edges curl in before roller nips	Adjust nip to collapsing frame. Adjust lateral film slideways

Fluctuations in film thickness



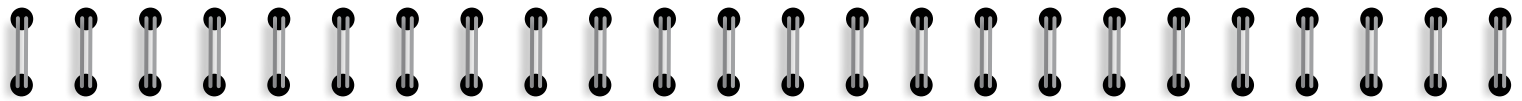
Description: Reel of film exhibits “piston rings”

Causes:	Remedies:
Unevenness of die slot	Check die slot and adjust
Uneven air speed in cooling ring	Adjust air flow rate by adjusting cooling ring
Uneven die ring temperature	Ensure even temperature distribution
Extruder pulsates	See “Pulsating”
Uneven speed of take-off rollers	Check drive of take-off rollers
Loose chain drive	Adjust chain drive
Bubble does not expand in cooling ring area	Increase inner bubble pressure. Reduce cooling output

Bubble exhibits insufficient stability

Description: Strength or stability of bubble not adequate

Causes:	Remedies:
Poor bubble geometry	Reduce nip height to collapse film before nip at a higher temperature (80° C - 110° C)
Uneven cooling of bubble	Check drawplate contact. Check lateral film slideways
Blow-up ratio too low	Increase blow-up ratio
Thin areas in film	Adjust die
Extrusion temperature too high or too low	Gradually adjust temperature



Scratches

Description: Surface scratches in direction of flow

Causes:	Remedies:
Film comes into contact with auxiliary equipment	Check the following units: - Bubble guide - Collapsing frame - Treatment unit - Non-driven roller - Dancing roller - Side gusseting unit - Film folding unit - Cutting blade holder - Mechanical equipment for eliminating static charges Check film tension

Bubble collapses

Description: Bubble collapses

Causes:	Remedies:
Insufficient cooling	Check cooling source
Melt too cold	Increase temperature
Blow-up ratio too high	Modify blow-up ratio
Inadequate weld line strength	Adjust temperature profile
Dirt particles below or inside die lips	Check and clean die lips

Uneven width

Description: Required film width is not achieved or fluctuates significantly

Causes:	Remedies:
Web tension fluctuates or is too high	Check and reduce web tension while reel is being wound
Escape of air from bubble	Check whether air is escaping at air connection point on mold
Pumping or breathing of bubble	Check whether collapsing frame is positioned too close. Check whether air speed in cooling ring is too high
Film web migrates in infeed area of winding station	Check web tension
Fluctuating web tension in trimming or slitting station	Check web tension
Melt too viscous	Increase die head temperature

Wrinkling

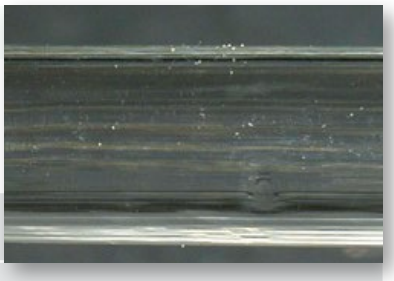
Description: Film wrap exhibits wrinkles and warping

Causes:	Remedies:
Marked fluctuations in thickness of film web	Ensure even die opening, cooling air speed and die temperature
Insufficient cooling, unstable bubble	Use cooler air or increase volume of air to increase bubble cooling
Lack of alignment in collapsing boards and primary nip rollers in relation to the die	Ensure clean infeed into collapsing boards. Eliminate drafts around bubble. Align collapsing boards and primary nip roller so as to ensure even winding tension and smooth film web
Rollers incorrectly aligned	Realign rollers

Excessive web tension or too many non-driven rollers	Check web tension and speed of downstream rollers
Rough surfaces in collapsing frame area	Eliminate rough surfaces
Uneven collapsing of bubble	Adjust collapsing boards and lateral film guide. Minimize movement of bubble by reducing distance between output of bubble and collapsing boards

1.5 Defects affecting hoses

Sink marks



Description: Hose exhibits small depressions on surface

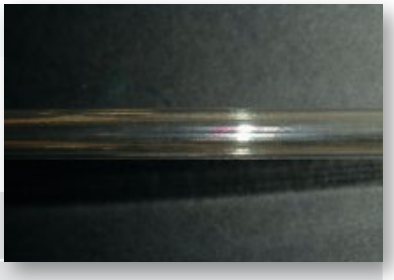
Causes:	Remedies:
Air bubbles on surface of hose in water bath	Cool with large, slow cascade of water

Bulging

Description: Bulging caused by shifting of melt

Causes:	Remedies:
Water droplets on surface in air cooling zone	Protect hot hose from splashes

Rough inner or outer faces



Description: Deposit forming on die is transferred to material

Causes:	Remedies:
Damp material	Dry material. Check dryer. Fog material in hopper with nitrogen
Low melt temperature	Increase melt temperature
Dirty die	Clean die. Apply thin coating of silicone grease to die
Melt fracture on the die	Increase melt temperature. Use die with longer conduits. Use die with smaller inner intake angles to conduit area

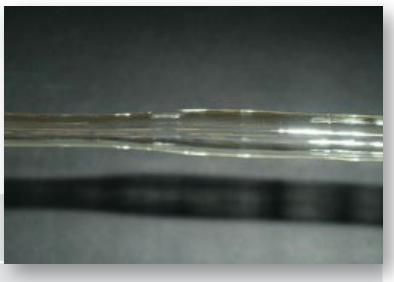
Insufficient mixing	Increase melt pressure Reduce screw temperature Reduce screw speed Check screw geometry
Filler content too high	Reduce filler content
Unsuitable filler	Replace filler

Tear in hose wall

Description: Hose tears at weld lines

Causes:	Remedies:
Weld lines fail due to insufficient melt temperature or excessive extrusion speed or low die lip pressure	Increase melt temperature. Extend dwell time. Increase viscosity in die lip area. Use die with longer conduit to develop more pressure
Thin points	Readjust die

Peripheral bead (inside / outside)



Description: Hose exhibits thick areas at irregular intervals

Causes:	Remedies:
Periodic back pressure on mandrel / die	Increase temperature of mandrel / die
Vibration in take-off unit	Repair take-off unit

Peripheral wave

Description: Hose exhibits thick areas at regular intervals

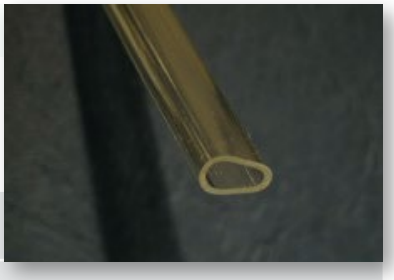
Causes:	Remedies:
Pulsating material flow	Use a smaller initial calibration unit. Check unit for wear and notches. Repair or replace if necessary
Uneven cascade of water	Ensure even flow of water around hose
Insufficient mixing	Increase melt pressure. Reduce screw temperature. Reduce screw speed. Use a better design of screw

Uneven wall thickness

Description: Wall thickness uneven over cross-section

Causes:	Remedies:
Overheated or cold areas in mold	Adjust mold temperature. Align take-off unit
Take-off unit poorly aligned to mold	Center mandrel

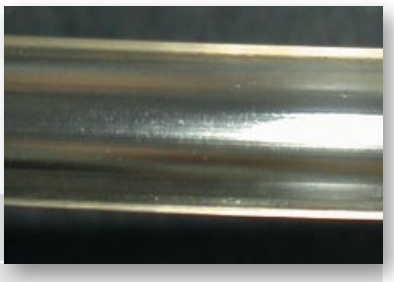
Hose out of round



Description: Hose is out of round

Causes:	Remedies:
Calibrating equipment in water bath defective or deformed	Replace calibrating equipment
Hose is too warm	Reduce water temperature in cooling bath

Lack of gloss



Description: Hose has a matt surface

Causes:	Remedies:
Damp material	Dry material. Check dryer. Fog material in hopper with nitrogen
Melt temperature too low	Increase melt temperature. Clean die. Apply thin coating of silicone grease to die

Hose too glossy

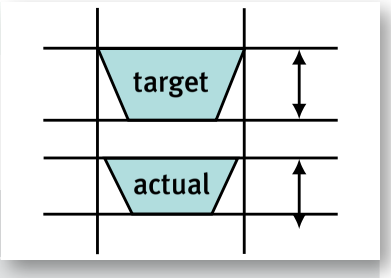
Description: Hose has a glossy surface

Causes:	Remedies:
Die temperature too high	Reduce die temperature Use matting batch

1.6 Defects affecting profiles

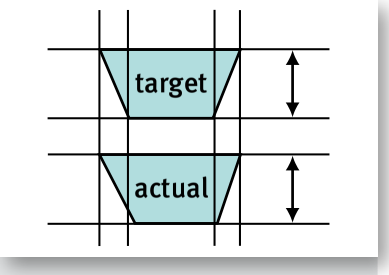
Incorrect dimensions

Description: Desired dimensions are not achieved



Causes:	Remedies:
Too much or too little traction on profile	Modify take-off speed or material temperature

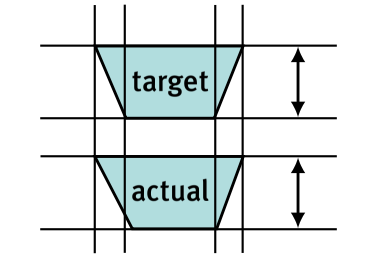
Skewed cross-section



Description: Profile exhibits correct dimensions but incorrect angles

Causes:	Remedies:
Uneven mold temperatures	Adjust temperatures. Insulate mold

Deformed profile



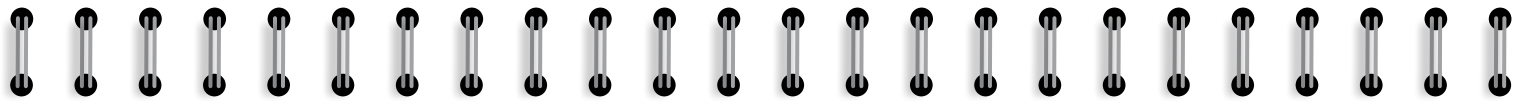
Description: Dimension and angle of profile correct when product leaves die, but change during post-treatment

Causes:	Remedies:
Insufficient cooling	Ensure that cooling is even and support profile until cool enough to retain shape by itself. Reduce throughput
Material too damp	Measure material dampness and dry. Protect material from moisture

Low gloss

Description: Surface exhibits too little gloss or is rough

Causes:	Remedies:
Contamination on die	Clean die. Apply thin coating of silicone grease to die
Die too cold	Increase temperature of die. Increase extruder temperature
Melt fracture – excessive output speed at die	Reduce speed of extruder and take-off unit. Use mold with more streamlined infeed, larger opening or longer conduits
Mold is scratching material	Polish inside of mold



Marks

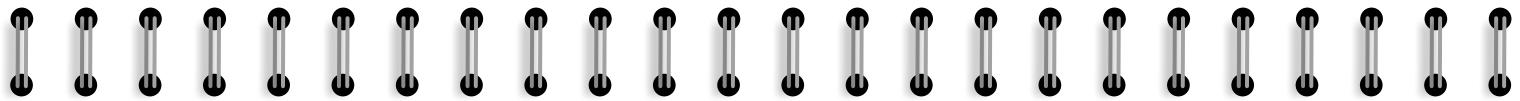
Description: Lines in direction of flow

Causes:	Remedies:
Dirty die	Clean die
Notch or press seam in take-off system or mold	Eliminate scratches

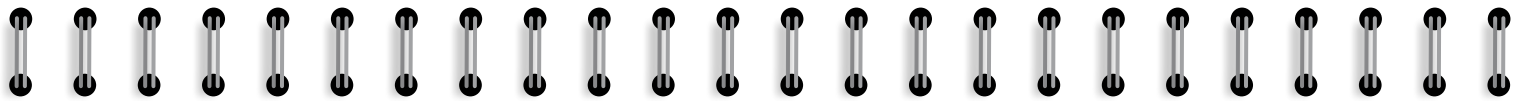
Sink marks

Description: Profile exhibits irregular depressions

Causes:	Remedies:
Extrudate is too hot when it reaches the conveyor	Cool underside of profile with air before it comes into contact with belt. Blow air through holes in belt onto profile



Notes



Notes