LyondellBasell Technical Tip

tech.topic

Shrinkback

Shrinkback occurs when the insulation "pulls back" excessively, exposing the conductor either after cutting or after a period of time (normally related to heat exposure). Several tests can determine shrinkback. These tests involve heating a sample in an oven at a specific temperature and for a specific time. Other shrinkback problems become apparent immediately after cutting the insulated wire.

There are many factors that can create shrinkback, so start troubleshooting by asking the following questions:

4. At what stage of production was the shrinkback noted? This answer is important because excessive tension at any stage of production can cause the problem.

5. Is the problem evident on product from only one machine or from several? If wire from several machines exhibits shrinkback, the problem may be resin-related. Has there been a resin change recently?

6. Is the problem related to shrink voids? Slice a length of insulation from the conductor and examine (under magnification) the conductor/insulation interface for presence of long voids.

7. Is the shrinkback associated with only one color or sequence of colors? If color related, look at the color concentrate or processing parameters of the equipment.

1. Is the problem associated with an increase in line speed above the process standard for the equipment?

2. Have any changes occurred in the extrusion line, i.e., conductor preheat, temperature profile, water trough temperature or take-up tensions?

3. Remember that efforts to correct shrinkback may adversely affect other properties, e.g., adhesion.

Possible causes of shrinkback and recommended solutions:

A. Excessive Color Concentrate.
- Too much additive can also reduce physical properties.

B. Conductor Preheat Temperature Too Low
- Start with 200°F and adjust accordingly. Too much preheat can affect the cooling rate of foamed insulation as well as the blowing rate. A balance with other parameters must be achieved for proper capacitance.

C. Foreign Material on Conductor
- Clean or replace wipes, or verify that the wire does not have a coating on it. Super-absorbent, paper-based materials are not recommended as wipes because they contain components that may actually cause

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Shrinkback *(continued)*

Note: Verify that the source of the copper for the wire has not changed. In rare instances, changing the supplier of the copper has affected the adhesion quality, due in part to microscopic scratches on the copper or its surface chemistry.

D. Excessive Drawdown Ratio

- Try reducing the drawdown ratio.

E. Melt Temperature Too Low

- The foam extruder temperature profile is crucial for proper blowing and cell structure. Proper balance with conductor preheat and cooling is necessary.

F. Water Bath Too Close to Head or First Trough Too Cold

- The cooling rate is critical to avoid shrinkback. Look for shrink voids along the conductor. If shrink voids are present, try gradient cooling. The initial air space length and subsequent water trough temperature must be balanced with preheats and extruder profiles for proper cell structure and minimum shrinkback.

Note: If the problem is in cooling too fast, the physical properties (yield strength) of the insulated conductor probably test low.

G. Inadequate or Poorly Set Up Cooling Trough

- If shrink voids are present, check to see if line speeds have increased. To eliminate shrink voids, try the following:

G. Inadequate or Poorly Set Up Cooling Trough

- If shrink voids are present, check to see if line speeds have increased. To eliminate shrink voids, try the following:

a. Lower the line speed; if voids disappear, cooling is most likely the problem.
b. If hot water to the trough is available, put hot water in the first trough and try to establish a gradient cooling system.
c. If slowing the line speed is not an option, and hot water is not available, try turning off as much water to the trough as possible and still cool the product before it hits the bobbin. This procedure only verifies if voids disappear; if the product is still too hot when it gets on the bobbin, problems occur later. If the voids disappear, inadequate cooling is the problem.

H. Excessive Tension Causing Copper Drawdown (Improper String-Up?)

- If tension on the insulated conductor at any stage is high enough to break the adhesion between the conductor and insulation, shrinkback can occur, especially if the insulation is cooled too fast. This tension can

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Shrinkback *(continued)*

Additional Note:
With HDPE in particular, there have been instances where shrinkback after insulating passes, but fails after pairing. But strangely enough, if the product is jacketed, the product may pass shrinkback after the pairing step.
If the problem is not due to copper drawdown resulting from excessive tension, the shrinkback may be caused by improper cooling after extrusion. In this case, the jacketing step added more heat history and thereby relieved stresses. Two possible solutions are:

1. Lengthen the water trough and put hot water in the first two baths. (see G above)
2. Use a mixing screw, lower the temperature profile and use a 40/80/120 screen pack combination. By making these three adjustments, you are improving mixing in the extruder, so make other adjustments accordingly.

A test for improper cooling involves taking two adjacent samples of insulated wire before pairing and testing one for tensile and yield strength and elongation. Place the second sample in an oven at 100°C for two hours and then test this sample for tensile and yield strength. A significant (greater than 20%) increase in the yield strength of the oven-aged sample indicates that the product may have been cooled too quickly and the heat aging relieved the stresses, resulting in increased strength and elongation.

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