WHITE PAPER

INVESTIGATING SEALING ISSUES IN FLEXIBLE PACKAGING PRODUCTS

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Find out how to identify and resolve sealing problems associated with products made using polyethylene film
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A consumer's purchasing decision can be influenced by how a product looks, feels and is packaged. For many product types, packaging is integral to brand recognition and loyalty.

Consumers are embracing the novelty and convenience of flexible packaging, especially for foods and beverages.

Packaging lines have become more automated and now operate at higher speeds. These lines require the optimum combination of good design, effective maintenance and correct settings to ensure efficient operation.

The sealability of films made from polyethylene (PE) is also critical – so the film can run effectively and efficiently through the packaging line.

The sealing performance of a PE product will vary according to the resin used. Resin properties affect seal strength and hot tack performance.

The most common causes of sealing problems are discussed in this paper.

THE FLEXIBLE PLASTIC PACKAGING INDUSTRY IS GROWING RAPIDLY AS CONSUMERS SWITCH TO SMALLER SERVING SIZES AND LIGHTER WEIGHT PACKAGING. IN THESE PACKAGING TYPES, SEALING IS A PIVOTAL PROCESS AND CAN MEAN THE DIFFERENCE BETWEEN THE END USER RECEIVING A GOOD QUALITY PRODUCT OR ONE WHERE THE PACKAGE HAS LEAKED, OR THE GOODS HAVE SPOILED.

In addition, packaging lines need to operate at maximum efficiency with minimal product wastage. Although the sealing process is largely automated, problems do sometimes develop. To maximise production uptime, it is important to identify, understand and rectify any sealing concerns as quickly as possible.

INVESTIGATING SEALING PROBLEMS

Investigating a sealing problem often involves running through a checklist of potential causes until the source is found. As the process is complex, the checklist can be long. Systematically gathering information can streamline the troubleshooting process.

Common questions to ask include:

- What does the problem look like? Some common types of seal defects include creases in the seal, product getting trapped in the seal, weak seals that peel easily, holes or thin spots appearing next to the seal.
- Which products are/aren't affected?
- Is the defect occurring on every seal or just a percentage of seals?
- On which production line is the problem occurring? Are there similar lines where it is not happening?
- When did the issue first arise?
- Is there a pattern or trend since the first occurrence? Has the issue varied over time?
- What steps have already been taken to investigate or solve the problem?

The answers to the above questions will help guide the action needed to resolve the issue. Based on experience, it is often best to look at the sealing process first.

IDENTIFYING ISSUES IN THE SEALING PROCESS

When a product film is not sealing as expected, there could be a fault with the sealing equipment or it could require some simple adjustments to the machine settings.

If creases are forming in the seal, check for any faults on the machine that may contribute to the film or bags not feeding correctly. Some examples include misalignment of rollers or other feeding equipment, or sticking rollers that do not rotate freely.

For other types of sealing problems, some of the more common machine faults include:

- Incorrect setting of sealing temperatures
- Sealing temperature readings that are incorrect due to a calibration error or other fault
- Incorrect setting of sealing time
- Incorrect setting of sealing pressure
- Sealing pressure incorrect due to a fault with the air supply or a solenoid valve
- Buildup of ink or other material on the sealing wire or bar
- Worn or damaged sealing wire or bar
- The Teflon coating (if used) may be worn or damaged
- Even if none of the above applies, it is recommended to try adjusting some of the sealing settings, such as increasing or decreasing the sealing time, or altering the sealing temperatures and observing the outcomes. These tests may solve the problem, and will also provide valuable information for troubleshooting. If the problem is not resolved after these tests and the packaging line equipment has been through a thorough maintenance program, the next step is to look at the film, as indicated in Figure 1.

IS THERE AN ISSUE WITH THE FILM?

If no faults have been found in the sealing process, and if changes to the sealing settings have been unsuccessful, then the next logical step is to look at the film or bags.

If the problem is a one-off problem (as opposed to an ongoing issue), then there may have been an error in the production of the film.

The following potential issues with the film may cause a problem with sealing:

- The film is too thick or too thin
- The thickness of the film is uneven, with thick or thin spots causing weak points
- An error made in extrusion resulting in the wrong mixture of resins being used
- If the film has been over treated during preparation for printing purposes using a corona discharge, the oxidation process could affect sealing
- If the film has multiple layers, it is worth checking whether the film may have been inverted, leaving the sealing layer in the wrong position

CHOOSING THE MOST SUITABLE POLYMER FOR EACH TYPE OF PROCESS

Typically, linear low density polyethylene (LLDPE) polymers blended with some low density polyethethylene (LDPE) are suitable for the type of flexible packaging that is used in many food and industrial packaging processes. If better sealing properties are required, metallocene linear low density polyethylene (mLLDPE) polymers offer higher performance.

Vertical form fill seal packaging processes require high performance resins. As the pack is filled while the seal is still hot, the polymer seal needs to support the load to avoid product falling through.

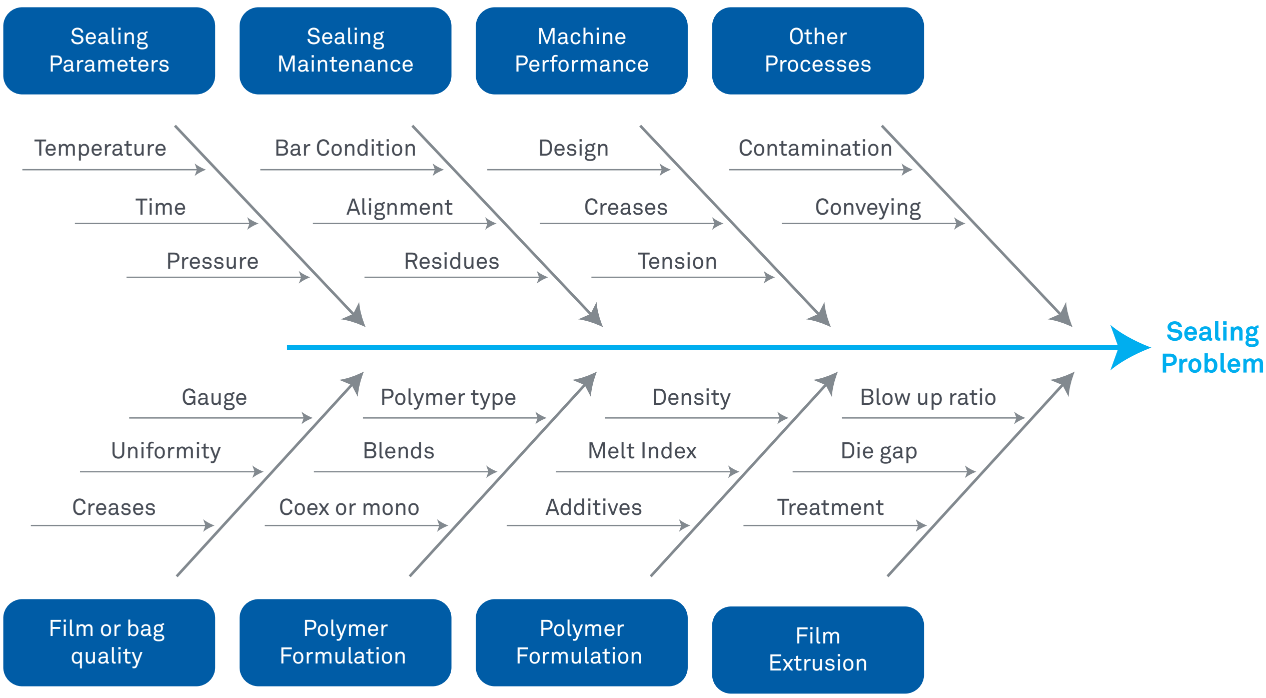

Figure 1. **Troubleshooting on-going sealing problems**

> SOLVING SEALING PROBLEMS QUICKLY WILL PREVENT BOTTLENECKING, DOWNTIME AND FAULTY PACKS REACHING THE CUSTOMER.

Operating temperature range

When sealing a PE film, it is important that the sealing temperature is set within the optimum operating temperature range of the specific combination of machine and film. Attempting to seal at a temperature below the operating range results in a weak seal.

Figure 2 shows the optimum operating temperature range for sealing a 50 mm LLDPE film and a 50 mm mLLDPE film in a hot jaw sealer. The chart shows that the average seal strength of both films increases with temperature until a steady maximum level is reached. At lower temperatures, up to 150°C, the average seal strength of both films is lower than the maximum seal strength. Also, sealing at these lower temperatures can lead to inconsistent results caused by minor variations in temperature or film thickness. To avoid weak seals or seal failures, the operating range needs to be set so the sealing process can accommodate such variations.

Figure 2 shows that the seal strength of the standard LLDPE film starts to be consistent at around 180°C whereas the mLLDPE film exhibits a consistently high seal strength from 160°C.

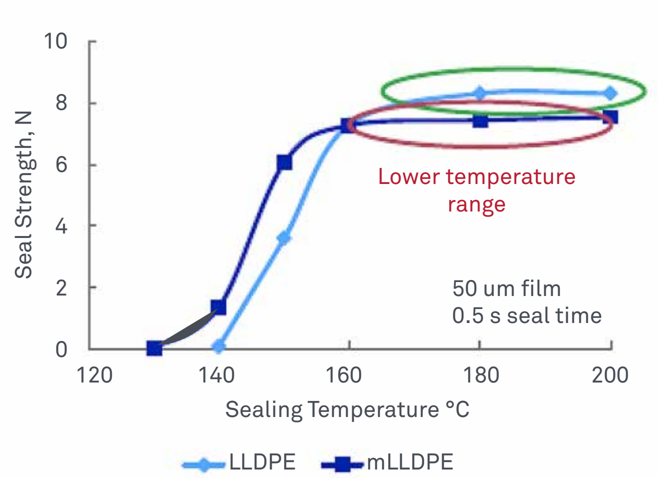

Figure 2. **Sealing curves for LLDPE and mLLDPE using a hot jaw sealer**

The lower optimum sealing temperature range of advanced polymers such as mLLDPE means that a lower temperature or a shorter sealing time can be applied during the sealing process. Either way, mLLDPE polymers can lead to lower machine-operating costs.

Hot tack strength

For vertical form fill sealing machines, the hot tack test is a more useful test as it simulates the actual packaging process of dropping a product onto a newly formed seal. The results of a hot tack strength test for a 50 mm LLDPE film and a 50 mm mLLDPE film (Figure 3) show that mLLDPE has higher melt strength and much wider operating range compared to LLDPE.

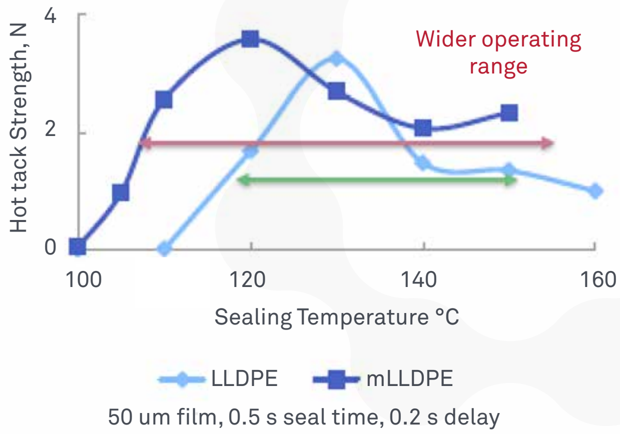

Figure 3. **Hot tack strength test of LLDPE and mLLDPE polymers**

Effect of corona treatment on sealing properties

Oxidation of the polymer by corona treatment assists the adhesion of printing inks and lamination adhesives. However, polymer cross-linking is a side-effect of corona treatment that reduces the flow and entanglement of the polymer. As shown in Figure 4, the hot tack and sealing temperature properties of polymers are affected by corona treatment of the sealing surface. These effects can be minimised by controlling the level of treatment or using strip treatment as an alternative method. It is not recommended to seal two treated surfaces together.

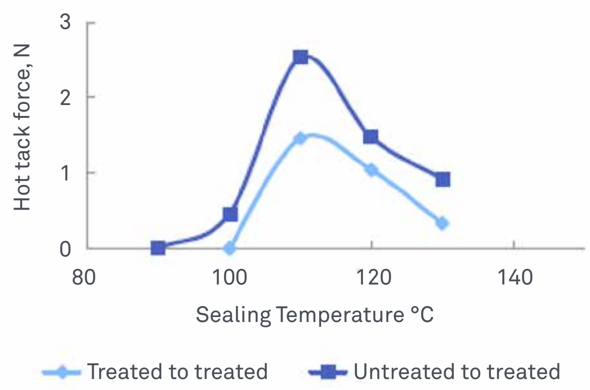

Figure 4. **Effects of corona treatment on sealing. Attempting to seal two treated surfaces to each other results in lower hot tack strength and a narrow sealing temperature range.**

Creasing and film thickness

Creasing causes many sealing weaknesses and failures, as the additional layers of film formed by a crease are more difficult to seal. Generally, stiffer films are less prone to forming creases during extrusion and converting, although the optimum stiffness will depend on the equipment. In some cases, polymers with a higher Melt Flow Index (MFI) will help seal through the creases as they are able to flow more easily.

Other film variables include film thickness. Heavier gauge film requires a higher sealing temperature or a longer sealing time than a thinner film.

TROUBLESHOOTING AN ACTUAL SEAL FAILURE

During initial trials of a new food-packaging operation, the processor noticed that most packs were not sealing. As indicated in Figures 5 and 6, a visual inspection of the seal failures suggested a major problem.

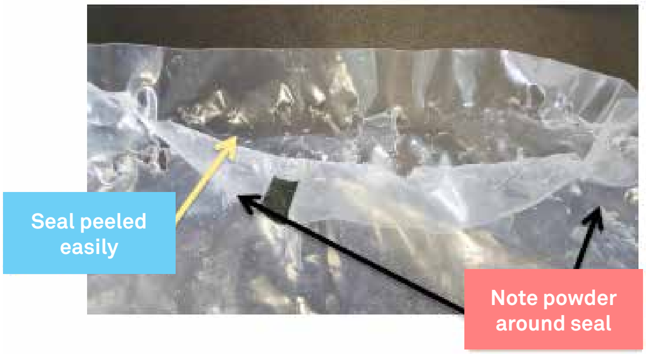

Figure 5. Seal failure in many seals due to peeling, particularly where powder was observed.

Seal failure due to peeling indicates poor polymer entanglement across the seal. The normal corrective action is to increase the sealing temperature. Figure 6 shows the result when the sealing temperature was raised. The film layers formed a strong seal, but the higher temperatures caused the film at the edges of the seal to become so thin and weak that the film tore.

Figure 6. Thin and torn edges adjacent to the strong seal indicate excessive temperature in sealing, particularly in areas where little powder was observed.

All attempts to adjust the sealing process failed to produce consistent seals. It was likely that the presence of powder (from the product being packaged) around the sealing area was affecting the sealing process, especially as the quantity of powder varied.

To overcome this problem, the packaging machine was redesigned to prevent powder forming in the sealing area.

TROUBLESHOOTING A SEALING PROBLEM WITH HDPE BAGS

A problem with seals peeling open was discovered during a packaging operation using HDPE bags.

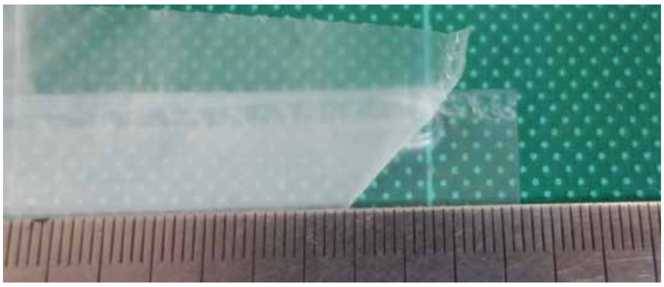

Figure 7. Seal failure of a HDPE bag

The cause of the issue illustrated in Figure 7 needed to be found quickly to prevent bottlenecking, downtime and faulty packs reaching the customer. Investigating the cause of the sealing problem provided the following information:

- The faulty seals were limited to a single batch of film, so the film producer became involved
- The most common film errors (gauge, uniformity, creases, and treatment) were checked and eliminated by the film producer
- It was suggested that an incorrect polymer may have been used in the film, perhaps due to human error in the extrusion process

The resin supplier tested the film for the film extruder using Differential Scanning Calorimetry (DSC) and compared the results to data obtained for a standard film that sealed well.

The DSC results confirmed that an incorrect grade of HDPE had been used in the film. The melting curves from the DSC tests (Figure 8) showed very different melting profiles for the two HDPE film samples, which is strong evidence that the films were made from different grade polymers. The DSC curves also explain the different sealing behaviours of the two films. The standard film was almost completely melted by 138°C (Figure 8, bottom), whereas a significant proportion of the polymer in the film that did not seal well had not melted by 138°C, and required up to 144°C to melt (Figure 8, top).

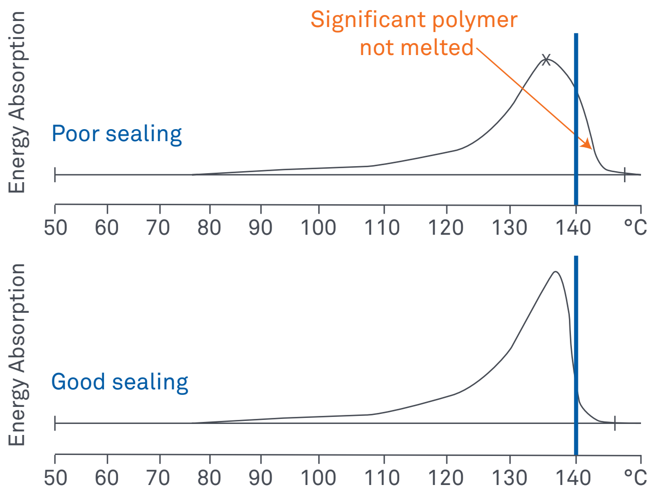

Figure 8. DSC curves show the amount of energy being used to melt the polymer over a temperature range. At any given temperature, a higher energy level indicates that more of the polymer is melting at that temperature.

HOW CAN THE RESIN SUPPLIER HELP?

Qenos is committed to helping the flexible plastic packaging industry produce high quality, suitable and reliable products.

Qenos offers a range of low density, linear low density, metallocene linear low density and high density polyethylene grades of resin designed for blown and cast film processes in single and multilayer structures. Qenos resin grades come in a variety of melt flow, density and additive packages tailored to suit specific processes and applications.

If sealing issues do arise, Qenos can help investigate and solve issues quickly and efficiently. The company has extensive lab and testing facilities, equipped with state-of-the-art equipment and instrumentation, and staffed by experienced technical service specialists.

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