CHAPTER 3

INTEGRITY FACTORS

Contamination of the processor's seal area is a major problem that affects the hermetic seal of the flexible pouch. Incorrect vacuum or improper pouch handling causes this problem. For liquid products, too high a vacuum could suck product into the seal area just before heat sealing which could affect the integrity of the seal. Also, improper handling of empty pouches on-line could result in contamination of the seal during filling (i.e., post-fill drip from an overhead filler spout).

Two of the major causes of pouch failure are improper filling and sealing. Sealing with a high order of reliability must be of primary concern to the processor. Fat and water contamination of seal areas seriously reduces seal strength reliability.

Incorrect handling of pouches during processing and post process could cause physical damage to the pouch and seal, which could weaken the seal or compromise the pouch hermeticity.

Thus, flexible pouch integrity factors are concentrated in three main areas of the process and are outlined in the following sections of this manual:

1. Improper filling can cause contamination of the seal area

    - post-fill drip on seal from filler spout
    - incorrect vacuum
    - overfilling

2. Improper sealing will compromise the integrity of the pouch

3. Improper handling during processing or post process can cause damage to pouch and seal.

3.1 POUCH FILLING

Filling pouches is a critical stage in the operation, since it is essential that the pouch be filled to the proper level with product and that the product never contacts the seal area. Overfilling the pouch must be avoided because it not only increases the potential of seal contamination and seal failure, but also could lead to underprocessing due to the greater thickness.

Product dripping from the filler nozzle after the pouch has been filled is a potential seal contamination problem that must be prevented. The use of positive cut-off pumps, the removal of product drips from dispensing nozzles by blow-off or vacuum suck-back systems, and the use of moveable protective shields, which greatly reduce the chances of fouling the seal areas, are essential when fibrous foods or sauces containing particles are being packed.

In the seafood industry, smoked salmon and other fishery products are commonly hand filled into preformed pouches through a filling shield, which serves to prevent seal area contamination.

As each product has its own flow and particle size characteristics, detailed filler specifications aimed at eliminating seal area contamination are difficult to define. The following steps can be used as guidelines to minimise seal area contamination:

1. Fillers should be matched to product characteristics through actual filling tests. For example, although cake dough may resemble chicken loaf mix in apparent consistency, comparative tests showed that an auger filler with a sliding-tube nozzle worked better for the chicken loaf, while a gear pump (Creamy Package stuffer) with a rotary valve nozzle performed better for cake dough.

2. Nozzles should be designed with such features as:
   - ♦ circumferential suction holes on nozzle tips to suck back dripping product;
   - ♦ external suction rings; or
   - ♦ sheet-metal guards to physically prevent drippings from contaminating seal surfaces.

3. Bottom-to-top filling and no filling within a specified distance (e.g., 3.8-cm) of the top of the pouch should be specified.

4. Control over the configuration of the pouch opening should be assured by means of:
   - ♦ conveyor clamps on both leading and trailing pouch edges;
   - ♦ air-jet assistance to initiate opening; and

- external suction cups and/or spoonbill internal forming devices.

5. Controlled handling of filled pouches during and between operations will prevent contamination of the seal area.

6. Measures should be in place for the removal of residual package air to prevent splashing, especially with viscous products prone to air occlusion (i.e., sugar syrup and gravy). These measures include obvious care to avoid occluded air, control over the rate of air removal, and control over product fill temperature to prevent flashing.

As shown in figure 3.1, winged or formed guards that swing into the package opening can be used at the moment of filling to physically protect the inner seal from contamination.

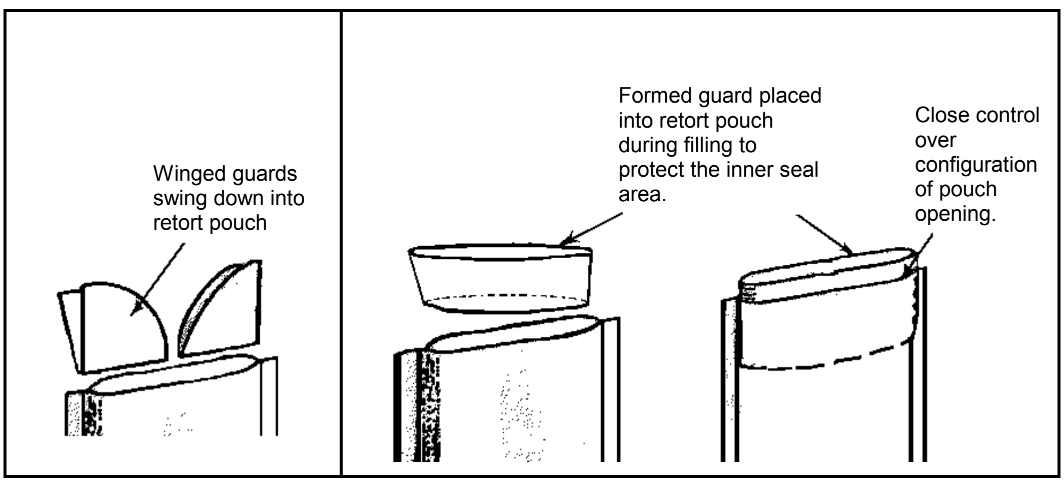

Figure 3.1 Two Styles of Guards for Filling Retort Pouches

3.2 EXHAUSTING THE FILLED POUCH

The control of the "air content" in the filled pouch, which includes any inert non-condensable gases such as carbon dioxide, is important. The residual air content in the sealed pouch could lead to excessive stressing of the seals during the thermal processing and could significantly affect the rate of heat transfer.

In some products the "air content" is purposely entrapped in the fill material for product texture development (i.e., bakery products). In solid products (such as unblanched meats) large amounts of gas are trapped in the tissues; also cold-filled sauces or liquids could release high volumes of non-condensable gases during the thermal process.

A producer may also backflush with an inert gas such as nitrogen. In the backflush procedure, the headspace gas must be controlled in order to remove oxygen, which will:

- extend shelf life
- protect package integrity, and
- promote uniform and predictable heat transfer.

The control of "air content" in retortable pouches must be defined as a critical process factor by the processor, if it will affect the scheduled thermal process. This is specified in the scheduled process as being the residual gas.

The product type will determine whether a vacuum sealer should be used. Some processors use steam tunnel atmosphere to complete the open, fill and seal operations. Whatever method is used, the processor must consider the factors that will result in a satisfactory final finished product. Rapid evacuation of the pouch could result in a failure to allow sufficient time for proper air removal. Rapid evacuation in a vacuum sealer will increase the chance of the seal area becoming contaminated, in products that are hot filled.

3.3 SEAL FORMATION

A hermetic seal is achieved in retortable pouches by the fusion of two heat-sealable layers (such as polypropylene) to each other. Types of sealing methods include:

- Contact sealer (hot bar or impulse)
- Induction (molecules become excited and heating is by conduction)
- Ultrasonic (sound waves excite the polymers to produce heat); and
- Dielectric (dielectric waves cause the polymers to re-align).

The most commonly used method is the contact sealer, either with the impulse sealer or the hot bar. The processor's seal is generally applied using one of these sealing devices, either within a vacuum chamber, or without a vacuum chamber, using steam injection to remove headspace air.

There are a number of prerequisites for achieving a good seal:

1. properly formed and undamaged pouches;

2. the absence of foreign materials in the sealing area of the pouch (e.g., product, oil);

3. the proper placement of the pouches within the jaws of the sealing machine;

4. flat, smooth and parallel sealing surfaces;

5. miscellaneous factors that can affect the hermetic seal such as:

    - the temperature of fusion;
    - the pressure created by the sealing tool holding the pieces together;
    - the dwell time of the sealing tool holding the pieces together;
    - sealing material compatibility; and
    - seal area contamination and the condition of the sealing surface.[12]

Heat-sealing temperatures must fall within the specifications provided by the laminate manufacturer. If the sealing surface is too hot, the polyester may delaminate from the foil[12]. Different polymers will melt and seal at different temperatures depending on the polymer's molecular weight and elemental constitution. The most desirable polymer is one with a wide temperature range. Sealing temperature can be affected by the thermal conductivity of the sealing jaws, air or gas in the container head space, and the presence or lack of a container head space. A lower temperature of sealing may sometimes be compensated for by increasing pressure and dwell time at the sealing jaws.[12] Other factors which might be taken into consideration in forming a proper seal are the room and pouch temperature and the humidity.

An acceptable seal is one where it is impossible to distinguish the individual surfaces after tensioning a welded seal to the point of failure. The bond between the sealing layers should be stronger than the bond between the layers of the laminates. The opposing surfaces must form a total weld. A performance standard on weld strength must be established for every type of package[13].

The presence of contaminants like moisture, oil or other food particles can contaminate the seal area and seriously affect the seal weld. The presence of foreign material can cause voids or blisters to form within the seal as heat is applied, forming a visible depression as the seal cools. Voids or food particles may also form channels that permit the inclusion of bacteria. One proactive approach that has been devised to address some of these problems is to have sealing bars with curved surfaces that squeeze out some potential contaminants as they clamp onto the pouch.

Sealing surfaces must also be smooth, flat and parallel. Contamination of the sealing bar surface can create convolutions (refer to Chapter 7 - Contaminated Seal) or impressions on the outside surface of the sealed pouch. Seal width (as shown in figure 2.4) is an important factor.

3.3.1 Hot Bar Sealer

The "hot bar" has two sealing jaws that clamp down with pressure onto the pouch. These bars remain hot at all times and as a result it is sometimes hard to get even heating. It is advisable that a thermocouple be placed in the sealing bar, to independently measure the temperature at the sealing point.

It should be noted that the thermocouple reading (read from the control panel) might differ slightly from the actual temperature on the surface of the sealing bar. There can be a temperature gradient of several degrees between the thermocouple reading and the actual temperature on the sealing bar surface. The temperature on the sealing bar surface can be checked with a pyrometer and compared to the thermocouple reading on the control panel.

It is very important that the food processor knows exactly what the sealing bar surface temperature is and that this temperature is attained continually during production.

The processor should have specifications from the pouch supplier for sealing bar temperature, pressure and dwell time necessary to obtain a good seal. Using these specifications, it is important that the processor first validate the heat sealer by running several filled pouches through the sealer, followed by burst testing. During production, monitoring the sealing bar temperature, pressure and dwell-time and carrying out burst testing on a regular basis will demonstrate that the specifications are achieved on a continuous basis.

3.3.2 Impulse Sealer

The "impulse" sealer has two cold bars that come together under pressure. An electrical current is sent through the bar producing heat. The impulse sealer mechanism has many adjustable variables including dwell time and pressure.

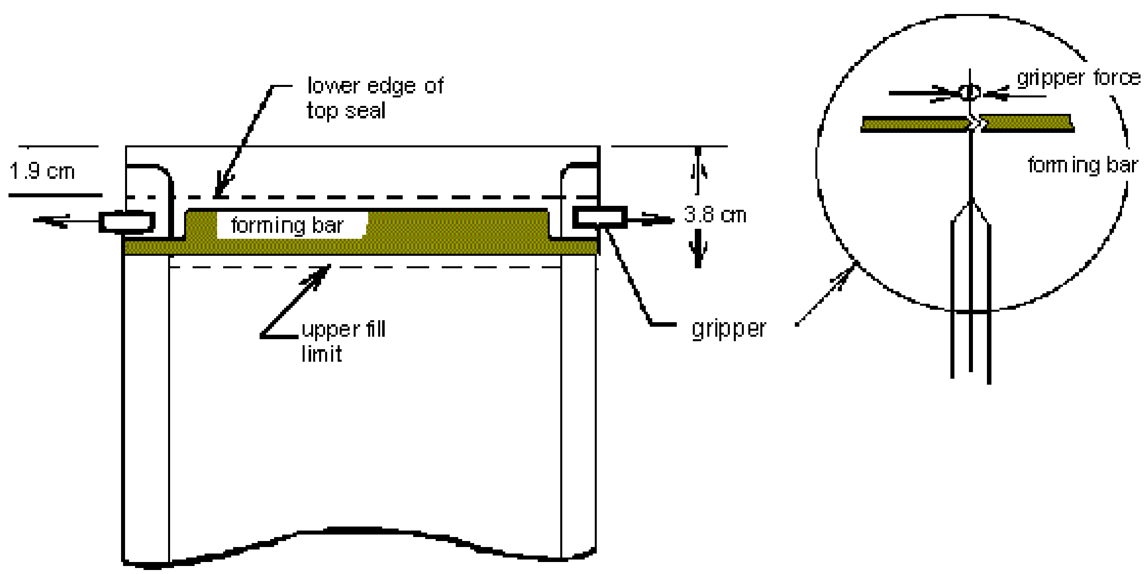

Figure 3.2 Design Criteria for Eliminating Top Seal Wrinkles
(From Lampi, 1976, "Performance and Integrity of Retort Pouch Seals")[13]

3.4 HANDLING OF CLOSED POUCHES

Original research has been carried out at various centres for retort pouches demonstrating the potential for re-contamination as a result of manual handling of the retort pouches[17]. Manual handling has been demonstrated to expose retort pouches to a food-poisoning hazard, in addition to a commercial spoilage risk. The processor must minimize manual handling as much as possible, recognising that the risk of re-contamination could result from either punctured or defective laminate or as a result of the seal failure. The Quality Management Program controls the sanitation procedures used by the processor during production. All equipment and surfaces contacting the pouches must not result in damage or abrasion to the pouch material.

Pouches should not be overlapped or touching while in the retort, or in other parts of the process. There is a high probability that pouch-to-pouch contact will create container defects, as the edges of the pouches are quite rigid and sharp. In the retort, pouches should be held in separate compartments that will restrain them and prevent incidental contact and the overlapping of the individual pouches, called "shingling". If the processor’s practice is to overlap the loose edges of the pouches during basket loading, the processor needs to be concerned that the product inside the pouches does not overlap, as this would impact on the maximum pouch thickness specified in the thermal process. Special dividers need to be provided, which would ensure that the specified pouch thickness could not be exceeded.

Retorts should also be kept clean of rust and scale. Rust and scale may drop onto the pouches and could cause container defects such as pin-holes and scratches.

3.5 POST-PROCESS POUCH HANDLING

The safe preservation of food in retort pouches is dependent on the ability of the sealed pouch to prevent re-infection by microorganisms leaking through the seals or the pouch body after the product has been heat processed. To minimise microbial contamination of the pouch's external surfaces, the processor should follow recognised sanitation requirements, dry the pouches and enclose them as quickly as possible in a protective outer-wrap.

3.5.1 Pouch Drying

Retort pouches should be properly dried after the thermal process to prevent re-infection by microorganisms leaking through the seals or pouch body. Minimizing the possibility of microbial contamination of the pouch's external surfaces can be accomplished through post-process control procedures, adequate drying of the individual retort pouches and enclosing the pouches in a protective outer-wrap as quickly as possible. Water left on the retort pouch presents a possibility that the water could reduce the strength of the permeable outer-wrap and leave watermarks or staining.

The product center temperature should be checked on a sample of pouches taken from various locations throughout the retort baskets. At the time the pouches are removed from the retort for subsequent handling/drying, the pouch temperature should be cooled to an internal temperature of 110-140 ^{0}F[23] for subsequent air cooling and drying. This temperature is at the low end of the thermophilic range and thus reduces the possibility of spoilage by heat-resistant organisms.

Pouch drying is accomplished by utilising a combination of residual heat to promote evaporation, wetting agents in the retort cooling water, and mechanical dryers, air blowers or air knives to drive off the adhering water from the pouches.

3.5.2 Outer Wrapping

The retort pouch is punctured easily by sharp objects and is susceptible to flex cracking when subjected to repeated flexing and folding. Excess flexing of the pouches will fracture the foil film and pin-holes will allow oxygen to enter the container. Excessive vibration or movement of liquid during shipping can also cause flexing. Both of these problems can be minimised by the use of appropriate filling, sealing and handling equipment in the packing plant and by the use of a correctly-sized envelope or carton for over-packing each unit.

Proper over-packaging techniques must be assessed for each product and evaluated for durability and shipping exposure. Over-packing the flexible pouch in a rigid board container so that the container gives maximum support to all surfaces of the pouch gives good protection to the seal areas from impact, especially if the case is dropped.

Individual outer-wrap on each pouch is not considered essential for distribution of retail size retort pouches. Institutional sizes are normally packed in a high-quality protective carton that will properly restrain the pouch during distribution. Prior to packing in the carton each pouch should receive a final inspection. A product label should be affixed to the pouch.

It is recommended that final protective packaging be done at the primary processing plant. If final packaging is done elsewhere, extreme care should be taken in transportation of the pouches to the final packaging location. Personnel at the final packaging location should be adequately trained to inspect the pouches prior to packaging.

3.5.3 Transit Packaging

For retort pouches, various methods of transport and final distribution procedures are used. Specific requirements for the transit packaging will vary depending on the conditions that may be encountered. The following points are normally considered in the specification of the transit package:

1. The transit packaging should be able to provide protection to the individual retort pouch. It can be the protective carton as the outer case or a combination of the over-packing and the outer case. The transit packaging should be capable of supporting the weight of stacking and protecting the pouches from any handling abuse.

2. The heights for palletisation and stacking of the cases should be specified to minimise the risk of compressing the pouch contents and thereby stressing the seals.

The retort pouches should not be subjected to temperature extremes during storage and transportation. At low temperatures there may be a danger of reduced flex-crack resistance and at higher temperatures there may be a danger of growth of thermophilic organisms which may have survived the thermal process. High humidity conditions may reduce the strength of the outer case.