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ADDRESSING PANEL SINK IN PLASTIC BOTTLES

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Panel sink in plastic bottles—the sidewalls of a bottle being sucked in and deformed—gives a product an unsightly appearance on the retail shelf and reflects negatively on the quality image of the brand owner. Labeling may also no longer adhere properly, or become loose or wrinkled. The result is a damaged brand image that reflects on both the quality of the product and the reputation of the brand owner, which can lead to loss of consumer confidence and sales, perhaps for an entire product line.

Panel sink is seen primarily on cylindrical bottles, and is the result of an increased pressure differential between the internal bottle contents and the surrounding environment. There are numerous causes for that differential, which makes it a universal concern for bottlers. However, there are also numerous ways to prevent it by varying the structural design of the bottle, the resin from which it is made or the way it is treated before it is filled. This paper will discuss all of these options.

CAUSES OF PANEL SINK

The fundamental causes of an increased pressure differential between a bottle's contents and the ambient atmosphere are a change in the volume of the contents of the bottle or a loss of gas and/or moisture through the bottle walls. The causes of these involve the pressure and temperature of the environment, the state of the product and the material from which the bottle is made.

Temperature And Atmospheric Changes

Products that are hot-filled, either to enhance flow properties or to control microbial growth, enter bottles at a temperature higher than ambient conditions. The bottle is usually capped immediately downstream of the filler, and as the product later cools the contents and/or the air in the headspace contract, creating a negative pressure within the bottle. As a result, the side panel is sucked in to compensate for the loss of product volume.

A significant change in pressure from filling location to storage location can also result in panel sink. If a bottle is filled at a high elevation (low atmospheric pressure) and then moved to a lower elevation (high atmospheric pressure) for storage, distribution or sale, the change in altitude will result in a pressure differential, causing panels to suck in.

Moisture Vapor Migration

Moisture vapor can also migrate through the walls of a bottle molded using a resin with a high Moisture Vapor Transmission Rate (MVTR), such as Polystyrene or Polycarbonate (PC). As with the earlier cases, as vapor passes through the wall, the volume of the contents is reduced and the bottle wall sucks in to compensate for that loss.

Manufacturing Issues

Sometimes bottle handling issues can become a factor in panel sink. If rails or clamps are used during filling, for example, they may be squeezing bottles too strongly just before capping, creating panel sink at that point which will increase if a pressure differential occurs later.

Likewise, if label application equipment applying pressure-sensitive or wrap labels exerts excessive pressure on the bottle walls during application, just before capping, side panels may be deformed. That can cause a defect that invites further panel sink.

During capping, the application of induction seals to a package combines with the closure to create an air-tight seal when applied properly. The presence of this air-tight seal, combined with any one of the conditions described above, will prevent any opportunity for pressure equalization. While not leading directly to panel sink, this condition exacerbates most of the above issues more than most of the seals created by using the closure alone.

Product Issues

Chemical incompatibility between the product being filled and the bottle's resin can result in a reaction that will compromise the integrity of the bottle by causing a weakening, softening, pitting, or other damage to the bottle walls. Over time, this incompatibility will manifest itself by causing panels to cave in. Any particular product can be packaged safely in one resin and not in another, and only testing will determine which will be compatible.

ACTIONS TO PREVENT PANEL SINK

The first solution that comes to most brand owners when the panel sink problem occurs is to increase the gram weight of the bottle, making the panel walls thicker and stronger. Unfortunately, doing this will usually add to the cost of the bottle (and to its transportation cost, because of increased weight) without having a significant effect on the problem.

Why not? Because adding volume does not necessarily add strength. If paneling is going to occur, it will invariably happen at the weakest place on the bottle, no matter how thick the bottle walls are overall, and adding material will not eliminate those weak spots. We have seen bottles with very thick walls suck in at their thinnest panel areas. Unless the bottle is a brick, a strong vacuum will inevitably find the weakest point in the panel walls.

The more effective alternative is to improve the structural integrity of the bottle walls. This can be accomplished either by slightly changing the shape of the bottle, from a straight cylinder shape to an hourglass or other shaped structure, or by adding ribs to the panel area. These can be either plain longitudinal ribs or annular ribs around the bottle perimeter or ribs incorporated into a design so they do not detract from the visual appeal of the bottle.

These design changes add structural strength by replacing flat areas with curved elements that resist the pressure. This solution enables a brand owner to overcome panel sink problems without incurring the cost of adding material to a bottle.

In regards to oxygen migration or moisture transmission through the walls, the pragmatic solution is to explore the barrier properties of the resin being used. If paneling is being caused by oxygen migration, choosing a resin with a high oxygen barrier capability, such as Polyethylene Terepthalate (PET) or Polyvinyl Chloride (PVC) will solve the problem. If the issue is moisture transmission, choosing resins with low MVTR, such as Polypropylene (PP) or Polyethylene (PE) will work.

After choosing the bottle resin, bottle molders should conduct elevated stability and compatibility studies in order to ensure there will be no adverse reactions between the product being bottled and bottle resins. Initially, this can be done theoretically by researching resin compatibilities with the product ingredient listing. But physical testing should be done for complete confidence that there will be no interaction.

Alternatively, many of these issues can also be rectified by fluorinating the bottles, which would keep both oxygen and moisture vapor from leaving the bottle. Fluorination also reduces chemical permeation, weight loss, odor emission and flavor or fragrance loss. The process exposes the surfaces of plastics and other materials to elemental fluorine. Hydrogen atoms on the exposed surfaces are replaced with fluorine atoms, creating a permanent fluorocarbon barrier on all exposed surfaces. Fluorination also changes the bottle surface to enhance wettability, leading to improved labeling for both pressure-sensitive and silk screen printed labels.

Another simple solution to panel sink is to explore the use of vented liners to equalize pressure between the inside and outside of the container. These liners allow gas and moisture to pass in or out of the container. This would seem to be an ideal solution for the brand owner bottling product at a high altitude and then shipping it to distribution at lower levels.

However, it is very important to select the correct liner for each application, as all vented liners are not created equal. It is also critical, when relying on vented liners, to ensure that caps are not being re-tightened after the induction seal process, as this will tighten the cap against the neck land and prevent gas ingress and egress, rendering the venting path ineffective. If applying induction (heat) seal liners with the venting option, the closure torque will back off slightly during the induction process, thereby resulting in lower removal torque values.

These structural and chemical changes are the most effective ways to eliminate panel sink. Each adds cost to the bottle, but pays for itself by eliminating a problem that can reduce revenue by weakening consumer confidence in a product. Those cases of panel sink due to handling operations during filling require a different set of solutions. Bottlers should also review their manufacturing and production processes for any possible mechanical situations that may be causing panel compression. These include any areas were the bottle is held in place during filling or where the rails are squeezing the bottle as it is being capped; labeling areas, such as the application of pressure sensitive labels, if done before capping; and shrink-sleeve label application that may be using excessive heat, resulting in bottle paneling. Given this range of solutions, there is no reason that a panel sink problem cannot be solved quickly and cost-effectively, with no lasting damage to a brand image or loss of consumer confidence in a product.

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