Apple Rubber

CASE STUDY

How Are Your Seals Affecting Your Brew?

The Problem

Rubber o-rings, sanitary gaskets and tri-clamp gaskets are widely used in food, beverage and medical processing plants. In the brewing industry, certain rubber formulations can change the taste of different types of craft beer.

The Solution

Apple Rubber tested five common FDA compliant materials with five different craft brews to find out which o-rings were best for brewing. Our intended outcome was to:

- Identify which rubber compounds result in the lowest volume swell after immersion in different craft beers
- Verify if any ingredients that migrate out after immersion will affect the taste of the beer

Background of Rubber O-Rings

Any time you use rubber in a critical process, the rubber should not change or affect the product. In these situations, not only should proper sealing materials be utilized, but rubber formulation should also be considered to ensure the o-ring does not react with or change the product.

Rubber formulations are made up of:

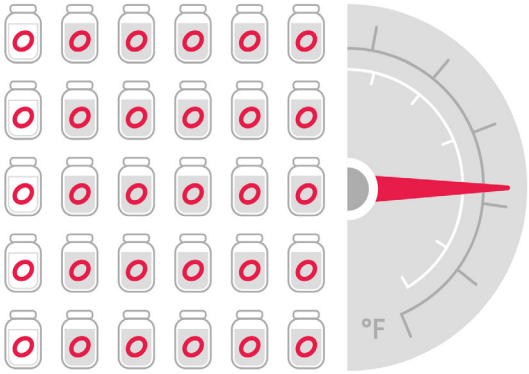
- Polymers
- Fillers
- Plasticizers
- Antioxidants
- Cures

Each of these formulations can bleed out and change the fluid the rubber intended to seal. In typical industrial applications, the small extraction into a hydraulic fluid will not affect the overall process. For critical processes, such as food and beverage production, small extraction can have a large effect. For example, curing systems that use peroxide can cause additional reactions to chemical processing, and plasticizers can get extracted out by solvents and change color and taste.

Most countries have come up with a list of chemicals that are allowed to be in contact with food or beverages. The USA uses FDA 21 CFR 177.2600, Germany uses KTW and EU uses EC1935. These are the list of materials a rubber compound can use to build a rubber formulation for a food sealing application.

The Process

Five of our common FDA compliant materials were tested into five different craft brews. FDA compliant means that these elastomers are formulated using FDA whitelist ingredients, also known as 21 CFR 177.2600, which is a guideline for creating rubber articles for repeated use. We picked materials from a variety of different elastomer types.



The test materials we used were:

- Nitrile (32BN7AP)
- EPDM (53EP7AP)
- Fluorocarbon (27VT7AP)
- HCR silicone (13SL7SX)
- LSR (14SL7ML)

The LSR is a platinum-cured material, nitrile is sulfur cured, and EPDM, fluorocarbon and HCR silicone are all peroxide cured. In addition to the standard curing time of 10 minutes at 350°F, the silicones received a post-cure of 4 hours at 400°F and the fluorocarbon received a post-cure of 4 hours at 480°F. Post curing is generally done to increase the material's physical properties and strengthen their resistance to taking a compression set, which is typically the most desired property of seal material.

For craft beer, we also tried to pick from different styles to get a broader understanding of how differences in these brews might affect the elastomers. To represent common light and dark styles, we chose:

- Ellicottville Brewing Companies Ellicottville IPA
- Southern Tier's Double Milk Stout
- Great Lakes Dortmunder Gold Lager

We also chose MackJac Hard Cider Black Currant Passion and Westbrook Brewing Co. Gose specifically because ciders and sours tend to have a higher acidity to them, which is very important when looking into seal materials.

Testing Seal Compatibility

To test seal compatibility with the different brews, we submerged test pieces at 37°F and 194°F for 168 hours and measured the volume swell of the material. In the rubber sealing, volume swell is used as a general indicator of how resistant a material is to a given fluid. Higher swell means much more fluid has worked its way into a material, weakening it and destroying the integrity of the elastomer. Another potential outcome is a negative swell. In this case, the fluid actually extracts something out of the rubber, which is undesirable for two reasons:

- The extracted chemicals end up in the brew that was being created which may affect the taste
- Due to that same extraction, the seal would shrink in size

This could potentially lead to a loss of compression on the seal and the creation of leaks as an o-ring or gasket retracts from the materials it was supposed to seal. It is possible to get both extraction and a positive swell overall in an incompatible material.

Taste Testing

Taste-testing was something we had been both looking forward to and slightly dreading. 30 mason jars were numbered and used to test each material in all five beverages and in tap water, which would act as a neutral and hopefully easier to detect taste in. After 168 Hours at 37°F, the test specimens were removed from the jars. The jars were then resealed so that our taste testers would be blind to the specific tests of each jar. Unexposed drinks were provided so that any taste differences from the original specimen could be derived.

Throughout this taste test, there were some mixed opinions on certain materials and an overwhelming agreement on the negative effects of others. As an observation, it seemed to be easier for someone that preferred a particular style of beer to detect a potential subtle taste change. In contrast, the nitrile and EPDM changes to the taste were so strong that the changes could be smelled before anyone even tasted them, and only the bravest of our testers were willing actually to try them.

As an extra test, we wanted to see if we could reduce or remove the effect of the rubber on the taste of beer. Given that the post-cured materials performed the best, we wanted to see if adding post-cure to the EPDM and nitrile could burn off any chemical that might be altering the taste of the beer. To achieve this, we took the 32BN7AP and the 53EP7AP and post-cured them for 4 hours at 300°F before retesting them for 168 hours at 37°F. The results were very promising, as there was no smell and almost no detectable change in the taste of the tap water.

32BN7AP uses sulfur and sulfur donors to vulcanize the rubber. Post-curing helps remove any un-consumed cures. The same goes for the peroxide cure EPDM–post curing reacts to any residual peroxide. The EU is getting away from sulfur cured materials for food and fluid contact. They also limit peroxides to a few types. In these cases, a taste test is also used for materials approved for contact with potable water.

The Key Takeaways

Looking at the overall volume swell data, the silicone materials were virtually unaffected by any of the brews. In our opinion, the only materials that performed poorly were the 32BN7AP material in high acidity sour beer and the 27VT7AP, which had a negative swell in the stout. The post-cured materials also performed the best when it came to the taste testing in the various brews and water. If you want a quality seal that isn't going to affect the flavor of your beer, silicone appears to be the best choice for your craft.

About Apple Rubber

For over 45 years, Apple Rubber has set the standard for quality, high-performing rubber o-rings. Today, as the leading designer and manufacturer of seals and sealing devices, Apple Rubber serves a wide range of industries around the world, from automotive and aerospace to pharmaceutical and medical. We offer the sealing industry's broadest range of products with an unparalleled range of in-house capabilities and services out of our Lancaster, NY facility.

Learn more about Apple Rubber's capabilities by visiting applerubber.com or armedicalseal.com for more information about medical seals.