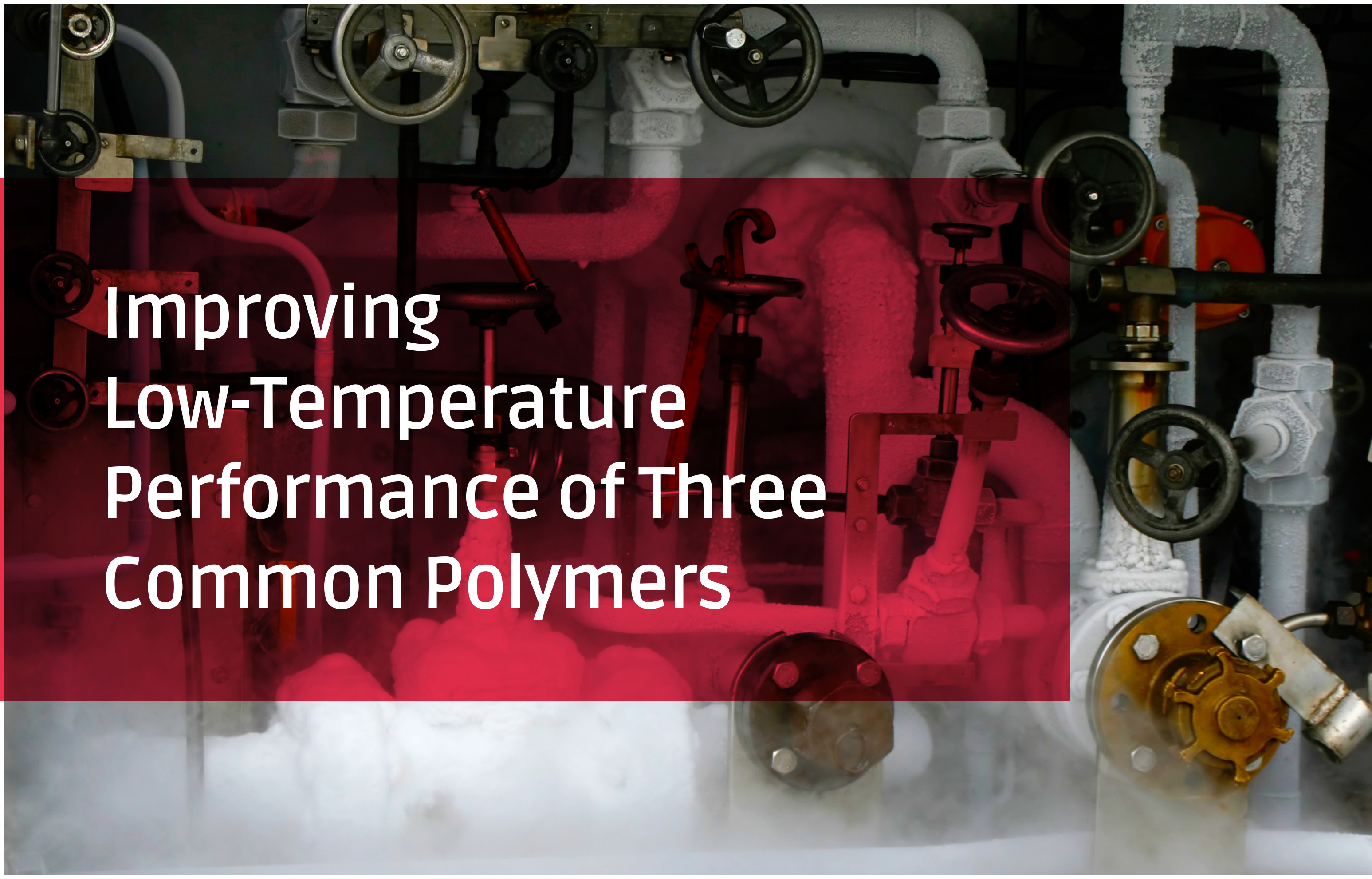
Apple Rubber

CASE STUDY



Improving Low-Temperature Performance of Three Common Polymers

The Problem

New applications are pushing the limits of low-temperature performance in standard rubber compounds. In most cases, formulation changes must be made to meet these new criteria.

For most rubber compounds as the temperature drops, the material begins to reach its glass transition temperature and the hardness of the rubber increases. We also see higher modulus or increased resistance to deformation. This can cause leakage for seal applications as the material is not deforming into the seal gland properly, which is a real problem for low-pressure applications.

The Solution

We took a closer look at three common polymers, Nitrile Rubber (NBR), Silicone (SL) and Fluorocarbon (FKM) to find ways to improve their performance at low temperatures.

Nitrile Rubber (NBR)

In an air braking system application for a rail car, a customer's industry requirements unexpectedly lowered from -30°C to -50°C. Since petroleum-based lubricants were present in this application, NBR o-rings were used, however the current compound contained a 33% acrylonitrile content (ACN).

For NBR compounds, the higher the ACN, the lower the volume swell in oil but the higher the glass transition temperature. Therefore, to meet lower temperature performance our compounders needed to change the ACN.

To improve low temperature performance, we used a base polymer of 23% ACN. ACN can range from 19% to 50%. To compensate for higher volume swell, we changed out the plasticizer that resists extraction. This allowed our customer's air valve to operate at a lower temperature while maintaining the same lubrication, and the polymer price was not affected.

Silicone (SL)

A well-known aerospace customer of Apple Rubber was using a standard dimethyl silicone that was rated to -65°C. During performance testing, they noticed that the flex strength was still too high at -65°C, and other durometers provided the same results. This was going to require the customer to replace the current motor with a higher force capability.

Our recommendation was to use a phenyl-based silicone. These silicones are rated down to -104°C. Typically, the polymer can be interchanged in compression molded formulation, but it would double the cost of the rubber. With Liquid Silicone Rubber (LSR), new tooling needed to be created, meaning that a new mold design and tool path was required. This is because phenyl-based LSR does not actually exist on it's own. Applying the phenyl-based silicone resulted in a lower torsional stiffness at -65°C and allowed the device to operate at lower forces.

Fluorocarbon (FKM)

A customer that produces sensors for oil field pipelines came to us for help. Since they primarily supplied to southern pipelines, low temperature performance was not a big concern for their sensor applications. When our customer wanted to increase their market share, they decided they needed to improve lower temperature performance of their sensor.

Their sensor application required a bisphenol cured standard FKM o-ring. These compounds are typically rated to -15°C for static applications. Moving to a low-temperature performance FKM base would change the polymer and cure system of the formulation. This change would then rate the compound to -40°C temperature performance. The new FKM compound would be cured with peroxide and have a slightly higher compression set. While the price of the new rubber compound would triple, the small size o-ring used for this application would not require a lot of material.

Additional Material Alterations

In some cases, a base polymer change will not meet requirements for an application and a completely different class of rubber may need to be used.

For example, if a customer is using silicone and needs to meet -65°C performance but now requires more oil and fuel resistance, they would need to change their material to a fluorosilicone to accommodate these requirements. We've also helped customers who have used EPDM rubber to seal a housing down to -40°C, but a new application requires a housing seal to resist oil. For advanced fuel resistance and ozone protection properties, we changed the housing seal material to HNBR.

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.