



NORA Technical Note
Nitrile Rubber and B20 Biodiesel Blends
March 2020

The purpose of this note is to provide updated technical information on the latest data evaluating the performance of nitrile rubber found in conventional U.S. heating oil equipment when using 20% biodiesel meeting today's stringent ASTM standards blended with 80% conventional petroleum-based No. 2 heating oil.

Introduction

Nitrile rubber is the material of choice for gaskets and O-rings used in conventional heating oil burner pumps in U.S. Some questions have been raised about nitrile rubber and its compatibility with biodiesel as some previous, older literature indicates nitrile rubber may not perform well when exposed to pure biodiesel (B100) or high biodiesel blends. Much of this previous testing was done with chemical grade methyl esters prior to the adoption of stringent ASTM specifications for pure biodiesel and B20 blends, so new data with fuel meeting today's standards was needed.

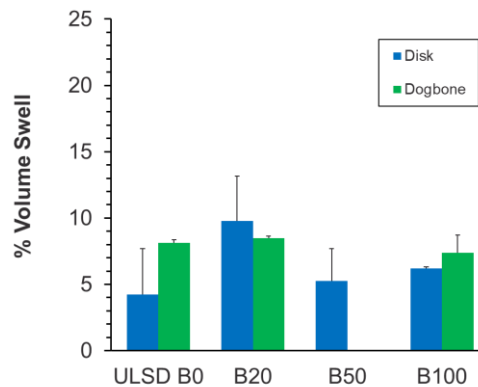
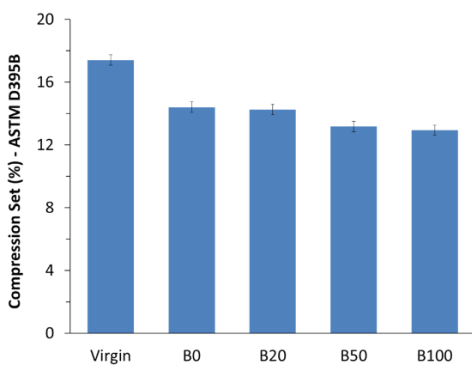
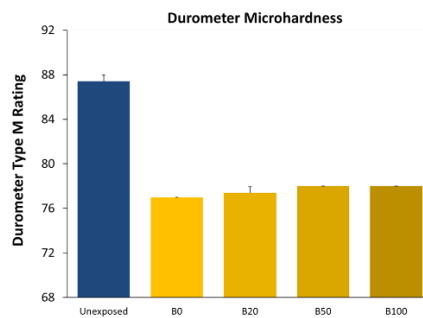
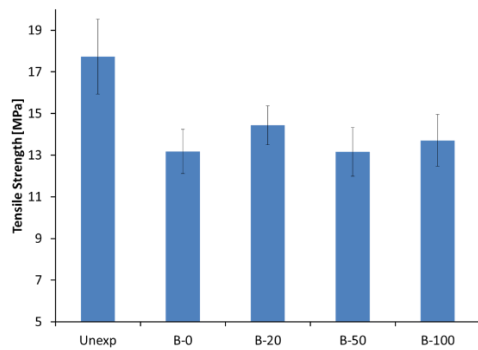
Nitrile rubber, also called Buna-N or NBR, is a copolymer constructed of acrylonitrile and butadiene monomers. The presence of the acrylonitrile monomer imparts permeation resistance characteristics to a wide variety of solvents and chemicals, while the butadiene component in the polymer contributes toward the flexibility. Like any given polymer, the mechanical properties and chemical resistance properties of nitrile rubber vary depending on the percentage of each monomer, reinforcement fillers, plasticizers, antioxidants, processing aids, cross-linking agents and other curing and manufacturing processes. Unfortunately, in much of the literature, the source and type of nitrile used in testing with biodiesel is not specified.

Nitrile rubber of the type found in common burner pumps in the U.S. was tested for various important elastomer properties (i.e. swell, tensile strength, elongation, ability to maintain its shape under compression, etc.) when exposed to biodiesel and biodiesel blends meeting today's stringent ASTM standards. These properties were compared to those when the nitrile rubber is exposed to conventional petroleum-based No. 2 oil. In addition, pumps were also cycled using petroleum No. 2 heating oil and blends of petroleum heating oil with 12% and 20% biodiesel for 7000 hours. The results, summarized below, showed the nitrile rubber gaskets and O-rings in common heating oil pumps and equipment in the U.S. perform the same or better than those exposed to conventional No. 2 heating oil.

Recent New Data on Nitrile Performance with B20.

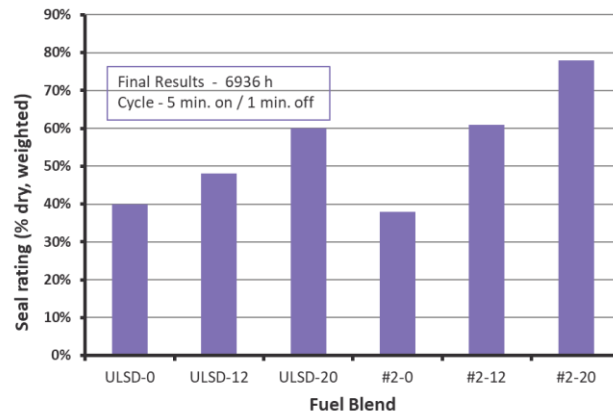
To understand the impact of today's biodiesel on elastomers in existing U.S. heating oil systems, Brookhaven National Laboratory (BNL) collaborated with Stony Brook University of New York (SUNY) to conduct standardized testing that is commonly used to evaluate gasket and seal material performance. The common nitrile material used in the vast majority of U.S. heating oil pumps was obtained from the manufacturer. The nitrile was soaked in No. 2 oil (B0) and various biodiesel blends (B20, B50, B100) for 670 hours at 125F, much harsher than the traditional elastomer testing which is done for 70 hours at room temperature. The soaked nitrile was evaluated for how much it will stretch without breaking (Tensile Strength), its hardness (Durometer Microhardness), its ability to bounce back after being compressed (Compression Set), and how much it swelled (Volume Swell).

The results can be seen below. In all cases, there was no appreciable difference in the elastomer properties between nitrile soaked for 670 hours at 125F in conventional No. 2 heating oil vs. the biodiesel blends, including the pure biodiesel (B100).



To confirm performance in actual operation, pumps representing the vast majority of those installed in the U.S. were run for 7000 hours using a 5 minute on / 1 minute off control cycle pattern with 12% (B12) and 20% (B20) biodiesel blended with both high and ultra-low sulfur conventional petroleum-based No. 2 heating oil. Seven (7) pumps were run using each fuel, and

the pumps were evaluated for small leaks throughout the 7000-hour period. The evaluation and grading criteria were developed in consultation with the pump manufacturer. Over the 6936 hours period, the seal performance improved using the B12 and B20 vs. both ULSD or high sulfur heating oil, with the B12 and B20 pumps showing less leakage. This data is corroborated by information from pumps in service, as surveys and reports from the field over the last 10 years have not indicated more leakage with B20 vs. No. 2 heating oil.



Some manufacturers are currently offering nitrile materials which they recommend for use with biodiesel. Atlantic Gasket Company offers a nitrile material for use with B20 and B100 [<https://www.atlanticgasket.com/gasket-manufacturing/types-of-gaskets/bio-diesel-grade-nitrile-60-spec.html>]. American Biltrite Company also offers nitrile material suitable for use with petroleum fuels and biodiesel [https://www.american-biltrite.com/rubber_us/ab-355/]. Sid Harvey's, a major heating equipment wholesaler, currently offers a B100 flexible fuel line made with hydrogenated nitrile rubber.

Conclusions

A significant amount of new testing data on nitrile performance in U.S. heating oil equipment with biodiesel meeting today's stringent ASTM standards is now available. This recent testing shows common nitrile elastomers in typical heating oil burner pumps in the U.S. perform the same or better using B20 than those using conventional No. 2 heating oil. The validity of this testing is supported by elastomer manufacturers marketing B-100 nitrile which could, if appropriate, be used by burner manufacturers.

For more information, contact the National Oilheat Research Alliance.