Northeast GAS ASSOCIATION

NYSEARCH

Technology Brief

Hydrogen Blend Impact on Elastomer Materials

Description: **Multiple phase project to understand how the physical properties of elastomers will change when introduced to a hydrogen and natural gas blends.**

Status: **Completing laboratory testing of SBR and NBR materials against varying gas compositions is ongoing.**

BENEFITS

As hydrogen/natural gas blends are being considered as an alternate fuel to be distributed through the existing natural gas infrastructure, whether there is a need to understand the performance of elastomeric materials in the presence of hydrogen. The results of this testing will provide a full understanding of the impact of hydrogen on critical infrastructure components. These results could factor into operational decisions regarding the use of blended hydrogen on existing LNG infrastructure and the push to use that infrastructure toward future decarbonization.

BACKGROUND

Previously, NYSEARCH members worked on a project performed by the Gas Technology Institute (GTI Energy) to determine the effects of gas interchangeability on components carrying elastomeric materials of the infrastructure such as couplings and diaphragms. Additionally, it determined the effects of mechanical properties on elastomeric materials under various pressure and temperature conditions. The impact of the higher-order hydrocarbons found in natural gas was studied systematically.

Results showed that the gas composition has a lesser effect on virgin restrained couplings than changes in temperature. For the field-extracted restrained couplings, the low temperature was the dominating factor for observed leaks and lean gas was the secondary contributor.

With that information, NYSEARCH developed a multi-phase project with GTI Energy to determine if blending hydrogen with pure methane will change the physical properties of these elastomers. The ongoing project currently has two phases. The first phase, which was completed in April 2021, focused on exploratory tests with a limited set of test gases at a single temperature on virgin Styrene-butadiene Rubber (SBR) and Nitrile-butadiene Rubber (NBR) elastomeric coupling materials to determine if hydrogen alone had an impact on the elastomeric materials. The data obtained in Phase I was used to plan more detailed and more extensive testing in Phase II.

Phase II is further developing the information obtained in Phase I by performing tests on field-extracted and virgin materials using a wider set of test gases, and temperatures. Additionally, a test will be conducted to determine if there are any effects with the presence of higher-order hydrocarbons found in natural gas blended with 20% hydrogen.

TECHNICAL APPROACH

The objective of this project is to determine whether the presence of hydrogen will change the physical properties of elastomers used as materials within the natural gas delivery system. Small test coupons were cut from the elastomer couplings using a die cutter. The cutter is designed to keep all the sides of the coupons as parallel as possible, minimizing data variables.

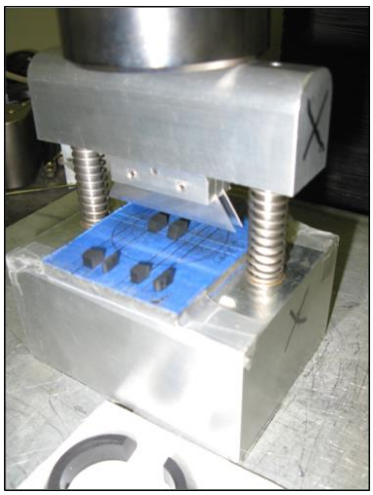

Figure 1: Die Cutting Machine

The exposure experiments were carried out at ambient laboratory temperature conditions and at a set pressure, under trickle-flowing gas using a high-pressure test chamber. Figure 2 shows the stainless-steel rack holding the coupons and the fully assembled pressure vessel.

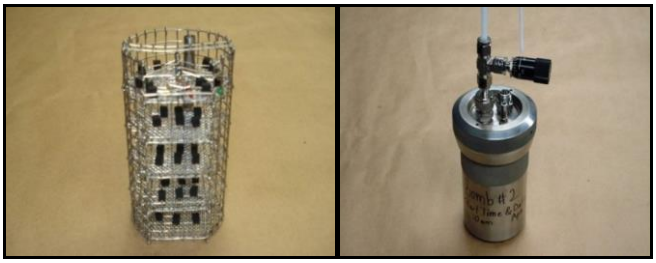

Figure 2: Coupon Test Vessel

The coupons were placed in this vessel and removed after specified times of the gas exposure and placed into a headspace vial for subsequent analysis where the hydrogen concentration was plotted versus the time to construct the saturation curve.

Using the time to saturation that was determined in Phase I, additional specimens of the materials were cut and subjected to further testing performed in a Thermo-mechanical Analyzer (TMA). This instrument, which was used in both phases of the project, performed (4) four tests: shrinking (dimensional change as temperature is lowered), swelling (dimensional change as temperature is raised), creep (change in dimension at constant force over a defined test period), and stress relaxation (change in load under constant displacement over a defined test period). After the TMA testing, all test coupons are undergoing Oxidative Induction Time (OIT) testing to assess if the presence of hydrogen changed the level of stabilization of the material under the presence of oxygen and if the material starts to burn.

The results of the testing is being assembled to detail the response from the set of elastomeric materials under limited operating conditions to the presence of hydrogen. The Final Report will document the actual test data results, analysis, discussions, and conclusions leading to the summary matrix/table so that utilities can better understand how materials will react to the presence of hydrogen in the natural gas pipeline.

PROGRAM STATUS

The testing of virgin NBR and SBR materials at 5%, 12%, 20%, and 30% hydrogen is complete. The testing for Phase II also expanded the temperature range to three points, 0°F, 60°F, and 120°F.

Testing of NBR and SBR field-extracted materials at the various hydrogen and pure methane blends are being performed. Additionally, the 20% hydrogen blended with simulated natural gas with higher-order hydrocarbons is being performed on virgin SBR. The results of the testing and a Final Report are expected in 2023.

Highlights

- Assess the impacts of Hydrogen/Natural Gas blends on virgin and field-extracted LDC infrastructure.
- Comprehensive results cover the range of operating conditions of interest to LDCs.

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