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 blend.**

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

BENEFITS

The results of the testing will be put together detailing 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 with the presence of hydrogen in the natural gas pipeline.

BACKGROUND

As gas supply in the United States gets increasingly diversified, the composition of the gas delivered through the distribution network to the end user is experiencing an increasingly greater variation. Distribution system components and end-use equipment have been designed and operated over the last decades based on a well-defined gas composition. Thus, the concern emerges regarding the impact of these diverse compositions on various parts of the existing LDC infrastructure.

From 2005 to 2016, NYSEARCH members funded a Gas Technology Institute (GTI) study 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 restrained couplings than a change 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.

As hydrogen/natural gas blends are being considered as an alternate fuel to be distributed through the existing natural gas infrastructure, there is a need to understand the performance of elastomeric materials in the presence of hydrogen.

TECHNICAL APPROACH

The objective of this project with GTI is to determine if blending hydrogen into a fuel gas will change the physical properties of elastomers used as materials of construction in a natural gas delivery system.

This project is designed to have multiple phases. Currently, two phases are in discussion. The first phase is a set of exploratory tests using a limited set of test gases on virgin Styrene-butadiene Rubber (SBR) and Nitrile-butadiene Rubber (NBR) elastomeric coupling materials. The data obtained in Phase I is being used to inform additional testing needs for a Phase II effort. Phase II is further developing the information obtained in Phase I by performing tests on field-extracted and virgin materials using an expanded set of test gases.

The first task of Phase I was to determine the time to saturation for hydrogen exposure for the selected test gases. Small test coupons were cut from the virgin coupling using a die cutter. This device is designed to keep all the sides of the coupons as parallel as possible, minimizing data variables.

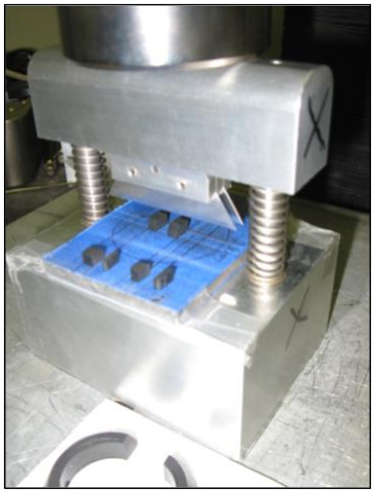

Figure 1: Die Cutting Machine

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 five level 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.

After the time to saturation was determined, additional specimens of the virgin materials were cut and subjected to further testing performed in a thermomechanical analyzer. This instrument 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). The goal is to determine hydrogen impact on the elastomer.

PROGRAM STATUS

In the preliminary analysis of Phase I testing the results showed the SBR elastomers deformed less when exposed to hydrogen, which was not surprising due to the softness of SBR elastomers. All of the testing is completed which includes baseline testing of specimens not exposed to a hydrogen blend and specimens exposed to 5% and 20% hydrogen blend. The results are being compiled into a report that will also provide the data in a reduced test summary matrix.

Based on the summary of results from Phase I, funders are deciding on the Phase II tasks. The scope and extent of the Phase II work will be determined based on number of vintage materials and gases tested.

Highlights

- Assess impacts of Hydrogen/Natural Gas blends on LDC infrastructure.
- Hydrogen/Natural Gas is considered an alternative fuel source.

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