Seal-Lok™ CNG

Bonfire Test Summary

Parker

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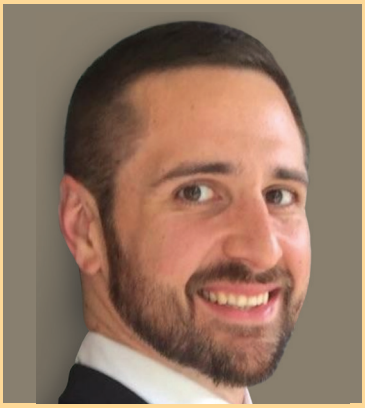

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Applications Engineer

John Holzheimer has worked in new product development as a Design Engineer for the past 8 years across multiple Parker Divisions. At the Tube Fitting Division, his primary focus is helping customers solve application-specific problems where fluid connections are made in industrial, mobile or transportation applications. John has his Bachelor of Science in Mechanical Engineering from the University of Dayton.

Overview

Natural Gas Vehicles (NGVs) must pass specific industry safety tests. One of these is a bonfire test, which is a requirement for the Pressure Relief Devices for pressurized CNG cylinders (or tanks). All CNG tanks have connections to tube or hose, many of which are made with Seal-Lok™ O-ring Face Seal technology. However, there are no specific bonfire test requirements for fittings and seals. Parker Seal-Lok CNG utilizes an elastomeric seal compound that is specially designed to address the needs of the natural gas market. The CNG compound is a hydrogenated nitrile which improves ozone resistance and supports wider temperature range requirements making it the ideal compound for CNG applications. Because Seal-Lok is used in these CNG applications, it was important for us to frist perform a bonfire test with our Seal-Lok fittings to ensure the product met critical safety requirements.

To determine how Seal-Lok CNG would perform if exposed to a fire, existing standards for CNG cylinders were utilized. The criteria for passing was defined using the most rigorous requirements from ANSI/CSA NGV 2 and CSA B51: samples pressurized to 3,600 psig and exposed to a minimum of 1,094 °F (590 °C) for 20 minutes. Parker used an outside testing facility, Southwest Research Institute's (SwRI) Fire Technology Department, to perform a series of tests according to the industry requirements.

Seal-Lok CNG passed the bonfire test. Passing the bonfire test confirms that Seal-Lok CNG meets the industry safety requirements for CNG components used in motor vehicles.

Requirements and Results

The SwRI Fire Technology Department performed a series of tests to evaluate the integrity of tube fitting assemblies when pressurized with CNG and exposed to a bonfire. Since there are no existing bonfire standards for fittings and seals, the bonfire standards for high pressure CNG cylinders were used. To qualify as passing the bonfire test, all seals had to maintain pressure for at least 20 minutes after being heated to a minimum of 1,094 °F (590 °C). The PASS criteria for this test was also based on the CNG cylinder standards previously mentioned.

The following sealing methods were covered: Seal-Lok CNG and SAE ORB port end (*see Figure 1*). All sealing methods passed the bonfire test as shown in the table to the right.

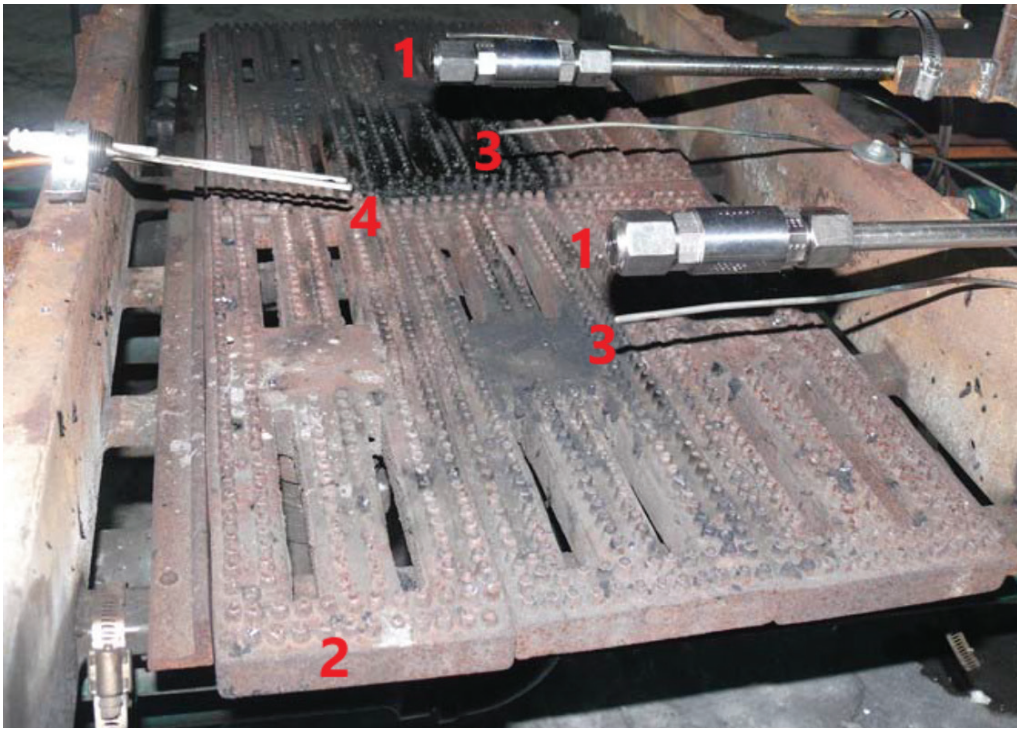
Part	Seal	Pass/Fail
8F5OLO	Seal-Lok CNG	Pass
	SAE ORB	Pass

Reference figure 1

Test Setup

Two samples of each Test Assembly (**1**) were secured 4 inches above the burner and tested imultaneously. Both samples were connected to the pressurization system which consisted of high pressure tubing, CNG supply (methane, nominal 98% purity), and an air-driven booster pump. A cross-section of each assembly can be found in *Figure 1*.

Each test assembly was pressurized to 3,600 psig with CNG and tested for leaks prior to turning on the burner. During the test, pressure was monitored and controlled remotely with a pressure transducer. A multi-stage valve system maintained the pressure at approximately 4,000 psig.



Test assembly setup, numbers defined in the article.

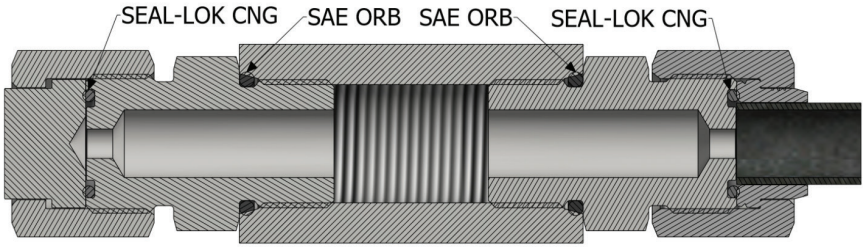


Figure 1 – Test Assembly 1

The burner (**2**) consisted of six separately controlled burner plates and had overall nominal dimensions of 14×24 inches. A distribution manifold with control valves and air intake adjustment was used to adjust the supply of propane to each burner plate. Two stainless steel-sheathed Type-K thermocouples (**3**) were secured 1 inch below the bottom surface of each sample to monitor flame temperature. A thermocouple of similar design was installed internally to the sample on the side of the burner opposite the test samples (**4**).

If pressure was maintained throughout the fire exposure (20 min), the samples were subjected to a rapid water-cooling test until the sample temperature was ≤392 °F (200 °C). The water-cooling test was performed using a 1 ½ inch fire hose with a spray/stream nozzle.

The nominal water flow rate was 50.8 gpm, with a nominal pressure of 35 psig immediately prior to the spray nozzle. The water pressure (dial gauge) and temperature (1/8 inch diameter thermocouple) at the water-cooling nozzle were monitored. A leak check was performed to identify if any leaks existed.

Results

The test plan was to expose the fittings to the bonfire for 30 minutes or until a leak was detected. Test assemblies were pressurized to 3,600 psig and leak checked prior to the start of each test. *Figure 2* depicts the time, temperature and pressure during the test.

An image of the sealing surface post-bonfire test can be seen in *Figure 3*. The left image shows the elastomeric compound was heat hardened after the exposure to the bonfire test. This was the expected failure mode for any elastomeric O-ring exposed to 1,094 °F (590 °C) for an extended time. The second image shows that even though the seal was heat hardened, the sealing integrity was maintained throughout the 20 minute exposure. This can be seen by the metallic colored ring, which is where the seal held contact with the flat metal surface.

A leak was eventually detected after 22 minutes of exposure. The leak was only seen on the SAE ORB coupling connection. Since the assembly held pressure for over 20 minutes of fire exposure and the integrity of the sealing surface was maintained, both fittings received a PASS for the bonfire test.

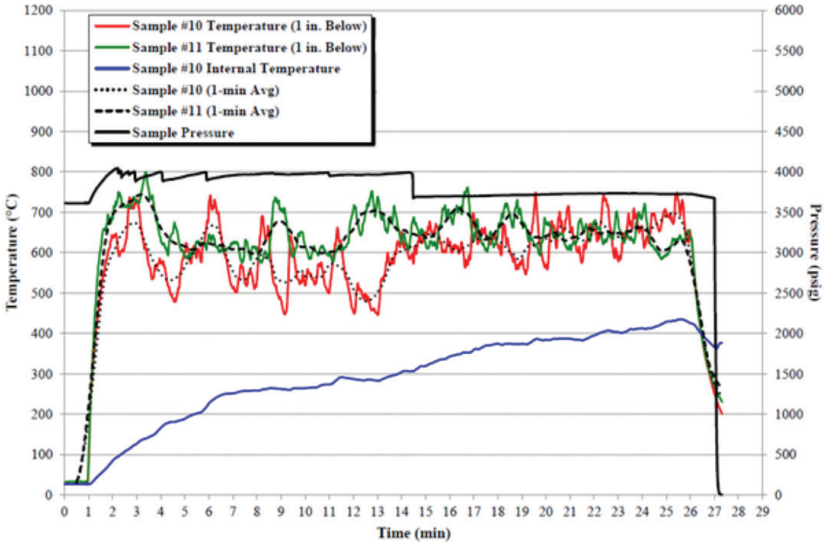


Figure 2 – Seal-Lok CNG

Figure 3 – Seal-Lok CNG after passing Bonfire Test

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