Propane Fuel Quality

Improvements through hose conditioning

Propane, the main component in liquefied petroleum gas (LPG), is widely recognized as a clean-burning fuel for a variety of applications, including vehicles. However, propane hoses used to transfer propane are one source of fuel contamination because of extractable materials released when exposed to propane. Studies in Europe, Australia, Japan, and North America indicate propane fuel contaminants are materials commonly used in the manufacture of propane hoses, which typically include plasticizers—see sidebar. Contaminants may be deposited in vaporizers of propane-fueled vehicles, causing poor engine performance and excessive tailpipe emissions.

Most materials, including rubber, are porous at a microscopic level, allowing liquids and gases to pass through via permeation. The permeation rate in LPG hose is controlled by internal pressure and hose construction. If the permeation rate is high enough, it may trigger failures in the Sealed Housing for Evaporative Determination (SHED) test, part of evaporative emission control test protocol and regulations. The SHED test consists of operating a vehicle inside a sealed chamber for a specified time to detect the level of hydrocarbon emissions.

Project Description:

In response to these issues, the Propane Education & Research Council (PERC) initiated a research effort, *Conditioning LP Gas (Propane) Hose Prior to Entering Service* (**Docket 11297**), to determine which contaminants are released from hose, the magnitude of contamination, and a method to treat hose prior to use that greatly reduces subsequent releases. Battelle Memorial Institute undertook this project, including:

- Conduct an international survey of published literature, industry practices and standards, and hose manufacturers with respect to extractable material or permeability of propane hose
- Measure the permeability of new propane hoses
- Determine the feasibility of conditioning propane hoses prior to use for transfer of propane fuel
- Devise a practical method for reducing LPG contamination that can be used by propane retailers or equipment distributors

Plasticizers Contaminate Propane Fuel

Plasticizers are manmade organic chemicals such as phthalates and fatty acid esters that are added to materials to increase flexibility, durability, and ease of use.

Plasticizers leached from propane hose are yellow oily deposits that are heavier than propane. They could accumulate in vaporizers, regulators, and in the bottom of storage containers, and may eventually compromise equipment performance. In engine applications, plasticizers may contribute significantly to the deposits in the vaporizer/converter.

Oily residue from test hose

Propane Refueling Station

Project Implementation

The primary objective of the project was to determine the merit of conditioning propane hoses prior to placing the hoses in service. "Conditioning" is defined as a procedure to reduce the extent of extraction of chemicals from the hose as a result of exposure to propane.

First, Batelle reviewed global studies of leaching and permeation, followed by a thorough assessment of global propane hose standards and practices. Based on this information, Battelle developed a model test protocol for hose and tested three-layer propane hose, which represents the most common type of hose used in the United States. Test variables included hose size, hose length, flow rate, time of exposure, type of contaminant, and LPG supplier. A dynamic testing system (to simulate flowing conditions) and a static testing system (to simulate stagnant conditions) were constructed and used for the testing.

Project Status

The project is complete.

Significant Results

- Plasticizers accounted for the majority of leached chemicals
- Most extraction occurs in the initial days of contact, but the extraction may continue (at an ever decreasing rate) for a considerable period of time (A Japanese study showed measurable extraction after three and a half years of in-service use)
- The hose manufacturer and model determine the chemical species extracted and the rate of extraction
- Propane lost through permeation depends on the hose materials and construction; to illustrate the typical loss through permeation, 125 feet of new bobtail delivery hose can lose about 2 oz LPG each day
- Although new nylon-lined hose was not tested, manufacturers claim that it meets CGA Type III specifications, is designed for use in propane-fueled engines, and greatly reduces both contaminants and permeation

Propane Hose Conditioning System: simple, quick, and cost effective

Battelle conceptualized, designed, and fabricated a prototype hose conditioning system to significantly reduce plasticizer leaching from new propane hose and verify operational feasibility of hose conditioning.

Conclusions

- Plasticizers are extracted from propane hoses in sufficient quantities that mitigation should be considered for applications where the presence of plasticizers would be detrimental
- Conditioning of hoses prior to service is technically feasible and can be accomplished in a relatively simple, and practical, single process
- The measured rate of propane loss through permeation for the hose that was tested was less than U.S. and international standards

More details can be found in the document, *Final Report to the Propane Education & Research Council (PERC) on an Assessment of the Merit of Conditioning LP Gas Hoses*, Battelle, (January 2005).

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For More Information:

Propane Education & Research Council
Gregory Kerr
Director of Research and Development
1140 Connecticut Avenue
Suite 1075
Washington, DC 20036
202-452-8975

www.propanecouncil.org
www.usepropane.com

Project Partner:

Battelle Memorial Institute
Rodney L. Osborne
Assoc. Mgr. of Applied Energy Systems
505 King Avenue
Columbus, OH 43201
614-424-4833