

POSITION STATEMENT

CLEANLINESS FOR PROTON EXCHANGE MEMBRANES HYDROGEN PIPING/COMPONENTS

Background

The Society of Automotive Engineers (SAE) requested that the Compressed Gas Association (CGA) provide cleaning requirements for equipment used in hydrogen vehicle fueling applications.

Presently, there is no United States or international standard that specifies a grade of hydrogen fuel acceptable for proton exchange membrane (PEM) fuel cell vehicles. As a result, a recommended list of constituents, which includes the stipulated chemical compounds as well as their maximum concentration levels in the hydrogen fuel, is not available. Since this is new technology, this purity requirement could change considerably over time and with technological improvements.

Nevertheless, fuel cell developers working with government-sponsored groups (e.g., California Fuel Cell Partnership [CaFCP], New Energy and Industrial Technology Development Organization [NEDO], Japan Automobile Research Institute [JARI], and U.S. Department of Energy [DOE] national laboratories) and universities are exploring the impact of impurities on PEM fuel cell performance.

Several groups have brought experimental data and analyses to SAE for consideration. Specifically, JARI has addressed hydrogen fuel quality for fuel cell vehicles based on results of experiments that measured the impact of selected impurities on a fuel cell. Fuel cell developers have brought information on specific contaminants such as carbon monoxide, sulfur, and halogenates into consideration.

Based on input from the fuel cell industry and input from energy and hydrogen suppliers, SAE developed SAE J2719, *Hydrogen Fuel Quality for Fuel Cell Vehicles*, which identifies hydrogen impurities of concern [1]. The proposed location for testing hydrogen supply systems for these impurities is at the transition between the station and the vehicle (at the dispenser/nozzle interface), which could range in temperature from -40 °F to 176 °F (-40 °C to 80 °C). These impurities of concern can adversely affect the fuel cell or hydrogen storage systems and ancillary devices on a vehicle and are in the following three categories of contaminate:

- **Gaseous impurities** (such as nitrogen, oxygen, helium, carbon monoxide, carbon dioxide, and many others) that are only present in the vapor phase;
- **Solid impurities** (such as dirt, metal filings, polymers, and other particulate materials) that can be introduced to the hydrogen supply system by improper cleaning techniques, poor standards of system installation, or decomposition (erosion) of materials of construction, valve seals, and components; and
- **Liquid and transitional impurities** (such as water, oils, and grease) that can be in liquid, solid, or gas phase in varying degrees depending upon temperature and pressure. These impurities can be present as condensed liquids, as vapor dissolved in the hydrogen, or carried as an aerosol in the sometimes high velocity hydrogen stream being delivered to a vehicle. Additionally, sodium- and potassium-based salts can be present as a solid particle or dissolved in water.

This position statement addresses the potential negative impact of impurities on PEM equipment and the steps that may be taken to manage the solid, liquid, and transitional impurities that can be introduced into a hydrogen supply system during the fabrication and installation of a hydrogen supply system.

This position statement does not address the cleanup of gaseous impurities or the need to keep components such as compressors in the hydrogen supply system from contaminating the system due to poor component selection or component degradation during system operation, although the station design shall consider these factors.

Question

Should CGA G-4.1, *Cleaning of Equipment for Oxygen Service*, be used as a guideline for cleaning hydrogen piping and components by those constructing hydrogen supply systems intended to comply with guidelines in SAE J2719 [2, 1]?

Answer

CGA recommends using CGA G-4.1 for cleaning hydrogen piping and components because components and piping that are cleaned, capped, and/or bagged for oxygen service are generally acceptable for use in hydrogen supply systems for PEMs [2].

To determine potential impurities associated with different cleaning methods, further studies shall be completed. Cleaning methods shall be evaluated for residual chemicals such as those in SAE J2719 (e.g., sulfur, formaldehyde, formic acid, ammonia, sodium, potassium, total halogenates, etc.) [1]. As this is an emerging technology, the list of impurities is not exhaustive and can evolve over time. The end user should specify allowed limits of impurities within the supply system.

Purging is an essential part of cleaning. Once the end product is clean, it should be fully dried with an inert gas. For drying and preliminary purging, the system should be purged with an inert gas such as nitrogen. The final purge should be completed with hydrogen once the system is fully piped and pressure tested.

Materials of construction for the supply system piping should also be considered as a source of contamination due to ion migration from the material to the product being delivered. Nonporous materials such as stainless steels provide the least opportunity for ion migration from the component to the supply system.

References

Unless otherwise specified, the latest edition shall apply.

[1] SAE J2719, *Hydrogen Fuel Quality for Fuel Cell Vehicles*, SAE Automotive Headquarters. www.sae.org

[2] CGA G-4.1, *Cleaning of Equipment for Oxygen Service*, Compressed Gas Association, Inc. www.cganet.com