Airborne Labs International

Hydrogen (H_2) Fuel Sampling & Testing Services

Airborne Labs International (ALI) offers passivated sampling equipment (rental or purchase), on-site sampling services and ISO-17025 accredited analytical testing of all gaseous or liquid grades of H_2 fuels. We can also evaluate the composition of various feed gas sources used for H_2 fuel production. Our comprehensive line of technical products, sampling & testing services can benefit H_2 producers, fuel station operators, regulatory agencies, vehicle & stationary appliance manufacturers.

H_2 Fuel Background – Fundamentals Part 1

High Pressure H_2 gas is being used as a fuel in a growing number of transportation and stationary appliance applications throughout the world. H_2 fuel based transportation applications include both fuel cell powered electric vehicles (FCEV) and internal combustion powered electric vehicles (ICEV). Both engine types are generally classified as "Compressed Hydrogen Surface Vehicles " (CHSV). The range of CHVS's currently in use around the world include cars, buses, trucks, forklifts and railroad engines. Stationary applications involving H_2 fuel often involve special back-up power generators.

The quality of H_2 fuel needed for these diverse applications is significantly different. FCEV's employing proton exchange membrane (PEM) fuel cells require the most demanding level of H_2 fuel Purity. H_2 fuel quality specifications for various H_2-fuel based applications are outlined in ISO 14687. This document defines 3 main "Types" (ex. gaseous, liquid, "slush" H_2 storage phases) plus various "Purity Grades within a Type" of H_2 for fuel producers that are application specific. For example, "Type I Grade A" gaseous H_2 fuel is appropriate for most ICEV's and residential / commercial appliance applications. For high H_2 purity demanding PEM FECV road vehicles Type I Grade D gaseous H_2 fuel quality is recommended.

For Type I Grade D H_2 fuel, ISO-14687-2 and SAE J 2719 (Surface Vehicle Standard) clearly identify the H_2 fuel impurity types and maximum limits allowed from H_2 fueling stations. These impurities are measured "at the fuel pump dispenser" to customer vehicles. Sampling methods such as ASTM D7606-11 are used to obtain a representative (gaseous) H_2 fuel sample. ASTM D7650-13 is used for trace particulate sampling. Both H35 (35 mPa / 350 bar / 5,000 psia) and H70 (70 mPa / 700 bar / 10,000 psia) vehicle pressure delivery class nozzles are typically involved.

This demanding H_2 fuel grade was generated based upon experience and knowledge of the potential damage that a specific impurity or contaminant could do to critical PEM fuel cell parts such as catalysts, electrodes, membranes, as well as negatively impact engine performance. A range of recommended ASTM analytical test methods are listed for the proper measurement of each impurity/contaminant. These ASTM methods include: D1945-14, D1946-90, D5454-11, D5504-12, D7651-10, D7653-10, D7675-15, D7892-15.

H_2 fuels are produced from a wide range of “feed gas” sources and generation / production processes. The Type 1 Grade D impurity specification takes into account basically all potential “feed gas source specific” impurities that could be introduced from any type of H_2 manufacturing process.

Examples of H_2 feed gas sources include:

– Natural gas - Coal Gasification – Ethanol – Methanol – Gasoline – Diesel – Biomass

“Reformation” type processes are used to chemically convert these hydrocarbon / carbonaceous feed sources into a liquefied H_2 product. Other reformation sources are envisioned in the future. These carbon-containing feed gas sources can potentially introduce H_2 fuel impurities such as light hydrocarbons, formaldehyde, formic acid, carbon monoxide (CO), carbon dioxide (CO_2), helium, nitrogen, oxygen, argon, volatile sulfur agents, ammonia, water vapor, and others.

H_2 fuel is also commercially produced using water (H_2O) as a feed stock via electrolysis at an electrode (cathode). For example: H_2O + electricity → H_2 + O.5 O_2. This commercial process involves several types of cell designs including: chloro-alkaline electrolytic cells (used for industrial Cl_2 production) or polymeric electrolytic membrane (PEM) cells. Various types of energy sources are used to generate the electrical current needed for electrolytic H_2 fuel production. For example, the power sources currently used for this electrical (non-carbon based = “Blue Hydrogen”) H_2 fuel production include: solar panels, wind turbines, hydro-turbines, electrical grid power, etc. Additional renewable power sources are envisioned in the future.

Electrolytic feed gas sources tend to contribute fewer H_2 fuel impurities than reformation-based sources. Their impurity profiles can include; water vapor, oxygen, inorganic acid gases, chlorine, halide anions, alkali metal cations (ex. if electrolyte salts are trapped within H_2O aerosol mists) and others.

Foreign impurities that can enter a H_2 fuel load through its transportation, storage & station delivery process are classified as “contaminants”. They include: air, water, particulates (ex. non-volatile residues such as dirt, wear metal, corrosion products, tramp oils), detergents, cleaning agents, halogenated cleaning solvents and others.

Of critical importance in many H_2 fuel-based applications (especially PEM type FECVs) are those impurities that can create expensive, irreversible damage to the fuel cell of an electrical engine. The most critical impurities / contaminants to monitor are volatile sulfur compounds (VSC’s), carbon monoxide (CO), ammonia (NH_3) and volatile halogenated compounds (VXC’s).

The maximum levels of many critical H_2 fuel impurities range from low ppm to low ppb v/v levels which is quite challenging to measure. Reliable confirmation of a desired H_2 fuel grade product requires the use of specialized, passivated sampling equipment, on-site testing for some highly reactive impurities, an array of highly sophisticated analytical instrumentation, appropriate test methods and ISO-17025 accredited laboratory facilities experienced in safely handling very high pressure (ex. 10,000 psig) H_2 gas.