BALLARD®

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Hydrogen Fuel Quality for Fuel Cell Buses

Hydrogen fuel cells are a clean, reliable, quiet, and efficient source of high-quality electric power. They use hydrogen as a fuel to drive an electrochemical process that produces electricity, with water and heat as the only by-products. The two main applications for hydrogen fuel cells are in stationary power sources and hydrogen fuel cell vehicles (FCVs).

The performances and durability of such a device are affected by the quality of the reactive gases. Depending on the way to produce and purify hydrogen, it can contain different kind of pollutants which impact the performances and the durability of PEMFC.

It was found that even trace amounts of impurities present in either fuel or air streams or fuel cell system components could severely poison the anode, membrane, and cathode, particularly at low-temperature operation, which resulted in dramatic performance drop. Significant progress has been made in identifying fuel cell contamination sources and understanding the effect of contaminants on performance through experimental, theoretical/modeling, and methodological approaches. Contamination affects three major elements of fuel cell performance: electrode kinetics, conductivity, and mass transfer.

Hydrogen is an abundant constituent element in water, biomass, and fossil hydrocarbons. The greenhouse gas intensity (and other environmental impacts) of hydrogen production depends on the sources and processes through which the hydrogen is derived. It can be extracted from water using electrolysis, using power from renewable solar or wind, nuclear energy, or fossil energy. It can be extracted from renewable biomass or coal using high temperature gasification. Or, using chemical catalysts, it can be derived from renewable biogas, renewable ethanol or methanol, or fossil natural gas. Today, most hydrogen is derived from fossil natural gas.

Water electrolysis and natural gas reforming are the technologies of choice in the current and near term. They are proven technologies that can be used in the early phases of building a hydrogen infrastructure for the transport sector.

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Steam Methane Reforming is most likely to provide the Synthesis Gas with the lowest complexity concerning composition and impurities. It typically has lower inert gas content than other processes involving hydrocarbons.

Hydrogen production from water electrolysis is leading to rather pure hydrogen with the main contaminants being oxygen and water. Water electrolysis is a process which can be used centrally and decentralized. The cost of hydrogen is strongly influenced by the electricity cost.
Recent studies showed the suitability of hydrogen produced from water electrolysis for use in PEM fuel cells.
Electrolyser systems include an hydrogen purification system which is capable of ensuring the output hydrogen complies with ISO 14687-2:2012, and meets the requirements given for refuelling fuel cell vehicles.
The purification system is designed to remove these impurities to levels of <5ppm(v) water and <5ppm(v) oxygen.
The hydrogen purification system is part of the electrolyser container.

By-product hydrogen from chemical processes can be used. Depending on the origin, the gas quality is similar to water electrolysis but additional purification might be needed and controlled.

The Society of Automotive Engineers (SAE) has developed a specification "Hydrogen Fuel Quality for Fuel Cell Vehicles", for hydrogen intended for use in a PEM fuel cell in a motor vehicle, SAE J2719. The specification was generated to identify impurities that could occur with various hydrogen generation methods and within filling station systems and define limits for these impurities based on acceptable long-term fuel cell performance. This same specification has been adopted internationally by the International Standards Organization (ISO).

Owners and operators may have to control fuel quality at the interface between the dispensing station and the vehicle.
In many cases, contamination resulting from maintenance actions will be depleted; owners/operators may elect to perform special measurements after maintenance activities to ensure that such events do not occur. Ultimately, the frequency and magnitude of fuel quality testing should be established by the station owners/operators and regulatory authorities to meet their needs.