Ammonia-Hydride Hydrogen Generator for Portable Fuel Cell Power Systems

- J. Schmidt (Ball Aerospace & Technologies Corp.), F. Lynch (Hydrogen Components, Inc.), J. Wilkes (United States Air Force Academy), R. Lucero (Ball Aerospace & Technologies Corp.), and R. Vaughn (United States Air Force Academy)

The objective of the ammonia-hydride hydrogen generator project was to design and develop a lightweight hydrogen (H_2) generator, with high specific energy density. Primary use of the generator would be to provide fuel for small portable fuel cell power systems. This generator is based on the reaction of anhydrous ammonia (NH_3) with lithium-aluminum tetrahydride ($LiAlH_4$), a process that is generically known as "ammonolysis." Unlike hydrolysis-based systems, the reaction of ammonia and lithium-aluminum tetrahydride is prompt at sub-zero temperatures, which allows for hydrogen generation in cold environments.

The best engineering-scale test results of this program showed a hydrogen yield of 6.7% of reactant mass—just over half of the theoretical maximum. Overall system yields approaching 4% have been demonstrated.

These ammonia-hydride hydrogen generators may be used with a variety of fuel cell sizes. They are self-regulating and able to generate hydrogen to follow varying electrical generation demands from the fuel cell. The present design is capable of generating up to about 1 standard liter per minute H_2 (~100W fuel cell). This design is also flexible in terms of scaling the H_2 generation capacity up or down.

Advantages of the ammonia-hydride hydrogen generator are compactness and simplicity of operation and safety relative to the alternatives.