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Ammonia as Hydrogen Source for an Alkaline Fuel Cell–Battery Hybrid System

by
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The biggest obstacle to commercialize Fuel Cells is the supply of hydrogen to fuel cell systems on a world wide basis. A very realistic way is the use of Ammonia. It is globally available and needed for supplying the fertilizer industry. The production actually grows with the world population. (1980: 70 Million tons/Yr., Population: 3.3 Billions, 2000: 105 Millions tons/Yr., Population: 5.5 Billions.) Ammonia can be efficiently produced from renewable energy sources (Water-, Solar-, Wind- and Nuclear Energy) via electrolysis, therefore (the present) way of producing it from fossil fuels (mainly from natural gas) can be reduced in steps and the CO_2 problem (Global warming) minimized. Ammonia is transported in insulated tanks in up to 50000 tons per vessels.

For smaller users (ice skating rinks) liquid Ammonia is transported in low pressure tanks. Hundreds of Millions of refrigerators operated for 20 years with ammonia coolant, they are still largely in use in Europe, so there is no question of consumer safety. Ammonia smells, which is only a problem if a system leaks, but this is also a warning advantage. Ammonia is not flammable, gives 1.7 times more H_2 than liquid H_2 (at same volume) and it is also relatively inexpensive, for comparison: NH_3: 1.17$/kWh; Methanol: 3.79$/kWh. The farmer distribution technology is available and in daily use.

The importance of Ammonia as hydrogen carrier for fuel cell systems:
A simple cracker technology to be used for Alkaline Fuel Cells has been developed by Apollo Energy Systems (Patents Pending), based on very efficient catalysts working at comparably low temperatures (600 to 700°C) allowing low cost construction materials. For AFCs no further cleaning of the reformed gas (H_2 and N_2) is necessary. PEM-FCs cannot tolerate even small traces of Ammonia.

The advantages of the present alkaline fuel cell system with liquid electrolyte:
- Low cost electrodes (carbon-based, plastic-bonded), used in mono polar stack designs.
- Bipolar plates are not required for systems under 100 kW.
- Low cost commercial accessories and controls for operating the stack.
- No humidifier, no compressors, no membranes are needed.
- Fuel (pure H_2 or from a NH_3 cracker or gas reformer) and Air are at ambient pressure.
- Simple shut down and starts as hybrid with a rechargeable battery supplying peak power.
- The water and thermal management is load dependent and self-controlling.
- AFCs tolerates approx.150 ppm CO_2 (50% of CO_2 in Air.), CO_2 removal by absorbent.
- AFCs with carbon electrodes tolerate far higher amounts of CO than PEM-FCs.

Extensive Literature References will be provided.
An Oral Presentation with Power point slides is planned.