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Ammonia Fuel Network Conference - 2008

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This is a guest post by Neal Rauhauser, known on TOD as SacredCowTipper. He is the executive director of the Stranded Wind Initiative.

The fifth annual Ammonia Fuel Network meeting was held September 29th and 30th in the McNamara alumni center on the University of Minnesota's Minneapolis campus. One hundred and forty registered attendees crammed into a sometimes standing room only auditorium to hear 29 presentations ranging from highly technical catalyst development to ammonia safety to updates on various clean production methods.

The sense among the attendees is that we're at a tipping point – the end of the beginning for ammonia fuel, and the beginning of a much more broad interest in the only hydrogen carrier that can be produced renewably.

Per closing remarks by Dr. John Holbrook, the co-founder of the network, this is probably the last free annual meeting. If they had they pushed a little harder, they could have doubled the number of attendees.

The presentations fell into several broad categories: improved ammonia synthesis methods, ammonia combustion efficiency, fuel cell development, ammonia safety, various energy storage schemes, and five ammonia production schemes, four of which were based on renewable energy sources.

Ammonia synthesis has remained essentially unchanged for the last century. Hydrogen and nitrogen are mixed at pressure in a vessel with an iron catalyst producing heat and ammonia. Nitrogen is simply extracted from the air and hydrogen has a variety sources; electrolysis, stripping from natural gas using steam methane reformation, or production using what is called a "switch" reaction, pulling hydrogen from water using carbon monoxide produced via incomplete combustion.

The most promising advance in synthesis seen so far has been the development of a process called solid state ammonia synthesis (SSAS), which is conceptually an ammonia powered fuel cell being run in reverse. Energy use for this system will be two-thirds of what is required for a hydrolysis/Haber Bosch and the capital cost will be less than half. The technology is at the bench top stage, and many of the attendees, myself included, came together at the end of the conference to see if we could identify a source of funding for the estimated $800,000 needed to bring the technology to pilot stage. There was no direct report on progress with SSAS this year, but you can view the one given for the 2007 conference.

Ted Hollinger of the Hydrogen Engine Center was the first of three presenters covering the use of ammonia as a fuel in piston engines. HEC has been building alternate fuel engines based on the Ford 300-6 for several years and they've had a unit powering an irrigation system in California. The only troubles reported had to do with a piece of third party electronics; the engine itself has been trouble free across 1,800 hours of operation. Durability and cleanliness were key, and performance in these areas was fine. The other reports were very detailed analyses of the behavior of ammonia as an internal combustion fuel; ammonia is hard to start and slower burning than liquid hydrocarbon fuels, but with some attention to detail it performs well in terms of emissions.

Bill Kumm of Arctic Energies, Ltd. spoke on the use of ocean thermal energy conversion to produce ammonia. The approach that was quite reminiscent of the concept of wind driven arctic ammonia production coupled with geo-engineering delivered by Dr. Homer Wang a few years ago. I asked Kumm and he thought that the cold water draw from OTEC would have no effect on a hurricane even if we built a vast number of platforms in the Gulf of Mexico. Dr. Wang's proposal was quite different, as the cryogenic storage of ammonia would allow for the production of water ice, with the albedo increase effect making dramatic changes in exchange for a relatively small amount of energy.

The energy storage schemes ranged from high level policy view provided by Bill Leighty of the Leighty Foundation to a clever solar thermal ammonia based storage loop described by Rebecca Dunn of the Australian National University. One of the big problems in renewable energy is that wind is irregular and solar is periodic; the firming of sources such as these is vital to a conversion to an all renewable energy economy.

Alaska's Energy Authority is looking into the use of ammonia as a fuel in many locations. They have remote villages where electricity is entirely generated by diesel delivered in World War II era flying tankers, locations with a thousand residents that need $40 million worth of power line construction to get on the grid, stranded hydroelectric resources everywhere, and fantastic wind and wave energy available in the Aleutian Island chain. David Lockard's presentation was a fascinating gateway into a world already facing many of the issues peak oil will bring to all human society.

Mark Huberty and his advisor Dr. Ed Cussler have taken a different approach on the firming issue, modifying a Haber Bosch reaction chamber to contain a simple ammonia absorbing salt. Once this is perfected, ammonia will be produced in small batches using wind driven electrolysis and nitrogen separation via a simple membrane plant.

The ammonia production projects were of varying caliber and maturity. The University of Minnesota Morris campus has a wind driven ammonia plant on the build but that is purely research oriented, with just a single 1.65 Vestas V-82 turbine as its power source. Dakota Gasification is running a coal based ammonia production facility with CO2 sequestration, the only non-renewable-energy system and the only one currently in production.

Our presentation on a project in the planning stage for renewable ammonia from Niagara Falls hydroelectric power was very well received, and I was quite pleased to see Freedom Fertilizer's presentation also on the docket, as I had a hand in writing the work that recently got them a $100,000 USDA value added producer grant. Kathy Showalter of Enerjyn was the lead grant writer on this one, and they have an extensive practice in renewable energy projects.

Freedom Fertilizer's grant was written with a great deal of assistance from those involved in the

Stranded Wind Initiative, and the intent was to leverage this small grant into a full scale ammonia production facility. A year into our explorations, it is now known that the traditional Haber Bosch synthesis method must have a full time grid connection to behave properly, so we've undertaken a patent application for some modifications to Haber Bosch which will enable it to perform with an irregular power input. I suspect both the improved Haber Bosch and solid state ammonia synthesis will be commercially viable, with the former being used in places where waste heat would have commercial applications and having a lower bound in the tens of millions of dollars as far as plant cost, while the later will be used across a broad spectrum of projects thanks to its ability to scale from a single tube up to entirely consuming the output of a large hydroelectric facility.

There were three presentations on ammonia safety. The consensus is that ammonia can be stored safely, even in urban settings, and that it'll make a passable motor fuel as well, but the Department of Energy does not view ammonia as a potential hydrogen carrier. Like so many other things in the world today, everyone is waiting patiently for an energetic new Congress and President Obama to correct these various misconceptions.

These are exciting times for renewable ammonia production given the existing demand for fertilizer and the soon to be booming need for this carbon free fuel. This report is not an exhaustive review of what was presented but you should find all of the presentations, albeit in PDF form, in the link at the top. If you have further questions the authors are generally very accessible and will have included their email addresses in their presentations.