substitute for the Haber–Bosch process, and thereby allow for "renewable" ammonia production.

Unlike CH_4 and CO_2, ammonia is not a greenhouse gas. In the atmosphere, it quickly forms hydrogen bonds to water vapor and returns to the ground in alkaline rain. However, NH_3 is toxic, chills its surroundings rapidly on vaporizing, and releases heat on contact with water. Engineering a safe fuel tank for an ammonia-fueled vehicle would be a key priority.

Ammonia is an excellent material for hydrogen storage. As Crabtree and coauthors report in their figure 4, the volume density of hydrogen in liquid NH_3 is more than 40% greater than in liquid H_2, and the comparison becomes much more favorable when one considers the weight of the required fuel tank and peripherals. Unlike H_2 gas, ammonia explodes in air only over a narrow range of concentrations. Shipping ammonia from production site to point-of-use does not require a great deal of cooling or high pressure. Thousands of miles of NH_3 pipeline in the US stand as evidence that reliable infrastructure for NH_3 transport and storage has been engineered. In sum, liquid NH_3 is not just an excellent hydrogen-storage material but also an ideal medium for moving hydrogenic energy from place to place.

Given these advantages, it is hard to avoid the conclusion that relatively modest investments in the science and engineering of NH_3 synthesis and fuel cells, and in safer transport, storage, and delivery of NH_3, are the best hope for making the hydrogen economy a reality in our lifetimes (and by the way, I am 62).

References

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George Crabtree, Mildred Dresselhaus, and Michelle Buchanan assert that the energy required to split the water molecule and release hydrogen is later recovered during oxidation to produce water. As any undergraduate student of thermodynamics knows, that statement is false; only some of the energy is recovered in any realizable manner. This fact points up the general fallacy in the public's mind about hydrogen being an energy source. Unless and until we are able to connect a hose to Jupiter, hydrogen should be viewed not as an energy source but as a storage medium.

Moreover, as the authors aptly point out, hydrogen does not store energy nearly as efficiently as does gasoline. As long as gasoline is abundantly available, hydrogen will not be cost competitive. Given the stress on the federal budget, large-scale government funding of R&D related to the hydrogen economy is not likely to happen. My guess is that, for the foreseeable future at least, hybrid gasoline technology is where the action will be in the energy sector.

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