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The Hydrogen Economy: Further Studies Needed Before Reaching a Conclusion

While hydrogen is clearly neither a magic bullet nor a short-term solution, we see no consensus as to what role hydrogen may ultimately play in future energy systems, or for how aggressively the U.S. should pursue research to address the many challenges that must be met to bring about this revolutionary change. The AIChE published a position statement in April, 2003 entitled, "Are Fuel Cells Appropriate for Cars and Trucks?" Their conclusion was "in the long term, maybe." They also stated that the movement toward a hydrogen economy has promise, and that it merits increased R&D attention.

In his Critical Issues Forum article (Nov. 2004, p. 4), Dr. Hirsch objectively outlined both the promises and the challenges of a hydrogen economy. His informed opinions were based on the results of thorough study performed by the National Academy of Sciences' National Research Council and published last year in the NRC report, "The Hydrogen Economy: Opportunities, Costs, Barriers, and R&D Needs" (2004). The report, based on analysis by objective experts and interviews with researchers in the field, examined the subject of hydrogen energy in great detail. Your readers would be well-served by reviewing the results.

The NRC report was not a blanket endorsement of either the hydrogen economy concept or of the current DOE hydrogen program. While concluding that the transition to hydrogen over the next several decades could "fundamentally transform the U.S. energy system" for the better, the report also pointed out the challenges that must be met. It recommended a number of programmatic changes that DOE has accepted and is implementing. The overall recommendation was to pursue further research and development on hydrogen energy technology. Dr. Hirsch fairly discussed many of the findings in his article.

In addressing the potential long-term impact of a hydrogen-based energy system, the Academies' report stated: "There is a potential for replacing essentially all gasoline with hydrogen over the next half century using only domestic resources. And there is a potential for eliminating almost all CO_2 and criteria pollutants from vehicular emissions." Likewise, the AIChE position paper concluded that if hydrogen were produced from water using nuclear, solar, biomass, or coal combined with CO_2 sequestration, then net CO_2 emissions would be eliminated and air pollution would be reduced or eliminated. The paper further stated, "the U.S. would eventually be independent of the world's limited oil and gas resources for transportation energy." These conclusions directly contradict Dr. Shinnar's claim that: "Any use of hydrogen as a substitute for a fossil fuel will increase our dependence on imported oil and gas, as well as increase global emissions."

We believe that it is important to contrast the well-documented, scientific views of Dr. Hirsch with the views expressed by Dr. Shinnar. Unfortunately, Dr. Shinnar has chosen to adopt a confrontational approach laced with ridicule and inflammatory rhetoric and based on unsubstantiated opinions-as-facts. He charges that hydrogen research is a "fantasyland", "nonsense", "myth", or "thermodynamic crime." He bases many of his arguments on thermodynamic analysis, but his explanations and examples do not make a compelling, or even reasonable, technical case. We would be happy to address this issue in more detail in the proper forum, but we believe that anyone rereading the several paragraphs in his article beginning with the sentence

"Electricity is a much more efficient energy source than fuel" can only be mystified about how Dr. Shinnar arrives at his sweeping indictment of the hydrogen economy.

Dr. Shinnar labels the conversion of electricity to hydrogen as a thermodynamic crime. However, this should be considered in the light of ongoing difficulties (and physical limitations) in the ability to store electricity effectively. Battery- powered electric vehicles have failed to meet market needs due to inherent storage/weight limitations, and even the most promising advanced battery technologies do not approach the longer ranges demanded by automotive companies for full-service vehicles.

Hybrid electric vehicles are a major improvement over conventional vehicles, but battery limitations still prevent plug-in hybrids (as suggested by Dr. Shinnar) from coming close to achieving the goals needed for operation beyond limited short-range use. Nearly all automotive companies are supporting the development of hydrogen fuel cell vehicles as the long-term solution. This is not "a thermodynamic crime."

Our modern society is based on numerous examples of accepting thermodynamic losses in order to produce energy in a more useful or convenient form. As an aside, there is a thermochemical route (with fewer thermodynamic losses) from high temperature heat directly to hydrogen that does not require the generation of electricity. Such a process is particularly well-suited for the use of advanced nuclear reactors.

"A reasoned and objective discussion on the use of hydrogen as a future energy carrier is certainly warranted, and even welcome. Our profession has enough room to sustain views on both sides of this debate."

Those of us actively engaged in research in the hydrogen field can cite plenty of additional facts that argue in support of hydrogen as a future energy carrier and storage medium, while critics can likewise point to the myriad technical and economic barriers that will have to be overcome for the technology to be practical. Some challenges could turn out to be insurmountable, but insufficient research has been done to reach that conclusion. A reasoned and objective discussion on the use of hydrogen as a future energy carrier is certainly warranted, and even welcomed. Our profession has enough room to sustain views on both sides of this debate.

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OPEN INVITATION TO AICHE HYDROGEN TOPICAL MEETING ATLANTA, GA, APRIL 11–13, 2005

Whether you believe that hydrogen is tomorrow's fuel or feel compelled to "demystify the hydrogen myth," the Nuclear Engineering Division (NED) of the American Institute of Chemical Engineers (AIChE) extends to you an open invitation to the upcoming topical conference: "Path Forward to a Hydrogen Economy," at the Spring 2005 AIChE meeting in Atlanta (April 11–13, 2005). Instead of spending seemingly endless hours reading through tomes of opinionated contrived chaff sifting out the wheat to be found floating on seas of pedantic verbosity, join us as researchers from across the globe discuss the latest technological breakthroughs toward the application of advanced nuclear energy concepts to produce hydrogen.

We will discuss a technology on the cusp of influencing mankind in three far-reaching areas (energy supply independence at home and in developing countries, global warming, and emerging business innovations and transportation). Although most hydrogen today is made by steam reforming of natural gas, significant R&D programs in Japan and expanding programs in the U.S. and Europe are developing the technology to use nuclear energy systems to produce hydrogen from water. With world hydrogen consumption for fertilizer production and oil refining at about 50 million metric tons per year and projected to grow by as much as 10% per year, development of hydrogen production from nuclear systems will foster our nation's energy independence. In addition, nuclear hydrogen production is devoid of carbon dioxide and other greenhouse gases; convincing data and models show that increasing amounts of these gases in the Earth's atmosphere will lead to a 2–10°F increase in average global warming by the end of the century. Finally, abundant sustainable fuels will lead to emerging business opportunities and innovations addressing pressing transportation needs at home and aboard.

The NED program in Atlanta will showcase advanced hydrogen production technologies, assess their viability, and foster discussions and debate on the needed R&D to enable the demonstration of nuclear hydrogen production. Production technologies to be discussed include both thermo-chemical cycles and high-temperature electrolysis. In addition to production technologies, the meeting will address: (1) critical interface issues between the nuclear reactor and the chemical plant, (2) systems analysis, (3) economics, and (4) hydrogen purification/sensor development.

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