NUCLEAR ENERGY RESEARCH INITIATIVE

Nuclear-Energy-Assisted Plasma Technology for Producing Hydrogen

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Most of the energy currently used in the world comes from fossil energy sources. The world's supply of fossil energy is finite and presents a variety of environmental problems from mining and extraction activities to air pollution caused by emissions when they are burned. Although the world's store of fossil fuels has already diminished, the world's demand for energy will not diminish. Moreover, the developed world is less willing to tolerate environmental damage from future methods of energy production, and is actively seeking new solutions for its energy needs. Among all the alternative energy possibilities, hydrogen is the strongest candidate to meet the global demand for energy without sacrificing the environment-it does not emit any air pollutants. Since hydrogen's energy density is high, it is a highly efficient energy source that can be used for transportation, heating, and power generation. If it can be produced, transported, and stored economically and cleanly in large quantities, hydrogen can replace fossil fuels in

- Automobiles and other personal transportation,
- Industrial processes, and
- Distributed power applications.

Several technologies exist to produce hydrogen, but they have disadvantages. For example, fossil fuel reformers produce hydrogen from methane, gasoline, natural gas, or other fossil fuels. These reformer systems are complex and capital intensive and the hydrogen produced is of low purity. The technologies also create polluting emissions from the carbon, sulfur, and nitrogen compounds inherent in the fossil fuel. Additionally, hydrogen from reformers contains carbon monoxide, which requires separation to produce pure hydrogen. Hydrogen generated from fossil fuels must still be stored—either compressed in cylinders or liquefied and stored as a cryogenic liquid. Both of these storage mechanisms have limited consumer appeal, particularly for transportation and residential power applications.

Thermal cracking of fossil energy sources also produces hydrogen and solid carbon residue, but the processes require separation to obtain pure hydrogen. Electrolysis is also used to generate hydrogen from water. The water-electrolysis process consumes significant amount of electricity with low conversion efficiency, and is designed only for stationary use. Another option is the use of metal hydrides, but only for storing the energy that hydrogen produces. Metal hydride systems still require a source of hydrogen gas for producing hydrogen fuel. An improved process to produce hydrogen must be developed.

Sodium borohydride is a safe and concentrated hydrogen carrier compound and can store an impressive amount of hydrogen. For example, 1 liter of 44-weight percent sodium borohydride solution at 1 atmosphere can release about 130 grams of hydrogen. Sodium borohydride releases more hydrogen and has a higher density of hydrogen than other sources of hydrogen. For example, cryogenic liquefied hydrogen has a density of 70 gm/lit. Hydrogen pressurized to 6,000 psi has a density of only 36 gm/lit. Rare-earth-nickel alloys can store hydrogen up to a density slightly higher than liquid hydrogen but still quite a bit less than that of sodium borohydride. However, the alloy is very expensive and not as easily handled as a liquid. The borohydride solution is also much easier and safer to handle than liquid or high-pressure hydrogen. The current gasoline-distribution infrastructure for automobiles can be easily converted to dispense "sodium borohydride fuel" for vehicles.

Sodium borohydride can be produced from sodium borate although at present, no technology exists to do so economically. Development of a nuclear-power-assisted plasma technology is proposed for economically mass-producing sodium borohydride from sodium borate.

A successful nuclear-power-assisted plasma technology to convert sodium borate to sodium borohydride will have a long-term significant economical benefit to the nuclear power industry. During peak operation, nuclear power reactors will generate electricity to meet peak commercial demand, and during off-peak operation, the nuclear reactor will supply electricity and nuclear process heat to produce sodium borohydride. Producing sodium borohydride during off-peak hours will in turn increase the demand for the nuclear industry.

We have assembled a team of highly experienced and qualified researchers to develop a new nuclear-energy-assisted plasma technology to produce hydrogen. Our proposed technology does not have the disadvantages of existing hydrogen-producing technologies. In contrast to the existing hydrogen-producing technologies, the proposed process to mass-produce sodium borohydride from sodium borate is

- Efficient,
- Economical,
- Environmentally acceptable, and
- Safe.

It will also help the country convert to a hydrogen economy. Sodium borohydride solution is also much easier and safer to handle than liquid or high-pressure hydrogen. This technology will help in facilitating hydrogen as the energy source to power the world.