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Nuclear Hydrogen for Production of Liquid Hydrocarbon Transport Fuels

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Liquid fuels (gasoline, diesel, and jet fuel) have major advantages as transport fuels: a high energy density per unit volume and mass, ease of storage, and ease of transport. However, there are major disadvantages: crude oil is increasingly expensive, most of the world's crude oil comes from unstable parts of the world, and burning of hydrocarbons releases greenhouse gases to the atmosphere. These disadvantages may be reduced or eliminated by use of (1) hydrogen and oxygen produced from water using nuclear energy as the energy source and (2) alternative carbon feedstocks in the production of liquid fuels.

As oil becomes scarce, liquid fuels will be produced with increasing frequency from heavier feedstocks such as heavy oil, tar sands, oil shale, and coal. With current technology, this conversion process can be summarized as follows:

$$\text{Carbon-based feedstock} + \text{Water} + \text{Oxygen} \rightarrow \text{Liquid fuels} + \text{Carbon dioxide} \qquad (1)$$

With nuclear hydrogen, this conversion process can become

$$\text{Carbon-based feedstock} + \text{Water} + \text{Nuclear energy} \rightarrow \text{Liquid fuels} \qquad (2)$$

When nuclear energy is used (Eq. 2), no carbon dioxide is released from the fuel production process. All the carbon is incorporated into the fuel. The carbon in the feedstock is not used as an energy source in the liquid-fuel production process. Carbon dioxide is released only from the burning of the liquid fuels. For feedstocks such as coal, which have low hydrogen-to-carbon ratios, the traditional technologies such as coal liquefaction (Eq. 1) may release more carbon dioxide to the environment in the fuel production process than will be released from burning the liquid fuel.

Hydrocarbon liquid fuels that have no greenhouse impacts can be produced if the carbon source for the manufacture of the liquid fuels is carbon recycled from the atmosphere (via biomass collection or direct removal from air) or from the vehicle. With nuclear hydrogen production, this conversion process becomes:

$$\text{Recycle carbon} + \text{water} + \text{nuclear energy} \rightarrow \text{Liquid fuels (No greenhouse)} \qquad (3)$$

The alternative processes and challenges for these alternative liquid-fuel futures are described and evaluated.