Reforming of Transition Fuels for the Hydrogen Economy

The world currently depends on fossil fuel resources for much of its energy needs. The inevitable depletion of fossil fuel reserves and concomitant increase in atmospheric greenhouse gases will force a transition from fossil fuels to renewable energy resources such as solar, wind, and biomass. Hydrogen is foreseen to play a dominant role in the renewable energy future. The time span between current conditions and the renewable energy future is a subject of lively debate. Hawaii lacks fossil fuel resources and currently imports most of its primary energy as crude oil and coal. Synthetic natural gas (SNG) and liquefied petroleum gas (LPG) are manufactured from crude oil on Oahu. SNG is distributed by pipeline to commercial, industrial, and residential end users over a roughly 30 mile swath on Oahu's south shore. LPG is available through local distribution pipeline networks in select areas and in bottles throughout the state. While hydrogen production on the mainland and other parts of the world is often based on natural gas, due to unique local circumstances, LPG has the potential to be the transition fuel leading from current conditions to the renewable hydrogen economy of the future for Hawaii.

LPG Reforming Research

Liquefied petroleum gas is primarily composed of propane (C_3H_8), propylene (C_3H_6), and butane (C_4H_{10}), with lesser amounts of ethane (C_2H_6), pentane (C_5H_{12}), and heavier hydrocarbons. The purpose of reforming is to convert the chemical energy of these compounds into hydrogen which in turn can be used in a fuel cell. Reforming can be accomplished by passing a fuel and steam mixture over an appropriate catalyst at elevated temperature (600 ? 800 ºC). The sensible enthalpy to attain elevated temperature may be supplied to the catalytic reactor externally from an auxiliary source, or internally by introducing oxygen or air and partially oxidizing the fuel in the catalytic reactor. The former is referred to as an allothermal process and the latter is an autothermal process, often referred to as a partial oxidation (POX) process.

The Hawaii Natural Energy Institute (HNEI) has designed and constructed a fuel reforming test bed with the capability of controlling process temperature, steam to carbon (fuel) ratio, oxygen to carbon (fuel) ratio, catalyst type, and residence time. The test bed is computer controlled and the reformate composition is monitored using on-line gas analysis equipment, thus providing long term test capabilities. Post-test analysis of catalysts for carbon deposition and sulfur deactivation are standard procedure. Current tests are utilizing two commercially available nickel-based catalysts.

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