Hydrogen Generation via Novel Supercritical Water Reformation Technology

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A novel, robust, fuel reformation technology has been developed for portable, mobile, stationary, and on-site generation of hydrogen from a variety of feedstocks involving both renewable and nonrenewable resources. Unlike conventional steam methane reforming (SMR), this novel reforming process is carried out non-catalytically in supercritical water, where supercritical water acts both as a highly-energized reforming agent and as an extraordinary homogenizing solvent. The unparalleled merits of this technology, as demonstrated in an experimental prototype system, are quite numerous, including: (a) catalyst-free reactions; (b) capability of handling high sulfur-containing liquid fuels; (c) high once-through conversion; (d) lower temperature operation and higher energy efficiency than conventional steam reforming technology; (e) alleviation and control of coking; (f) use of unpurified, locally available water; (g) compact size and minimal space requirements; (h) great flexibility in feedstock variety; and (h) near-zero discharge. The process technology is superbly applicable to the U.S. military's need for mobile electric power (MEP) generation based on integrated fuel reformation-fuel cell systems, for purposes of stealth (reduced noise and thermal signature), increased mission endurance (higher efficiency), and reduced logistical burden (overall lower fuel consumption). The process technology is also eminently suitable for on-site hydrogen generation via energy-efficient conversion of ethanol crude beer into hydrogen, thus providing a means of seamless integration between the Hydrogen Economy and the Ethanol Economy. Scientific and technological details of the supercritical water reformation (SWR) process will be discussed, with a particular emphasis placed on process chemistry, process engineering, energy materials, and prototype design.