

Hydrogen production by pyrolysis of ethanol on nickel catalyst

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Hydrogen is a perspective fuel for different kinds of power plants including the devices of low power (1–50 Wt) such as portable fuel cells and charging units to energize notebooks, cell phones, etc. However, the accumulation and storage of molecular hydrogen a nowadays problem connected with safety during use of hydrogen accumulator and a small capacitance to hydrogen. A generation of hydrogen from hydrocarbons, e.g. alcohol (methanol or ethanol) in the process of water steam catalytic conversion is one of the possible ways to overcome these difficulties. In this case ethanol has some obvious advantages over methanol: low price, low toxicity, easy transposition and use and a possibility to produce it from renewable sources (bioethanol).

In the present work the process of low-temperature pyrolysis of ethanol on nickel catalyst developed earlier for the production of nanostructures such as nanotubes and nanofibers has been investigated. The peculiarities of pyrolysis of alcohol vapors on the catalyst NiO/SiO in a continuous reactor have been qualitatively studied with the use of IR spectroscopy method. It has been shown that at the temperature above 400°C the alcohol molecules first decay into acetaldehyde and hydrogen, then to more simple compounds such as methane and carbon monoxide. Further disproportionation of CO resulted in the precipitation of nanofiber carbon on catalytic substrate. It has been established later that within the temperature range 250–350°C only the first reaction is realized, which makes the process suitable for production of hydrogen from ethanol.

The investigations of ethanol reforming were carried out in continuous cylindrical microreactor 70 mm in length with inner diameter 4 mm. The temperature of the process varied within the range 20–400°C. The rate of the gas carrier (argon) varied within the range 20–100 cm/min. A rectificate with water content 4 mass % was used as an initial mixture. The analysis was performed by gas chromatographic method in two phases: molecular sieve A5 (detection of gases, 2 m in length) and polysorb (detection of ethanol, water and vinegar aldehyde, 2 m in length). The rectificate was fed by two ways: by gas carrier from bubbler and by peristaltic pump.

It has been shown that during the process of ethanol reforming without prior activation of catalyst the catalytic pyrolysis with extraction of hydrogen took place. In this case other possible conversion products such as methane, carbon oxide, etc were not formed. At the temperature of the process 300–350°C ethanol was practically fully converted. In the case of prior activation of catalyst even at 200°C aldehyde, carbon oxide and methane were formed. At 350°C the yield of hydrogen reached its peak.