Koji Hashimoto, J Fundam Renewable Energy Appl 2017, 7:7 (Suppl)
DOI: 10.4172/2090-4541-C1-038

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Synthesized natural gas production by dually fluidized bed gasification of woody biomass and subsequent methanation

The current atmospheric carbon dioxide concentration on our planet exceeded 400 ppm, which corresponds to the atmosphere in Pliocene 3.5 million years ago. Our planet had to spend 2.5 million years to decrease it to the pre-industrial level of about 280 ppm mostly by solid carbonate formation as a result of weathering dissolution of rocks on elevated Himalayan Tibet mountain massif due to the heavy rain of the monsoon. It is, therefore, impossible for us to decrease carbon dioxide from 400 ppm to 280 ppm. Only the effort we can do is to decrease carbon dioxide emissions. Our effort of the use of woody biomass in the form of synthesized natural gas is one of the solutions. We formed synthesized natural gas by efficient gasification of woody biomass and subsequent methanation. For gasification of whole-wood pellets including bark, we carried out dual fluidization in both combustion furnace and gasification furnace. In this system we performed gasification by thermal decomposition and steam gasification avoiding nitrogen contamination and achieved more than 75% cold gas efficiency of the calorific value of the wood, obtaining high concentration of hydrogen. We used a novel tar reformer with a catalyst and attained 99.9% tar reformation in the pilot scale experiment, without deterioration for 8000 h in the laboratory scale experiment. After gasification, we sent a mixture of hydrogen, carbon monoxide, carbon dioxide and steam to the methanation reactor, which uses Ni-ZrO_2 type oxide catalysts. The reactor converts a mixture of 4 volumes of hydrogen and one volume of carbon dioxide to methane with almost 100% methane selectivity and about 90% conversion efficiency at 300 °C and ambient pressure. In fact, carbon monoxide at first reacted with steam shifting to hydrogen and carbon dioxide ($CO+H_2O=H_2+CO_2$). Thus, the amount of methane formed was a quarter of the sum of hydrogen and carbon monoxide in the reactant gas ($4H_2+CO_2=CH_4+2H_2O$). We performed a demonstration at 38 Nm^3/h of reactant gas with 40% steam to form methane with more than 70% calorific efficiency. The process simulation showed that the methane purity is higher than 99% after membrane separation.

Biography

Koji Hashimoto is the Professor of Emeritus Tohoku Institute of Technology and Visiting Scholar Tohoku Institute of Technology. He has completed his Postdoctoral studies at the Division of Applied Chemistry, ational Research Council,Canada. He has published over 540 papers in scientific journals in addition to review articles and book chapters. He is the Editorial Board member of "Corrosion Science and the Electrochemical Society of Japan, the Society of Chemical Engineers, Japan. In particular, he has built a prototype plant for global CO2 recycling in 1995 on the roof top of the Institute for Materials Research, Tohoku University.

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