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Microwave and membrane reactor applications for hydrogen and syngas from renewables

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Fast depletion of fossil resources and related environmental concerns facilitated research activities for the production of alternative fuels and valuable chemicals from renewable resources. Another very important issue in the future of chemical engineering applications is the development of more efficient and more environmentally friendly processes than conventional ones. Multifunctional reactors, involving reaction and separation processes in the same unit and use of alternative energy sources like microwave, solar energy etc., are considered as possible new developments within the general concept of process intensification. Bio-ethanol, with its high hydrogen content and low toxicity has been considered as an excellent renewable resource for the production of synthesis gas and hydrogen. Steam reforming of ethanol over Ni and Co based catalysts in a focused microwave reactor (MWR) was shown to give highly stable performance with negligibly low coke formation. Elimination of temperature gradients within the reactor due to bulk heating of catalyst bed by the microwave was shown as a major advantage in terms of product distribution and reactor stability. Besides these advantages, microwave reactors have energy efficiency advantages. Ammonia has been considered as a potential resource for on-board production of H_2 for fuel-cell derived cars. Results obtained in a MWR showed that H_2 production by decomposition of ammonia can be achieved at temperatures as low as 450°C, over iron based catalysts, while similar NH_3 conversion values were achieved over 600°C in the conventionally heated tubular fixed bed reactor. Catalytic conversion of biogas to syngas through CO_2 reforming of methane is considered as the first step of production of valuable chemicals and alternative fuels (like methanol, dimethyl ether) from two of the most abundant greenhouse gases. Results obtained over mesoporous alumina supported Ni based catalysts in a membrane reactor showed significant enhancement of hydrogen yield. Removal of hydrogen from the reaction zone through the Pd membrane wall of the tubular reactor helped to eliminate equilibrium limitations and minimized the occurrence of reverse water gas shift reaction. Recent results obtained in a microwave reactor and a review of membrane reactor applications will be reported in this presentation.

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