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Performance of Dealuminated Ni/ZSM-5 Catalyst in Dry Reforming of Methane

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Abstract: Ni/ZSM-5 modified Nano catalyst containing 3, 5 and 7wt. % Ni were prepared by impregnation method for DRM. Dealumination of ZSM-5 carried out by HNO3 solution as a dealumination agent. This process led to increase Si/Al ratio for ZSM-5. For approaching to the higher conversion and H2/CO ratio, higher concentration of acid and lower temperature for treatment of ZSM-5 must be used. The sample that was prepared by higher concentration of acid and lower temperature in dealumination process, with 5%wt Ni showed a better activity and stability than unmodified sample during DRM at 700°C for 30h time on stream.

Keywords: Catalyst, Dry reforming, Methane, dealumination, Ni/ZSM-5

1. INTRODUCTION

The process of CO_2 reforming of methane has received considerable attention in recent years as it constitutes a very attractive route for the production of syngas from greenhouse gases. This reaction (Eq.1) offer a potential method for reducing the concentrations of CO_2 emitted to the atmosphere (1) also that produce syngas (i.e. $CO+H_2$) with $H_2/CO \leq 1$ ratio, favourable for Fischer Tropsch reactions to produce liquid fuels When DRM combination with SRM for produce desire H_2/CO ratio for Fischer Tropsch reaction ($H_2/CO=2$) (2, 3).

$$CH_4 + CO_2 \rightarrow 2H_2 + 2CO \qquad \Delta H_{25}°C = 247 \text{ kJ/mol} \qquad H_2/CO = 1 \tag{1}$$

One advantage of dry reforming of methane is produce syngas with low H_2/CO ratio; and other advantage of this reaction is consuming two greenhouse gases and provide key intermediate for chemical industry. The process opens the possibility of combining steam reforming, partial oxidation, and dry reforming for the generation of syngas with a desired H_2/CO ratio (4-6).

However, CO_2 reforming reaction is intensively endothermic, consumes a large amount of energy and produced large amount of Coke therefore the activity of catalyst has been reduced.

Besides the reforming of methane to produce syngas (Reaction 1), reverse water gas shift (Reaction 2) and several series-parallel side reactions (Reaction 3-7), have indirectly led to lower products yield and concurrently, produced water as undesirable by-product (7)

$$CO_2 + H_2 \rightarrow CO + H_2O \qquad \Delta H_{25°C} = 41 \text{ kJ/mol} \tag{2}$$

$$CH_4 + 2CO_2 \rightarrow 3CO + H_2 + H_2O \qquad \Delta H_{25°C} = 288 \text{ kJ/mol} \tag{3}$$