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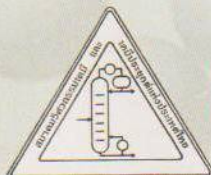
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COMPARISON STUDY OF RHODIUM DAN NICKEL OXIDE CATALYST TO HEAVY HYDROCARBON CRACKING TO METHANE ON *PRE-REFORMER* FOR INCREASING SYNGAS PRODUCTION AT PT. PUSRI

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Abstract

Pre-reformer is a catalytic reactor which is useful for reformation reaction of natural in gas cracking reaction of heavy hydrocarbons. This research aimed to study the effect of Rhodium catalyst for cracking heavy hydrocarbons into methane in the *pre-reformer* to increase the conversion of methane to syngas in Pusri II and to know the impact of additional pre-reformer at Pusri II against the feed gas composition, thermal efficiency and fuel consumption in *primary reformer*. The results showed that the use of rhodium as a catalyst in the reaction of the pre-reformer can crack heavy hydrocarbons like ethane, propane and butane to methane in a row at 71.9%, 88.2% and 88.2% and methane reformation reaction with steam to produce hydrogen gas and carbon monoxide at 24.9%. Installation of pre-reformer feed gas can alter the composition of the *primary reformer* and the methane conversion increased to 42.94% from 24.73% at a temperature of 973 K. Installation of pre-reformer can reduce fuel consumption of 97.74×10^{10} MMBtu / hr and an increase thermal efficiency of 13.28% in the *primary reformer*.

Keyword: *Pre-reformer*, Catalyst Rh, Methane Conversion, *Syngas*

Introduction

Steam reforming is an important step in the process of fertilizer production, because it will determine success in the production process. Reforming process took place on a device called a primary reformer. In this equipment, the catalytic reaction of methane with steam produce hydrogen and carbon monoxide at a pressure of 36, 44 kg/cm² and temperature with a range of 780-820 0C. The mixture is heated by conduction and convection through the catalyst bed with the heat supply to reach operating temperature through the combustion of the burner.

The reaction which takes place in a primary reforming existing two, namely the character of endothermic steam reforming and water-gas shift reaction which is exothermic. Steam reforming reactions preferably take place at high temperature and low pressure. The main

reforming reaction depends on the conversion of methane.

Material

Methane steam reforming research was conducted through thermodynamically and kinetically analysis. In the analysis of thermodynamic was done calculation of equilibrium calculation based on the reaction in pre-primary reformer and the reformer. This mass balance calculation related to the composition of compounds that enter into the pre-primary reformer and the reformer and the composition of compounds that come out of pre-primary reformer and the reformer.

After mass balance calculation, fraction of compounds involved in the reaction in the *pre-reformer* and *primary reformer* was calculated. From the calculation of compound fraction can be calculated equilibrium constants

(K). The reaction occurred in the *pre-reformer* include cracking reaction of heavy hydrocarbons into methane and steam reforming reaction of methane. Reactions occurred in the *primary reformer* include steam reforming reaction of hydrocarbons and water gas shift reaction. Calculation of equilibrium constants (K) based on the reactions that occur in *pre-reformer* and *primary reformer*.

Experimental

Two of reforming reaction are equilibrium reaction and whole reaction can be shown by equilibrium reaction rate. Reaction rate depend on distance to equilibrium (thermodynamic) and reaction speed (kinetic). Part of chemical thermodynamic include forward reaction speed ratio and reverse reaction speed. This ratio depend on temperature and can be calculate by equilibrium distance whereas both of reaction on the same reaction speed. Equilibrium constant for partial pressure (K_p) is used for this calculation. For steam reforming reaction of methane and water gas reaction, both of equilibrium constant can be formulated :

$$K_{p1}(T) = \frac{[CO][H_2]^3}{[CH_4][H_2O]} \quad (1)$$

$$K_{p2}(T) = \frac{[CO_2][H_2]}{[CO][H_2O]} \quad (2)$$

$$K_p = K_{p298} \exp\left(\frac{\Delta H}{R} \left[\frac{1}{298} - \frac{1}{T}\right]\right) \quad (3)$$

$$R = \sum_{i=1}^N \frac{R_U}{y_i M_i} \quad (4)$$

Equilibrium constant K_{p298} reference is given by equation :

$$K_{p,i,298} = \exp\left(-\frac{\Delta G_i}{R298}\right) \quad (5)$$

This research use rhodium catalyst data to increase conversion of methane in calculation.

Results and Discussion

Methane conversion on Pusri *primary reformer* at 973 K reach 24,73 % while teoritical conversion of methane can reach 61,47%. Therefore, *pre-reformer* is used to increase

methane conversion, this can be seen oh figure 1, else high methane conversion is obtained for *pre-reformer* that use rhodium catalyst and conversion of methane is 45.19% compare to nickel catalyst which only has 23,79% conversion of methane.

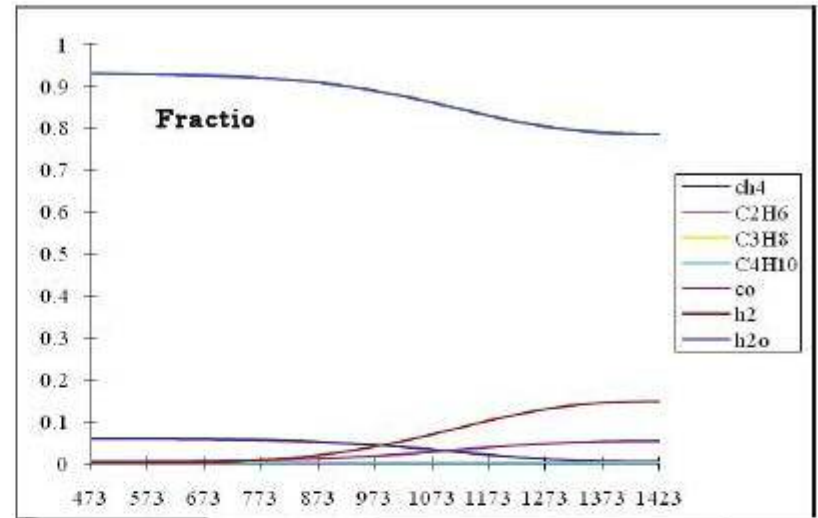


Figure 1. Component fraction of primary reformer

Conclusion

Based on the study which was conducted on comparison study of the effect of rhodium and nickel oxide catalysts for cracking heavy hydrocarbons into methane in the pre-reformer to increase the production of syngas in PT Pusri II, so it can inferred, methane conversion on modified *reformer* reach 65,74% compared to existing *reformer* of Pusri that has 24,73% at $T=973$ K, so PT.Pusri can use this catalyst to the next advance process.

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