CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From this work, it can be concluded that 11 wt% Ni was the suitable amount of metal loading which gave the high catalytic activity and stability for this steam reforming, however, it showed slightly lessening in catalytic activity throughout the reaction time. The catalytic activity of Ni/ZSM-5 catalyst increased with increasing nickel content up to 11 wt.% and then decreased above this value. The higher amount of Ni loading led to the higher Ni crystallite size, Ni sintering, and the lower Ni dispersion.

The steam reforming of methane with a feed gas of a H_2O/CH_4 ratio of 0.8 was successfully conducted with the lowest activity decreasing compared to the 11%Ni/ZSM-5 catalysts with the higher H_2O/CH_4 ratios. Noticeably, it is believed that the dealumination in zeolite's structure takes place during methane reforming and may explain the observed no activity at a H_2O/CH_4 ratios of 2.0. Additionally, the lower amounts of deposited carbon, as explained by WGSR, were formed on the catalysts with the H_2O/CH_4 ratios of 1.0 and 2.0.

It was found that the stability of the Ni/ZSM-5 can be improved by the addition of CeO_2 into catalysts, which also increases the dispersion of Ni, retards the sintering of active Ni particles, and promotes the reduction of deactivation rate. Surface enrichment of CeO_2 (7wt% CeO_2) may made a large portion of the Ni surface covered by these promoters and hindered the access of CH_4 and/or steam on the surface of Ni particles, as the high coke formation was appeared.

From all results, it revealed that the 11%Ni/5%Ce/ZSM-5 catalyst operated on the reforming reaction at a H_2O/CH_4 ratio of 0.8 showed the highest activity and stability (throughout 12 hours time-on-steam) performances.

5.2 Recommendations

In this work, it was found that the stability and activity of the Ni/ZSM-5 catalysts can be improved by the addition of CeO_2, but too high CeO_2 content negatively impacted both stability and activity performances. This effect might be a result of a promoter covered Ni active site of the catalysts. Consequently, the investigation of the reaction mechanism in the term of kinetic is recommended in order to explain this effect. Besides, preparing with other techniques or adding with other promoters is recommended for the further development of Ni/ZSM-5 catalyst.