Hydrogen production by reforming of CO_2 containing flue gases

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1 Introduction

In the near future, hydrogen may become an important energy carrier for sustained energy consumption with diminished impact on the environment. It can be utilised in combustion devices or fuel cells without any carbon emissions. It can be stored and transported, much like other gaseous fuels, though an infrastructure will have to be developed.

Hydrogen (and synthesis gas) can be produced by reforming from almost any carbon-hydrogen containing source, ranging from natural gas to biomass [1]. Therefore, various sources such as by-products or flue gases of industrial processes may be promising candidates for hydrogen production. Among them, coke oven gas (COG) and refinery gas (RG) are very attractive sources for hydrogen production. Coke oven gas is a by-product generated in the process of producing coke from coal at high temperatures whereas refinery gas is obtained during distillation of crude oil in refineries.

The objective of the present work was to study the possibility to use coke oven gas and refinery gas as a feedstock in the reforming process. Another aim was to evaluate the suitability of typical reforming catalysts for the process. The main criteria in evaluation of the process were the conversion of CH_4 and CO_2, the amount of H_2 in the outlet gas, and the resistance of the catalyst against carbon formation.

2 Experimental Part

Catalytic activity studies were performed with a tubular quartz reactor at 800ºC and atmospheric pressure. The apparatus for reforming is presented in Figure 1. Six commercial Al_2O_3-supported catalysts were under investigation. Two of them were base metal catalysts (Ni, Co), and the rest were noble metal catalysts (Pd, Pt, Rh, Ru). As a feedstock, six different gas compositions were considered. The product gas composition except hydrogen was analysed by FTIR. The concentration of hydrogen was detected by a XMTC analyser.

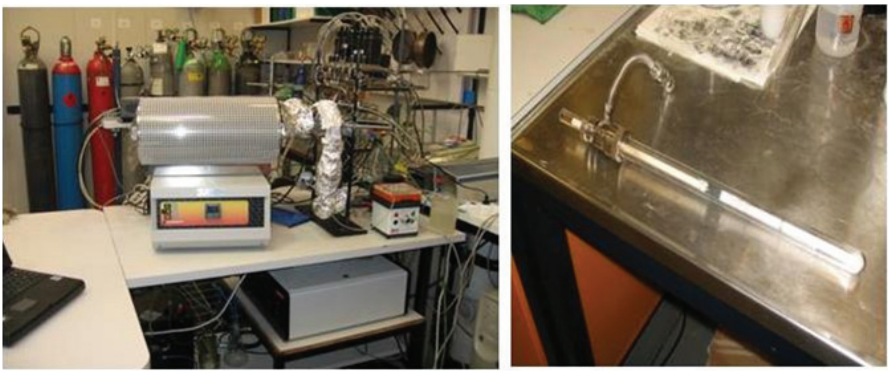

Figure 1 *Fixed bed reactor system for reforming.*

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3 Results

The results of dry reforming of the coke oven gas over six different catalysts are shown in Figure 2. The amount of synthesis gas is the share of H_2 and CO when the amount of dilution gas (N_2) is ignored. Temperature in the experiments was kept at 800 °C. The lowest curve in Figure 2 indicates the amount of synthesis gas in the feed gas.

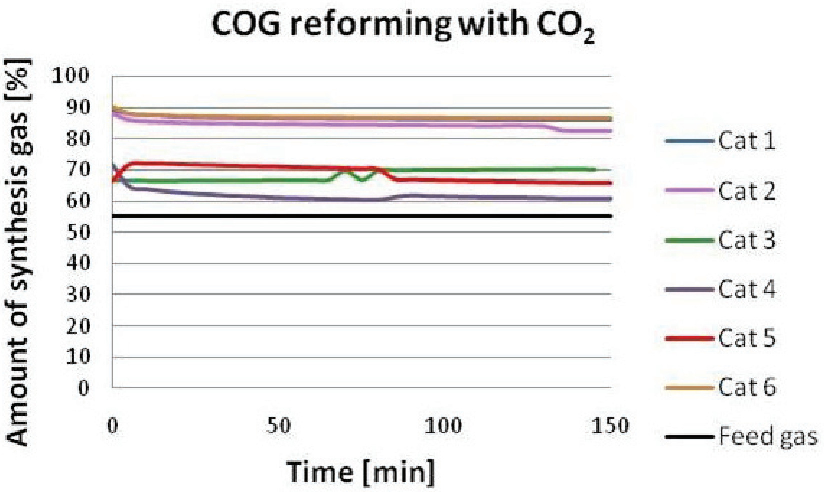

Figure 2 *Amount of synthesis gas when reforming COG with CO_2.*

By using nickel based catalyst (catalyst 6) or rhodium catalyst (cat 1), the amount of synthesis gas can be almost doubled by means of reforming. Instead, palladium based catalyst (catalyst 4) proved to be remarkable less active in the reforming reaction. Generally speaking, noble metal based catalysts exhibited better resistance to catalyst deactivation caused by carbon formation.

4 Conclusion

Based on the experimental results, it can be concluded that the coke oven gas and refinery gas are potential feedstock for hydrogen production by reforming. From the view of catalyst activity, nickel based and rhodium based catalysts were found to be most feasible for reforming reactions.

Acknowledgements

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References

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