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Methanol Reforming for Hydrogen Production

D. Li, H. Chen, L. Liang, S. Liu, H. Wu, S. Wang

Sino-Danish Center for Education and Research, Beijing, China

INTRODUCTION

Today in China, the use of fossil fuels in vehicles has caused several environmental problems, such as emission of particulate matters (PM), NO_x, SO_x and so on. As an ideal energy carrier, hydrogen has advantages of high energy density, high conversion efficiency and being harmless to the environment. Thus, hydrogen-based fuel cell becomes a good choice of power source for vehicles. Traditionally, hydrogen is produced from electrolysis of water, which consumes much electricity, and produces a mixture of oxygen and hydrogen which needs to be separated through expensive and complicated technologies. Consequently, it is desirable to find better ways to produce hydrogen. Hydrogen production from methanol reforming has the advantage of generating high-concentration hydrogen with low energy consumption. However there are challenges in design reactor for methanol reforming, such as uneven distribution of temperature in the reactor, low efficiency of heat exchange and large reactor size. Therefore, it is necessary to design an improved reactor to address these challenges.

THEORY

Methanol reforming is an alternative method to produce hydrogen. This technology converts the mixture of CH_3OH and H_2O into H_2 and CO_2, through the following reactions:

$$CH_3OH_{(g)} + H_2O \rightarrow CO_{2(g)} + 3H_{2(g)} \qquad \Delta H = 49.57 kJ/mol$$
$$CH_3OH_{(g)} \rightarrow CO_2 + 2H_{2(g)} \qquad \Delta H = 90.73 kJ/mol$$
$$CH_3OH_{(g)} + 1.5O_2 \rightarrow CO_{2(g)} + 2H_{2(g)} \qquad \Delta H = -675.91 kJ/mol$$

METHOD

In this project, a reactor for methanol reforming is designed through simulation, which is conducted by some simulation software, such as aspen or PROII. The designed reactor integrates reforming chamber, combustion chamber, vaporization chamber, heat exchange chamber and pre-heating chamber together. Therefore the gasification, preheating, catalytic combustion and auto-thermal reforming of methanol processes are integrated, in order to decrease the needed volume of the reactor and improve the efficiency through optimizing heat exchange.

RESULTS

With $ZrO_2/Pt/Al_2O_3$ and $Zn/Cr/La/Al_2O_3$ monolithic catalyst, our simulation results indicate that the concentration of hydrogen produced in this reactor can reach 70%. Besides, the hydrogen producing rate is around 1.5 m^3/kg (CH_3OH), and the energy consumption is below 3kw.

CONCLUSION

A reactor for methane reforming is designed through simulation. By integrating several processes into one reactor, we find the reactor can produce higher-concentration hydrogen and consume less energy, compared to the conventional approach.