

# A STUDY OF RADIAL HEAT TRANSFER IN A TUBULAR FISCHER-TROPSCH SYNTHESIS REACTOR

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## Summary

A series of heat transfer investigation experiments based on  $\text{TiO}_2$  supported Fischer-Tropsch (FT) Co catalyst with and without reaction were performed in a relative large ID tubular reactor. The first group of experiments was carried out with a heater in the center of the catalytic bed to simulate different FT reaction conditions and the second group of experiments was run at typical low temperature FTS conditions. The temperature profiles of the reactor with a heater in the center of the catalytic bed and with FT reaction in the reactor were measured at under a range of conditions. The aim of this work is to derive a radial heat transfer model for tubular FTS reactor which can be applied for FTS reactor design.

## Keywords

Fischer-Tropsch Synthesis, radial heat transfer, tubular reactor, heat transfer in packed beds.

## Introduction

Due to the global increase in energy costs, the Fischer-Tropsch Synthesis (FTS) reaction, which is a well known catalytic reaction that yields synthetic fuels from a mixture of CO and  $\text{H}_2$ , has received renewed industrial and academic interest for approximately the last two decades [1, 2]. At the same time, the fixed bed reactor is widely used in the chemical industry because of certain advantages when is compared to other kinds of reactors. When it is used for FTS, the applicable tube diameter is limited due to the large amount of heat generated and the poor heat transfer in the catalytic bed.

The FTS reaction is highly exothermic reaction and has an adiabatic temperature rise of up to  $1750^\circ\text{C}$ . Because of this, efficient heat removal is of crucial importance because too high temperatures may lead to a loss in selectivity, possible thermal runaways and rapid deactivation of the catalyst.

## Experimental

In this study, a tubular reactor with an inner diameter of 23 mm is used to investigate the radial heat transfer in a fixed bed FTS reactor. Thermo-wells were built into the reactor at different radial positions. Thermocouples could be moved up and down to measure the temperature at different axial positions. A heating coil was wrapped around the reactor and the heat input to this controlled to give a fixed value of temperature using a temperature controller. Two subsidiary heaters were placed at the two

ends of the reactor and these adjusted to give a flat axial temperature profile ( $<1^\circ\text{C}$ ) under no flow conditions

Two groups of experiments were carried out in the same catalytic bed. For the first group of experiments, the reactor was fed with  $\text{N}_2$  instead of reactant gases. The middle thermocouple was used as a heater to generate various amounts of heat to obtain different temperature profiles in the bed. For the second group of experiments, syngas was fed into reactor and FTS reaction was performed at typical low temperature FTS conditions. Different control temperature and flow rate were chosen. Fig.1 and Fig.2 show typical measured temperature profiles with a heater in the center of the catalytic bed and the FT reaction in the reactor respectively.

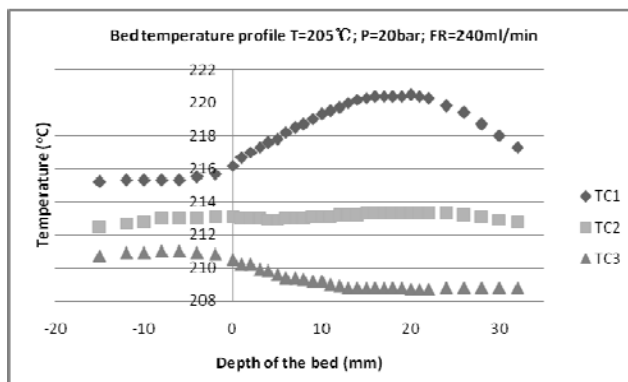


Fig.1 shows the temperature profile in the bed with the heater in the center. The bed depth from 0 to 22 is the catalytic bed and the other part is the bed support which is loaded with ceramic balls; the radius for TC1, TC2 and

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TC3 are at radius of 3.5, 6.6 and 10.9mm respectively measured from the inside wall.

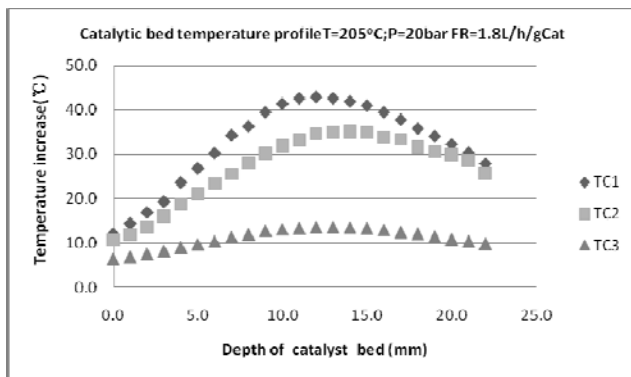


Fig.2 the catalytic bed temperature profile when the FT reaction happened in the reactor (the temperature increase across the bed can be as high as 42°C)

## Discussion

Experimental results for a whole range of flow-rates with only nitrogen flowing and different heater inputs were done. Under similar conditions a range of results with syngas flowing were also done.

Using the nitrogen results effective radial heat transfer coefficients for the bed were estimated. Using these values and measured rates of reaction in the reacting system the heat transfer model was checked for accuracy. The results from this analysis will be discussed with reasons for discrepancies highlighted.

## Conclusions

The aim of this work is to derive a radial heat transfer model for a tubular FTS reactor that can be used for a FTS reactor and catalyst design.

## References

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