CHAPTER VII

CONCLUSIONS

The main conclusions of the present work are as follows:

1. A high - pressure through - flow tubular reactor set (maximum design pressure = 50 atg, maximum design temperature= 450°C) has been fabricated and then tested for leakage up to the design pressure. A heating test to ensure uniform axial temperature distribusion in the middle section of the reactor furnace has also been carried out successfully.

2. A computer model based on Natta's rate expression has been developed for an industrial four-stage packed-bed high-pressure methanol synthesis reactor.

3. Simulation study of the effects of pressure, temperature and gaseous hourly velocity (GHSV) on the kinetic rate of methanol synthesis shows that the kinetic rate is greatly enhanced by high pressure , the optimum temperature being shifted to a higher value as either pressure or GHSV increases. Similarly the overall rate of methanol production in an adiabatic plug-flow reactor increases with both pressure and GHSV, the optimum temperature again being shifted to a higher value as either of these increases.

4. Based on a number of simulation results, " optimal " design of an industrial adiabatic four - stage plug - flow packed - bed methanol synthesis reactor to produce at least 850 metric tons of methanol per day has been carried out . The cross - sectional

area is 3.14 m^2, and the total effective length is 4 x 1.2 = 4.8 m. The synthesis pressure is 200 atm, whereas the reaction temperature is never allowed to exceed 390°C.

5. Using the above designed reactor, the effect of bypassing part of the feed gas for direct inter-stage quenching has been investigated. It is found that a "maximum" methanol production rate of 891 tons per day is obtained when 34% of the total feed gas is bypassed, of which 30%, 32% and 38% are sent to quench the product gases from the first, second and third stages, respectively. It is observed that generally the overall methanol production rate is enhanced by employing a lowest possible bypass ratio, and by allocating more quench gas for later stages. Furthermore, the methanol production rate at each stage should be essentially equal, while never allowing the reaction temperature to exceed 390°C.

6. The experimental results indicate that, at low GHSV, total CO conversion generally increases with temperature but decreases against pressure. As expected from thermodynamic equilibrium, methanol selectivity is found to increase with pressure, Dimethyl ether (DME) selectivity is likewise enhanced by high pressure especially at low GHSV; it is suppressed at high GHSV probably because the residence time is too short for methanol to dehydrate to DME. At high GHSV, methanol selectivity is relatively high since methanol is not dehydrated further to DME-A high GHSV and/or pressure tend to shift the temperature of maximum methanol selectivity upward. The effects of temperature, pressure and GHSV on the space time yield of methanol are similar to those on methanol selectivity.