5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This section briefly summarizes the major findings of the study effort. All comparative economic data referred to in this section are based on market basis cost assumptions and on plants configured to produce an all-liquid product slate.

(1) The slurry-phase Fischer-Tropsch synthesis results achieved by Mobil are substantially better in terms of conversion per pass and selectivity to premium liquid fuels than have been achieved and reported by other investigators since the Rheinpreussen experiments by Koelbel in the 1950's.

(2) Commercial designs based on Mobil two-stage results offer substantial economic improvement over designs based on established (e.g., SASOL) technology.

(3) The computed cost of gasoline from a commercial plant based on Mobil two-stage data is lower than costs derived from reference plants using SASOL or BGC/Synthol configurations and only slightly higher than costs from a commercial plant based on Koelbel slurry-phase Fischer-Tropsch data.

(4) In the Mobil low-wax case, the C_1-C_2 gas make is 12 weight percent versus 6.8 weight percent for Koelbel. The higher gas make represents an economic penalty since it increases the amount of gas which must be reformed to syngas and recycled to the synthesis reactor.

(5) In the Mobil high-wax case, the hydrocarbon gas make is 6.9 weight percent versus 6.8 weight per cent for Koelbel. In this mode of operation, diesel fuel from synthesis and from wax hydrocracking represents a large (37 percent) fraction of plant output. The high diesel output represents an economic penalty relative to Koelbel if it is assumed that diesel is only 95 percent as valuable as gasoline on a barrel basis. The expected trend toward higher diesel prices relative to gasoline will preferentially improve the conomics of the Mobil high-wax case. If diesel and gasoline values are assumed to be equal on a Btu basis, then the cost of product from a high-wax Mobil plant configuration would be slightly lower than the cost of product from the Koelbel reference plant.

5.2 Recommendations

(1) A broader experimental program on slurry-phase Fischer-Tropsch is required from the standpoint of establishing limits to maximum superficial velocities, catalyst concentration, and scale of operation. Continued development of catalysts of improved stability and activity combined with high selectivity to liquids is recommended.

(2) This analysis assumes that superficial synthesis gas velocities of 9.5 cm/sec as used at the Rheinpreussen pilot plant could be achieved in the slurry F-T first stage of the Mobil two-stage process. Actual superficial velocities obtained in the BSU varied from 2 to 6 cm/sec. This is consistent with the range of superficial gas velocities obtained by Koelbel in his laboratory scale unit on which the Mobil BSU is patterned. Failure to achieve the higher velocities will result in the necessity of increasing the number of slurry reactors, which would be an additional cost disadvantage. Substantiation of the scale-up potential of slurry F-T reactors with respect to superficial gas velocities and catalyst loadings must be undertaken to unequivocally quantify the space-time yields of these systems compared to conventional fixed-bed reactors.

(3) Substantiation of the ability of the slurry F-T reactor/precipitated catalyst system to process a syngas with an H:CO molar ratio of 0.5 should be undertaken, as was assumed in the Mobil Scoping Study.

(4) Wax withdrawal/catalyst recovery systems should be further investigated to determine ease of operation and ability to transfer recovered catalyst back into the reactor without loss of activation.

(5) The yield structure obtained from wax hydrocracking assumed in this study has currently not been achieved by Mobil. It was assumed that an identical product distribution to that obtained by Dry at SASOL when hydrocracking ARGE wax could be obtained with the Mobil wax. This point should be subtantiated.

(6) Further demonstration of F-T catalyst removal from recovered wax is needed so that the filtered wax can be processed in a fixed-bed hydrocracking unit with acceptable deactivation rates.

(7) Gasoline produced by wax hydrocracking will be of low octane and it is assumed in this study that this could be upgraded by using the zeolite reactor instead of by conventional reforming. This assumption should be investigated.

(8) It is recommended that the actual impact of the zeolite vis-a-vis conventional SASOL refining be evaluated for a product distribution of the type produced by the first-stage slurry F-T reactor in the Mobil two-stage systems.

(9) Future studies of the impact of the Mobil two-stage system on the cost of gasoline and diesel should be assessed using an advanced gasifier system like Shell which produces no gasifier C_1 and C_2 hydrocarbons.

(10) It would be very instructive in a future study to compare the performance and economics of the Mobil two-stage system operating in the high-wax mode (43 weight percent wax) to that of the conventional ARGE fixed-bed system. Both systems produce low C_1/C_2 gas makes (ca. 6-7 weight percent) and high wax makes (ca. 45 weight percent) although the Mobil system produces more gasoline boiling range hydrocarbons. Hydrocracking of wax for the two systems will both produce an attractive ratio of gasoline to diesel while minimizing the coproduction of SNG.