## VIII. DISCUSSION

Through intensive study of the relationships presented above and a careful point by point consideration of the data, it might be possible to deduce a consistent, plausible and conclusive theory of mechanism for the reactions involved in this synthesis. This was the intent of the present study but so many variables are involved that considerable further work is required before conclusions can be reached. At this stage of development all that can be done is to present a working hypothesis hoping that this will be confirmed and can be extended as time goes on.

Approach - Fixed Bed Theory

The approach used to interpret these data is similar to that used by Craxford* in interpreting the results obtained over a fixed bed of Cobalt catalyst.

He concluded that under these conditions the oil is formed first through the reaction

$$CO + 2H_2 = H_2O + (=CH_2)$$

followed, when conditions permitted, by the water-gas shift

$$H_2O + CO \rightleftharpoons H_2 + CO_2$$

If the space velocity was very small the reaction occurred completely in the bottom part of the bed, where the catalyst was carbided, and the remainder of the bed, where oil synthesis was not taking place, was left relatively free of carbide and therefore available for the water-gas shift. Under these conditions, $CO_2$ yield (from the shift) was high and in addition, the oil formed at the bottom of the bed was subjected to hydrogenation - cracking as it passed through the rest of the bed thereby producing a large amount of methane.

If the feed rate was increased, more and more of the bed was used for oil synthesis leaving less for the water-gas shift and hydrogenation-cracking until a point was reached where the oil yield was at its maximum and the $CO_2$ and $CH_4$ yield very low.

A further increase in feed rate resulted in a drop in oil yield because "the gas is not left in contact with the catalyst long enough for

* "Mechanism of Fishcer-Tropsch reaction", S.R. Craxford
Proceedings of Faraday Society - August, 1946

the synthesis to go to completion". At such high rates the methane and $CO_2$ yield drop still further.

When catalyst activity drops off with use i.e., as the synthesis reaction becomes slower, the length of catalyst bed required for synthesis becomes greater and greater so that the amount available for the water-gas shift and for hydrogenation-cracking becomes progressively less.

Craxford states that the above confirms the previously proposed theory that "oils are synthesized when the cobalt in the catalyst surface is in the form of carbide, whereas, uncombined cobalt gives methane, allows the water-gas shift reaction to take place and is active for the hydrogenation-cracking of hydrocarbons".

Craxford is not clear concerning the factors which determine the point where oil synthesis stops and the water-gas-shift begins but presumably, according to previous Craxford Publications, it is a function of the relationship between the catalyst carbiding, reducing and oxidizing tendencies of the components in the catalyst surrounding medium at that instant.