

SECTION II of Part I

OIL RECYCLE PROCESS

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Comments by L. W. Alberts

In this report the standpoint is taken that the problem of heat removal from an iron catalyst is more difficult than from a cobalt catalyst. The higher reaction temperature and the necessary higher pressure on iron catalyst are given as the reasons for this. The reviewer considers this viewpoint to be incorrect because on cobalt catalyst operating even at lower reaction temperatures a decomposition of carbon monoxide and deposition of carbon upon the catalyst occur to an appreciable extent. This is true even when the differences in temperature on the catalyst are essentially lower than on iron catalysts. On the contrary, the reviewer considers the iron catalyst less susceptible to temperature differences and, therefore, regards this as a decisive advantage in the heat removal problem. Similarly, he does not believe that the formation of methane and the decomposition of carbon monoxide is favored by the higher pressures necessary for iron catalysts. In general, an increase of the operating pressure at least within the limits of 5 to 30 atms. should result in a lower formation of methane and a smaller decomposition of carbon monoxide at equal productivity of the catalyst.

In the last section, on Page 11, the remark is made that according to the experimental results the application of the synthesis to a commercial scale will allow it to be performed in one stage provided the converter has a height of 18 meters. Results given later

in the same report support this conclusion only when the magnitude of the specific yield is neglected and one considers only the overall economics of the process and even this may be questionable.

On Page 12, it is stated that if the reaction heat is removed only in the form of sensible heat an increase of reaction temperature in the catalyst space must follow. Apart from possible theoretical calculations, the practical operating conditions will show that such an increase of the temperature along the catalyst bed must also appear when removing the heat by vaporization and oil recycle according to the Dufschmid^t Process. Withdrawal of the reaction heat by means of a sensible heat removal may permit one to operate the catalyst on a smaller temperature difference. The increase of temperature on the catalyst is a necessity in both cases, i.e., sensible heat and evaporative heat, but in the application of the Dufschmid^t Process this increase will be larger under conditions of equal practical yield by both processes.

On Page 20, the statement is made that in order to obtain higher capacities there should be present in the recycle oil constituents which vaporize under the reaction conditions. This statement appears to be entirely too broad. Although a small vaporization of the cooling oil cannot be avoided because of the saturating effect of the synthesis gas, there is no proof that when, for example, 50% of the reaction heat is removed by vaporization (as has been generally done in his experiments), a better capacity is obtained than when it (the reaction heat) is removed almost, exclusively by sensible means.

On Page 21, it is said that the boiling range of the cooling oil cannot be altered at will. With this statement, Dufschmidt admits that a temperature range in the converter is unavoidable and corresponds to the different boiling points of the various fractions of the oil. Because of this, the usage of the different portions of the catalyst bed were not particularly good.

The small conversion of only 55% in one stage is obviously a consequence of this principle. The deduction made on Page 22 that the small conversion rate is due to the short height of the converter (6 meters) and the following conclusions regarding the effect of height upon conversion rate are not comprehensible to the reviewer. Besides, this statement is contradictory to the hypothesis made on Page 11 in which the performance of the synthesis on a technical scale was considered possible in a converter of 18 meters height in a single stage. There is no doubt that the experimental conversion rates were approximately 50% in all experimental tests in which a single stage was employed. Those tests in two stages in which a total conversion of 75% was obtained show already a considerable decrease of the specific yield. The conclusion made on Page 22 that an increase in the specific yield in a full scale plant is definitely to be expected the reviewer finds to be without any foundation.

The space-time yield given on Page 25 of 20 to 25 grams total product per liter of catalyst per hour, or 480 to 600 kg. per cubic meter of catalyst per day is apparently the result of a 50% conversion of the gas in a one-stage operation. Extrapolated calculations of a

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total 90% conversion of the gas, which are based on the results from a 50% conversion in the first step and a 75% conversion in two steps, are definitely misleading. It is well known that an almost complete conversion of $\text{CO}+\text{H}_2$, i.e., above 90%, demands reaction conditions which will not permit the production of equal specific yields such as are produced under milder conditions, and this Dufschmidt^t himself, states on Page 22. At the same time, there is a change in the distribution of the products as well as in the usage ratio.

The yields and quality of products given on Page 25 and 26 are based upon the assumption of a 90% conversion of the $\text{CO}+\text{H}_2$ and are calculated upon the grams of $\text{C}_2+\frac{1}{\text{Nm}^3}$ of $\text{CO}+\text{H}_2$ converted. The Table on Page 26, however, is based upon an 85% conversion and all ^{e.e} this data obviously must be extrapolated from the 75% conversion obtained in two stages (see Page 10). Such extrapolations and those also given in earlier reports lead to final results which must be regarded with considerable caution.