IV. YIELD AND CATALYST ACTIVITY

The data have been averaged daily and also in groups of four or five days according to run conditions.[1] The water soluble acids have been included in the total liquid yields only in the group averages. Table I, opposite, summarizes the data from the group averages to facilitate comparison of the five runs.

The effect of catalyst age on liquid yield is shown in Figure 1, page 9. The yields have been projected as barrels per day of finished liquid product based on the Brownsville design feed rate of 9488 MCFH of H_2+CO. This method of expressing the yields has been retained for purposes of comparison with previous reported data even though The Texas Company no longer has a direct interest in the Carthage Hydrocol synthetic fuels plant at Brownsville, Texas.

The data from Run 49, made with Alan Wood magnetite, also have been shown in Figure 1 because they represent a run which produced high, consistent yields over a long period of time.

The yields from Run 58 were very low. This can be attributed to the poorly reduced catalyst. Run 61 produced the highest yields but at a sharply diminishing rate and had to be discontinued because of loss of control of catalyst temperature. This run, as well as Run 60, was made with a fresh feed rate of only 11 MSCFH instead of the normal 15 MSCFH.

The only run which was superior to Run 49 was Run 59 which produced a higher liquid yield for a longer time and showed no signs of weakening after 843 hours on stream. The throughput was similar to Run 49; namely, 13 to 17 MSCFH of H_2+CO and 1:1 recycle to fresh

---

[1] Daily calculation and data sheets are in the Appendix.

Figure 1

EFFECT OF CATALYST AGE ON LIQUID YIELD

CM&S Catalyst

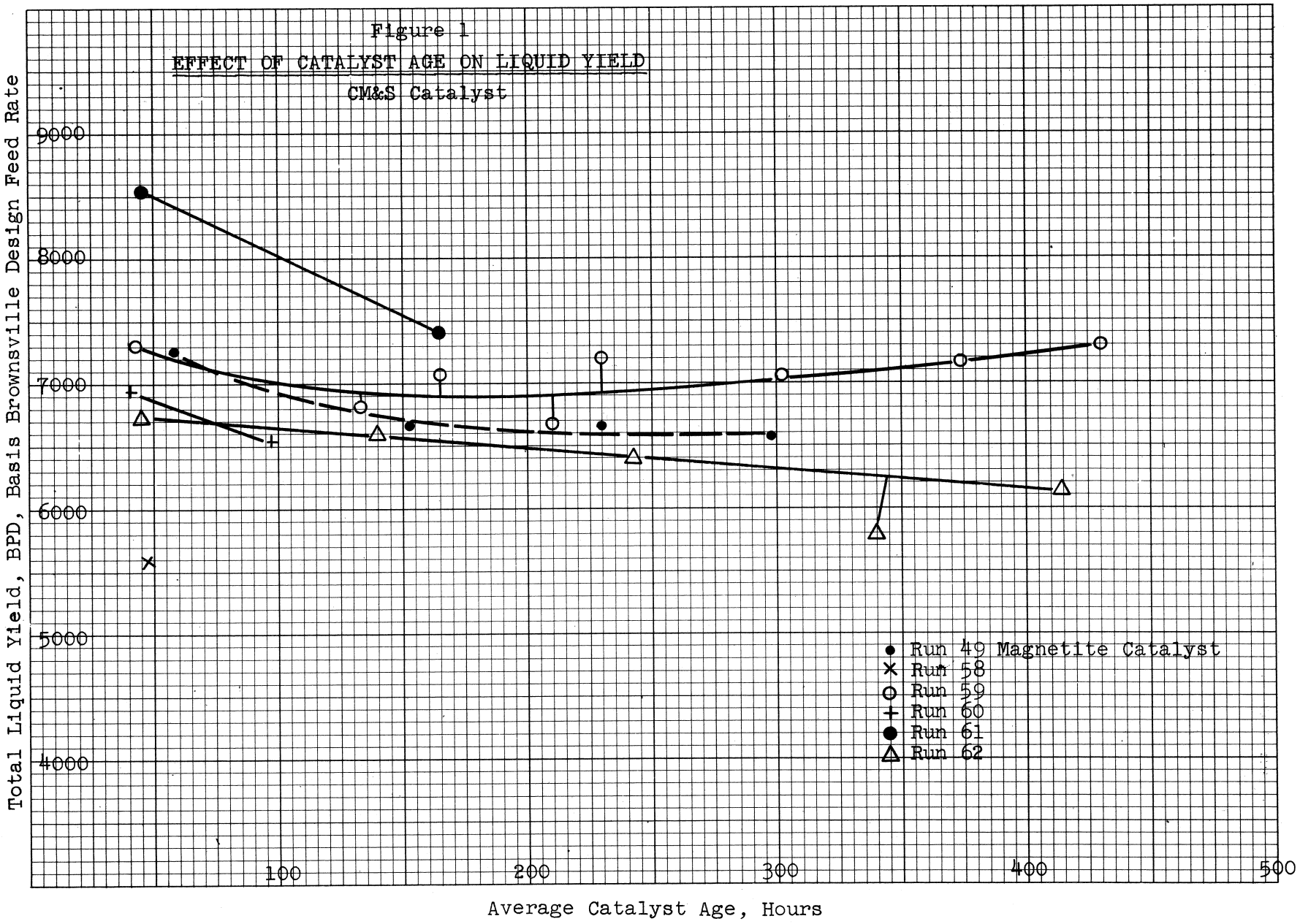
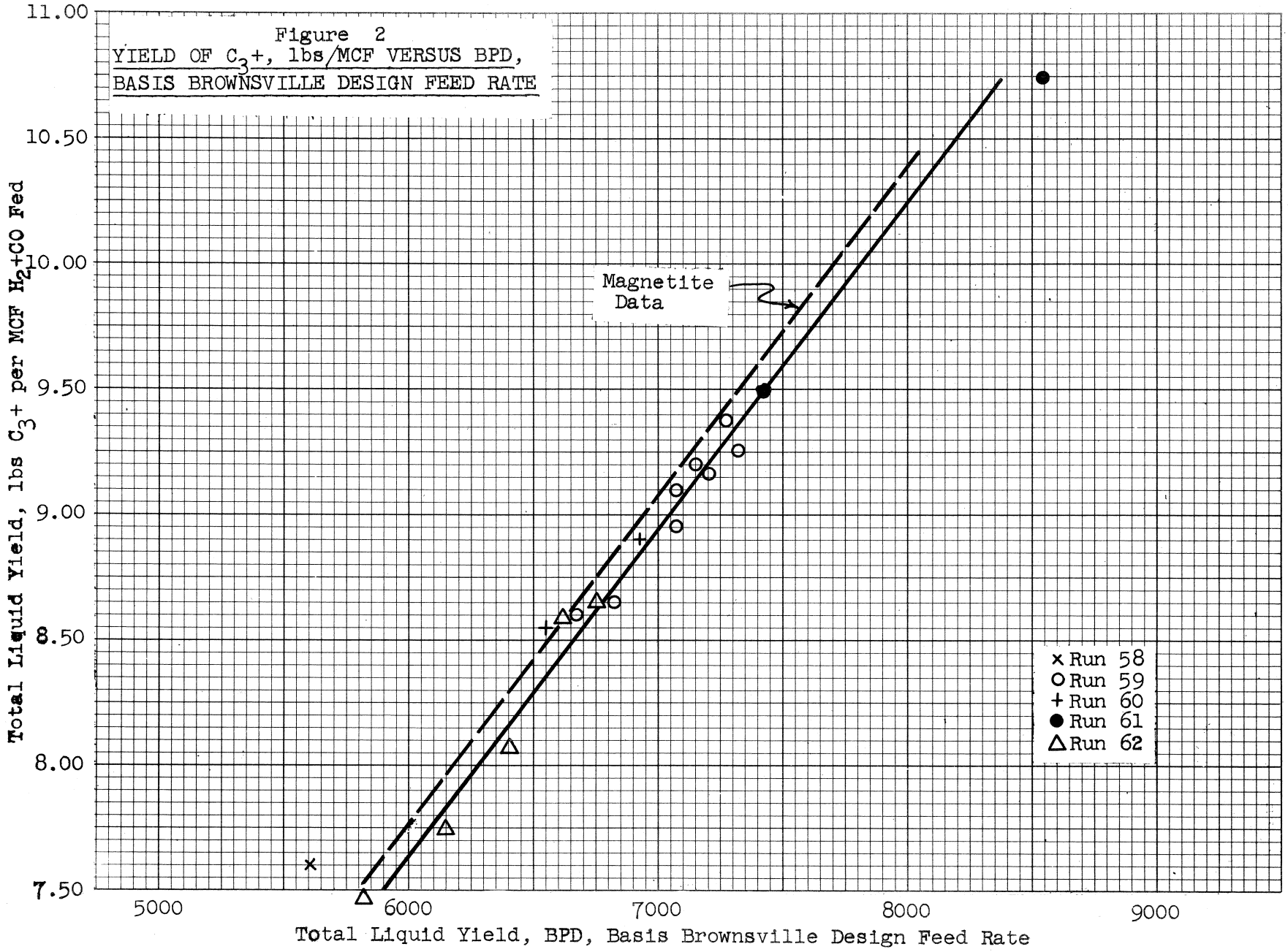


Figure 2
YIELD OF C_3+, lbs/MCF VERSUS BPD,
BASIS BROWNSVILLE DESIGN FEED RATE



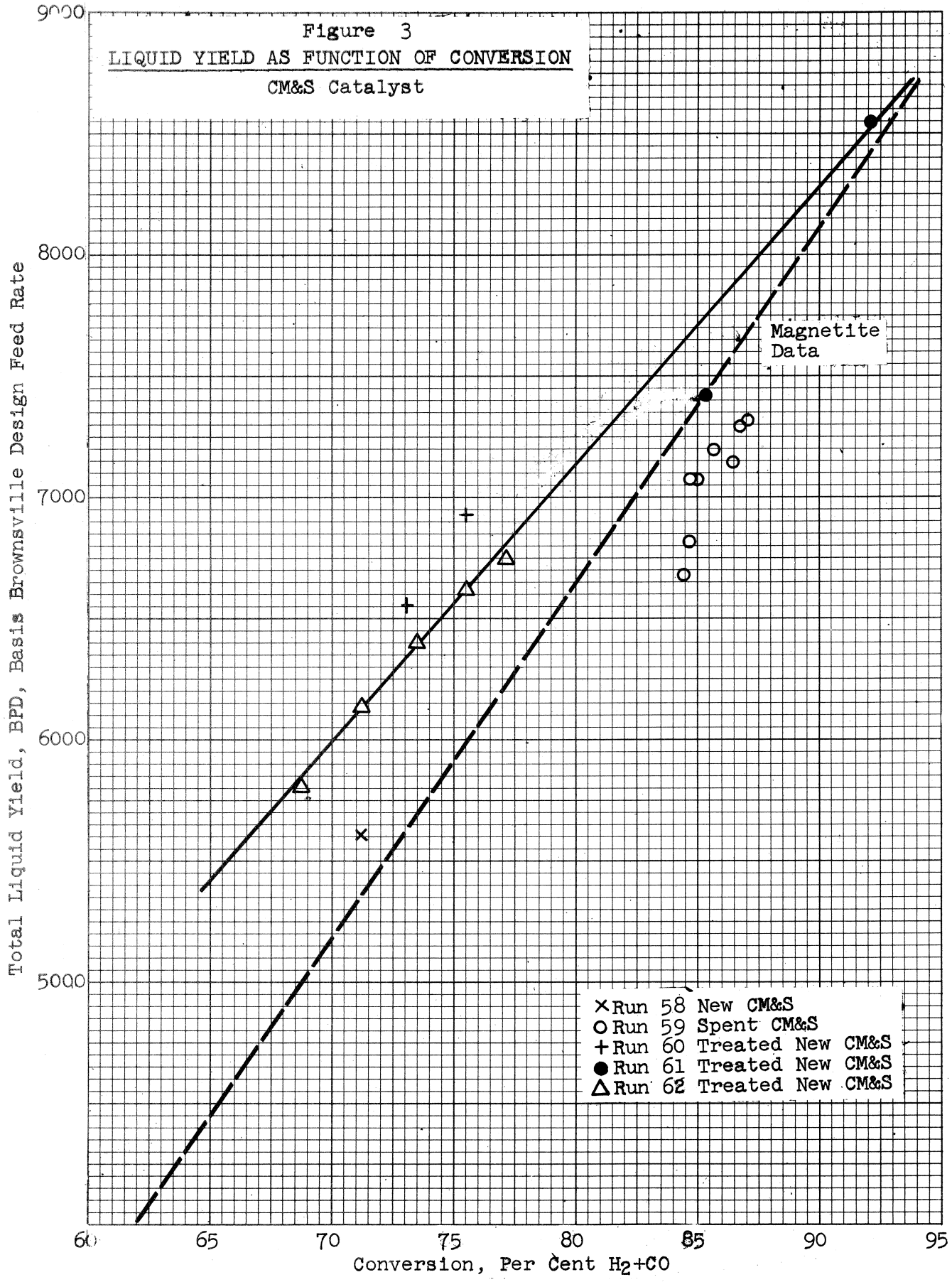


Figure 3
LIQUID YIELD AS FUNCTION OF CONVERSION
CM&S Catalyst
Total Liquid Yield, BPD, Basis Brownsville Design Feed Rate
9000
8000
7000
6000
5000
60
65
70
75
80
85
90
95
Conversion, Per Cent H2+CO
Magnetite Data
×Run 58 New CM&S
○Run 59 Spent CM&S
+Run 60 Treated New CM&S
●Run 61 Treated New CM&S
△Run 62 Treated New CM&S

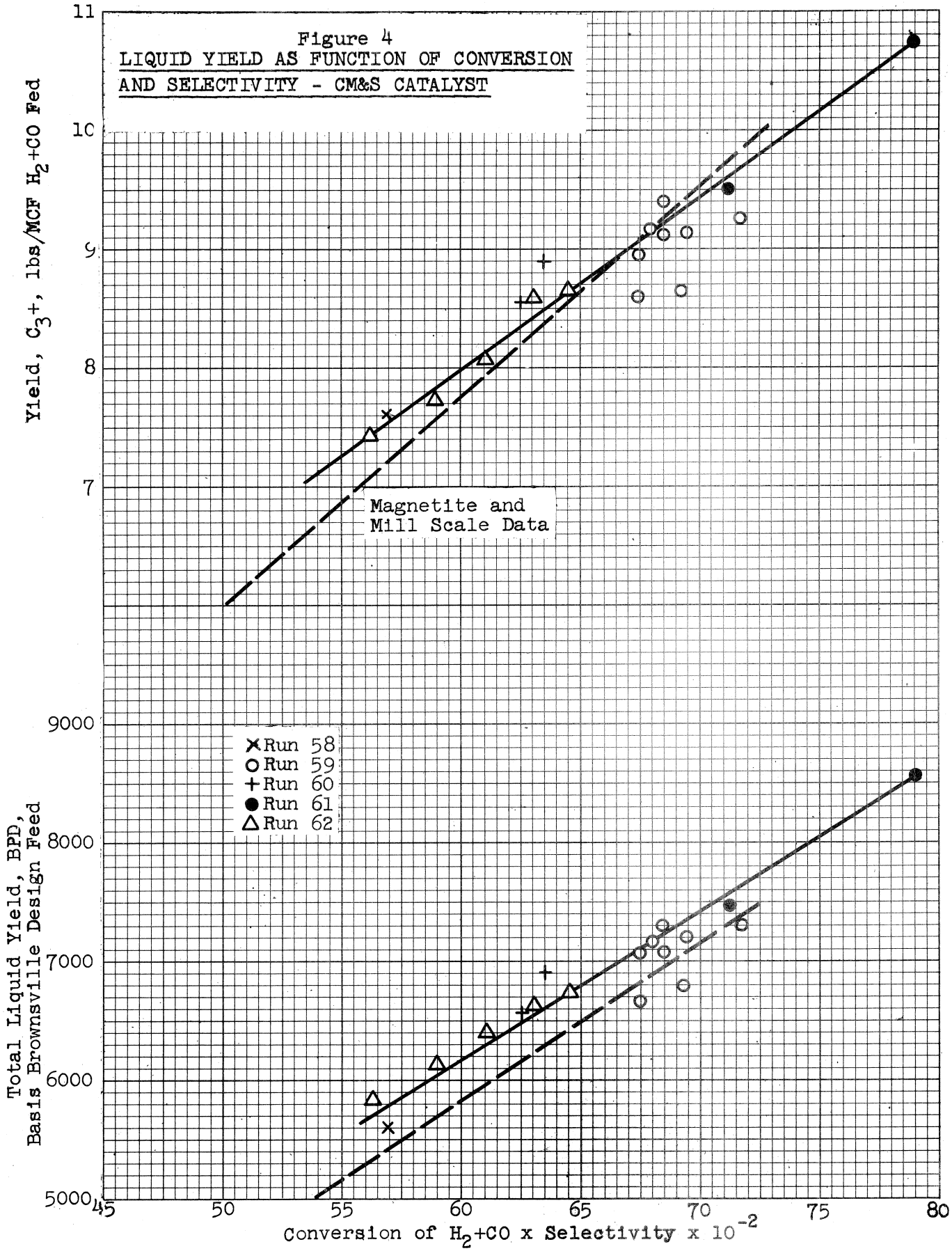


Figure 4
LIQUID YIELD AS FUNCTION OF CONVERSION AND SELECTIVITY - CM&S CATALYST
Yield, C_3+, lbs/MCF H_2+CO Fed
Total Liquid Yield, BPD, Basis Brownsville Design Feed
Conversion of H_2+CO x Selectivity x 10^{-2}
Magnetite and Mill Scale Data
Run 58
Run 59
Run 60
Run 61
Run 62
11
10
9
8
7
9000
8000
7000
6000
5000
45
50
55
60
65
70
75
80

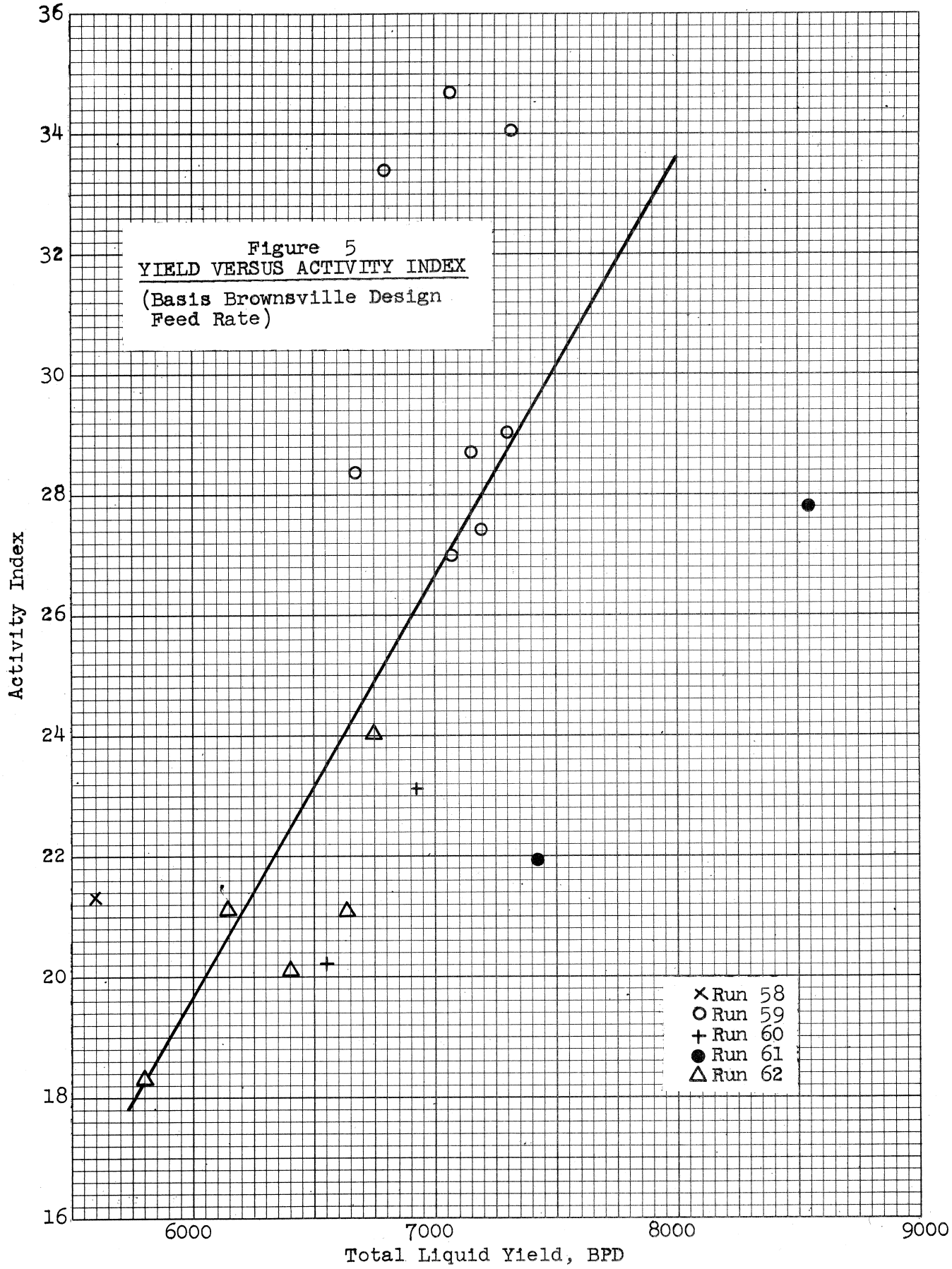
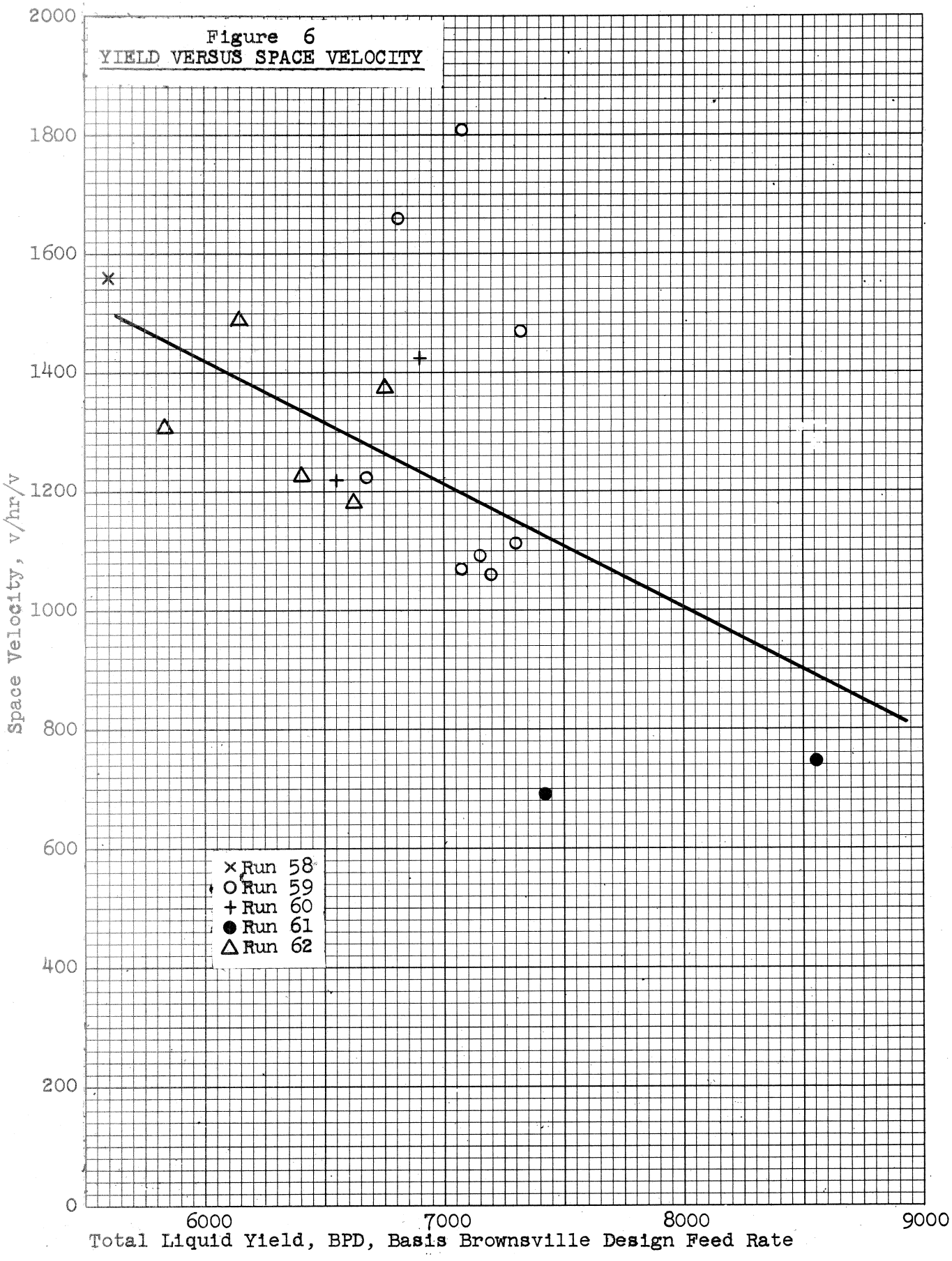


Figure 5
YIELD VERSUS ACTIVITY INDEX
(Basis Brownsville Design Feed Rate)
Activity Index
36
34
32
30
28
26
24
22
20
18
16
6000
7000
8000
9000
Total Liquid Yield, BPD
Run 58
Run 59
Run 60
Run 61
Run 62

Figure 6
YIELD VERSUS SPACE VELOCITY



feed ratio. The unique factor of this run was the use of reduced catalyst which had been previously used in ammonia synthesis. This catalyst was essentially fully reduced when received at Montebello Research Laboratory.

In Figure 2, page 10, is shown the relationship between the yield of C_3+ product and the yield basis Brownsville design. This relationship for CM&S catalyst is:

$$BPD = 780(C_3+, \text{ lbs/MCF})$$

The conversion factor, 780, is within 2 per cent of the factor for magnetite[1], 770, and is probably within the experimental error. It means that the data presented in this report on the Brownsville basis would show the same correlations, or lack of them, if presented in terms of yield of C_3+.

In Figures 3 and 4, pages 11 and 12, the liquid yield is shown as a function of conversion and of the product of conversion and selectivity. The yield data for CM&S catalyst are not very consistent as a function of conversion alone. When viewed as a function of both conversion and selectivity, they are consistent and in good agreement with previous data from magnetite and mill scale.[2] Plotting the yield as a function of the product of conversion and selectivity gives a check on the overall accuracy of the yield measurements and calculations.

The liquid yield is shown as a function of activity index[3] in Figure 5, page 13. The data points are quite widely scattered. They are scattered almost as badly in Figure 6, page 14, which shows the plot of yield versus space velocity, v/hr/v. Space velocity data are calculated using catalyst bed measurements which are

[1] TDC-802-40-P
[2] TDC-802-50-P
[3] $A = \sqrt{v/hr/v} \log\left(\frac{100}{100-\text{conversion}}\right)$

subject to some uncertainty. It is probable that some of the space velocity data are unreliable, and consequently the activity indices are doubtful.

The catalyst sample taps were plugged during all of Run 60 and most of Run 62 so that the particle size data are incomplete. Correlation of yield with catalyst particle size and space velocity has been made with magnetite and mill scale catalysts[1], but the combination of incomplete catalyst data and unreliable space velocity measurements rules out such a correlation with CM&S catalysts. With the former catalysts, higher yields were obtained with larger particle sizes and lower space velocities. With CM&S catalysts, however, in the two runs which produced high yields, one was made with coarse catalyst and high space velocity, and the other with fine catalyst and low space velocity.