Table H-10

Effect of Space Velocity on Yield and Selectivity for Carbon Monoxide

Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 503 K; Pressure = 4400 KPa; H_2/CO = 2/1

Activity		Product Distribution								Selectivity			
Space Velocity	CO Conv.	Yield (%)								Olefin/Paraffin Ratio			
($cm^3g^{-1}s^{-1}$)	(%)	C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	17.3	11.1	12.3	14.7	12.3	38.3	23.9	6.7	20.1	3.1	3.2	2.4	2.9
1.0	12.4	11.7	13.1	18.1	14.7	45.8	21.8	5.0	15.7	3.0	3.0	2.3	2.8
1.5	9.89	11.3	15.7	18.8	13.5	48.0	19.5	3.3	12.5	2.9	3.0	2.3	2.7
2.0	8.55	13.1	14.9	19.1	14.4	48.4	21.3	4.6	10.5	3.0	2.9	2.3	2.7

Table H-11

Effect of Space Velocity on Yield and Selectivity for Carbon Monoxide Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 493 K; Pressure =2760 KPa; H_2/CO =2/1

Activity		Product Distribution								Selectivity			
Space Velocity ($cm^3g^{-1}s^{-1}$)	CO Conv. (%)	Yield (%)								Olefin/Paraffin Ratio			
		C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	9.75	13.7	12.6	16.5	13.3	42.4	16.4	7.2	20.4	2.8	3.6	2.7	3.04
1	5.55	15.8	15.1	18.6	13.8	47.5	14.8	3.8	18.1	3.0	3.6	2.8	3.2
2	3.68	16.1	16.6	19.3	13.1	48.0	14.2	6.6	15.2	3.0	3.4	2.8	3.1
3	3.35	16.0	14.7	18.3	15.3	48.3	16.3	8.4	11.0	3.2	3.5	2.8	3.2
4	2.72	16.4	15.4	19.8	14.9	50.1	17.8	6.6	9.0	3.3	3.4	2.8	3.2

Table H-12

Effect of H_2/CO Ratio on Yield and Selectivity for Carbon Monoxide Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 503 K; Pressure = 1400 KPa; Space Velocity = 1 $cm^3 g^{-1} s^{-1}$

Activity		Product Distribution								Selectivity			
		Yield (%)								Olefin/Paraffin Ratio			
H_2/CO Ratio	CO Conv. (%)	C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	1.64	7.85	9.5	12.9	11.0	33.4	16.7	4.8	37.2	5.3	5.9	4.6	5.3
1	2.55	12.0	12.1	15.1	11.0	38.2	16.3	3.3	30.2	3.3	5.2	4.1	4.1
2	4.59	15.3	13.1	16.5	11.9	41.5	15.8	3.0	24.4	1.77	4.4	3.5	3.0
3	6.98	18.0	13.5	17.1	12.0	42.6	14.2	4.3	20.8	1.1	3.8	3.0	2.3
4	7.66	21.2	14.0	17.0	11.2	42.1	13.6	4.1	19.1	0.7	3.2	2.5	1.8

Table H-13

Effect of H_2/CO Ratio on Yield and Selectivity for Carbon Monoxide Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 503 K; Pressure = 2000 KPa; Space Velocity = 1 $cm^3g^{-1}s^{-1}$

Activity		Product Distribution								Selectivity			
		Yield (%)								Olefin/Paraffin Ratio			
H_2/CO Ratio	CO Conv. (%)	C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	1.95	6.5	9.8	13.6	11.5	34.9	18.5	4.9	35.2	4.9	5.2	3.9	4.6
1.0	2.94	9.4	11.9	16.0	12.8	40.6	16.8	4.7	28.5	3.5	4.7	3.7	4.0
2.0	5.02	13.2	13.2	17.4	13.2	43.7	15.6	4.6	22.9	2.6	4.0	3.2	3.3
3.0	8.13	15.5	14.6	18.9	13.9	47.4	15.8	4.3	17.0	1.7	3.8	3.0	2.7
4.0	9.50	19.5	14.6	18.3	12.7	45.5	15.3	3.9	15.8	0.9	3.3	2.7	2.0

Table H-14

Effect of H_2/CO Ratio on Yield and Selectivity for Carbon Monoxide Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 503 K; Pressure = 2600 KPa; Space Velocity = 1 $cm^3 g^{-1} s^{-1}$

Activity		Product Distribution								Selectivity			
		Yield (%)								Olefin/Paraffin Ratio			
H_2/CO Ratio	CO Conv. (%)	C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	2.42	8.6	10.8	13.8	11.0	35.6	16.3	4.8	34.6	5.2	4.6	3.5	4.3
1	3.72	11.9	13.2	16.3	12.1	41.7	16.6	4.9	25.3	4.0	4.1	3.1	3.7
2	6.53	14.3	14.2	17.5	12.0	43.7	19.0	4.3	18.7	3.0	3.6	2.8	3.1
3	9.42	17.2	15.5	18.4	13.1	47.0	16.5	4.0	15.3	2.5	3.5	2.7	2.9
4	11.54	18.3	14.8	17.6	12.5	44.9	18.4	3.7	14.6	1.8	3.3	2.5	2.5

Table H-15

Effect of H_2/CO Ratio on Yield and Selectivity for Carbon Monoxide Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 503 K; Pressure = 3200 KPa; Space Velocity = 1 $cm^3g^{-1}s^{-1}$

Activity		Product Distribution								Selectivity			
		Yield (%)								Olefin/Paraffin Ratio			
H_2/CO Ratio	CO Conv. (%)	C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	3.61	8.2	10.5	14.3	11.8	36.5	19.5	5.1	30.6	4.8	4.3	3.2	4.0
1	5.83	10.9	12.2	16.1	12.8	41.0	19.8	5.1	23.2	3.7	3.8	2.9	3.5
2	8.53	13.2	13.2	17.4	13.6	44.2	19.8	4.7	18.1	2.8	3.3	2.6	2.9
3	11.38	15.8	14.3	17.7	13.1	45.2	18.6	5.7	14.9	2.3	3.2	2.4	2.6
4	13.36	17.0	14.4	17.6	12.6	44.7	20.1	3.7	14.5	2.0	3.1	2.3	2.5

Table H-16

Effect of H_2/CO Ratio on Yield and Selectivity for Carbon Monoxide Hydrogenation in the Diluted-Bed, Pseudo Slurry Reactor

Temperature = 503 K; Pressure = 4400 KPa; Space Velocity - 1 $cm^3 g^{-1} s^{-1}$

Activity		Product Distribution								Selectivity			
		Yield (%)								Olefin/Paraffin Ratio			
H_2/CO Ratio	CO Conv. (%)	C_1	C_2	C_3	C_4	C_2-C_4	C_5^+	R-OH	CO_2	C_2	C_3	C_4	C_2-C_4
0.5	5.62	6.5	9.0	14.4	12.9	36.3	24.2	5.3	27.6	4.0	3.6	2.7	3.33
1	7.95	9.6	10.9	14.6	12.0	37.5	23.6	4.2	25.1	3.6	3.3	2.55	3.1
2	12.40	10.5	11.9	17.6	15.0	44.5	22.8	5.5	16.7	2.8	3.1	2.4	2.8
3	15.23	14.1	13.9	18.4	14.1	46.4	20.2	4.7	14.5	2.5	3.0	2.3	2.6
4	16.57	16.7	14.5	17.8	13.3	45.6	20.6	4.3	12.8	2.2	2.9	2.2	2.45

APPENDIX I

CALCULATION OF THE PARTIAL PRESSURE DEPENDENCE FOR CARBON MONOXIDE AND HYDROGEN IN A DILUTED-BED, PSEUDO SLURRY REACTOR

A rate equation proposed by Vannice[26] was used in this investigation to calculate the partial pressure dependencies of hydrogen and carbon monoxide for the hydrogenation of carbon monoxide over an iron-manganese catalyst in a diluted-bed, pseudo slurry reactor. The rate equation proposed by Vannice[26] was given by:

$$R = Ae^{-E_a/RT} P_{H_2}{}^{x} P_{CO}{}^{y} .$$

At low carbon monoxide conversions this equation can be written as follows:

$$X = K P_{H_2}{}^{x} P_{CO}{}^{y}$$

where X is the carbon monoxide conversion and K is a constant. If the hydrogen partial pressure is fixed, this equation can be further simplified as follows:

$$X = K' P_{CO}{}^{y}$$

or upon taking the natural logarithms

$$\ln_e X = \ln_e K' + y \ln_e P_{CO}$$

where K' is a constant. The plot of $\ln_e X$ versus $\ln_e P_{CO}$ should give a straight line and the slope of this line should give the exponent for the carbon monoxide partial pressure in the rate equation. If the partial pressure of carbon monoxide is then fixed, the same technique can be used to calculate the value of x in the rate equation.

The partial pressure of hydrogen was maintained constant at 1800 KPa during the experiments conducted to determine the carbon monoxide partial pressure dependence in the rate expression. The exponent for the carbon monoxide partial pressure was determined to be -0.091 from the data presented in Table I-1 and plotted in Figure I-1. The equation of the line in Figure H-1 is given by

$$\ln_e X = 2.599 - 0.091 \ln_e P_{CO} \quad .$$

The partial pressure of carbon monoxide was maintained constant at 900 KPa in a second series of experiments conducted to determine the hydrogen partial pressure dependence in the rate expression. The exponent x for the hydrogen partial pressure was computed to be 1.196 from the data presented in Table I-2 and plotted in Figure I-2. The equation of the line in Figure I-2 is given by

$$\ln_e X = 7.003 + 1.196 \ln_e P_{H_2} \quad .$$

The data presented in Tables I-1 and I-2 and plotted in Figure I-1 were obtained by interpolation of the data plotted in Figure 64.

Table I-1

Calculation of Carbon Monoxide Partial Pressure Dependence

P_{H_2} = 1800 KPa

Total Pressure (KPa)	P_{CO} (KPa)	H_2/CO	CO Conv. X (%)	$\ln_e P_{CO}$	$\ln_e X$
2600	800	2.25	7.35	6.685	1.995
3200	1400	1.286	6.9	7.244	1.932
4400	2600	0.692	6.6	7.863	1.887

Table I-2

Calculation of Carbon Monoxide Partial Pressure Dependence

P_{CO} = 900 KPa

Total Pressure (KPa)	P_{H_2} (KPa)	H_2/CO	CO Conv. X (%)	$\ln_e P_{H_2}$	$\ln_e X$
1400	500	0.556	1.7	6.215	0.531
2000	1100	1.222	3.33	7.003	1.203
2600	1700	1.889	6.30	7.438	1.841
3200	2300	2.556	10.10	7.741	2.313
4400	3500	3.889	16.5	8.161	2.803

Figure I-1

Dependence of Carbon Monoxide Conversion on
Carbon Monoxide Partial Pressure at
Fixed Hydrogen Partial Pressure

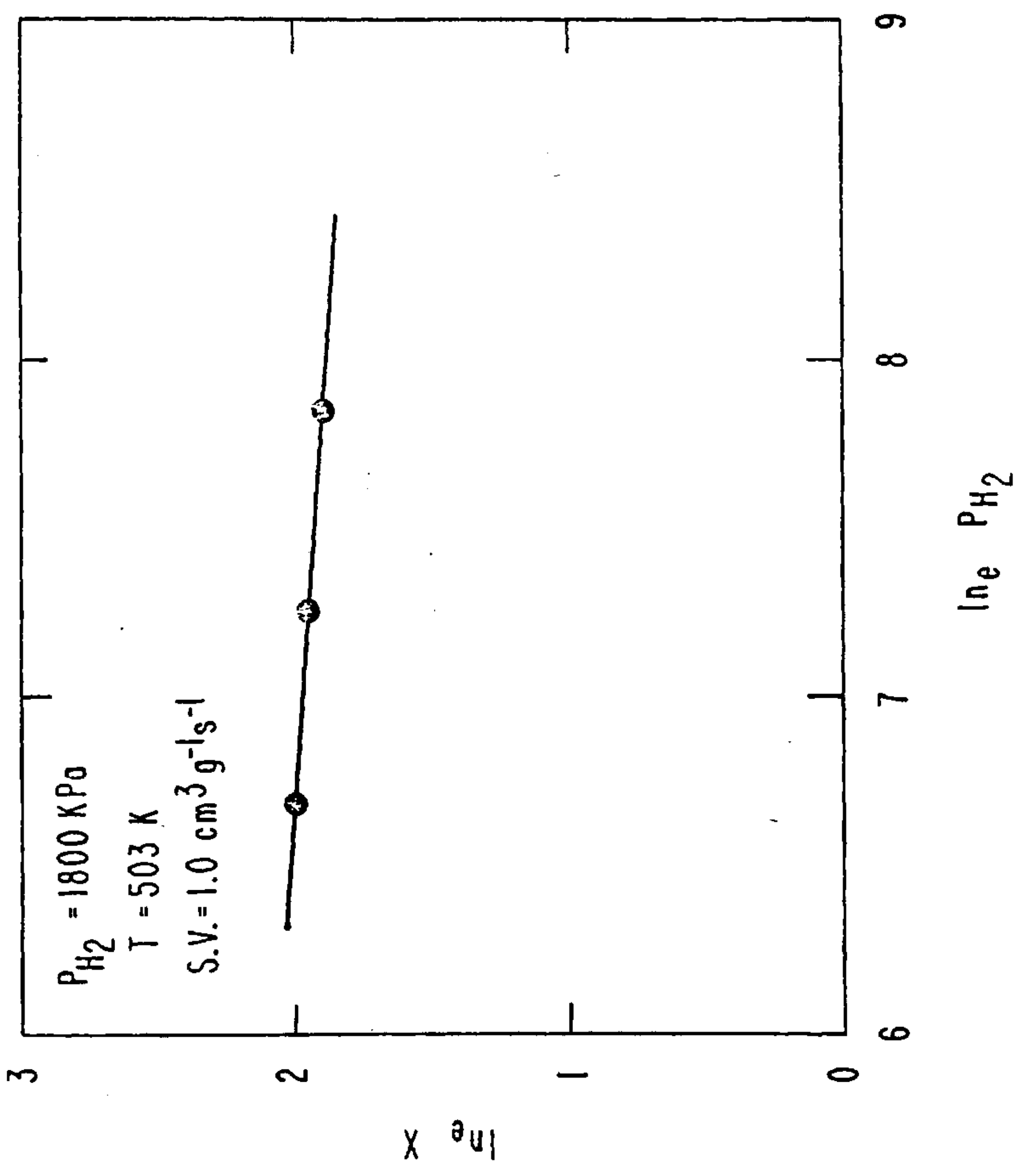
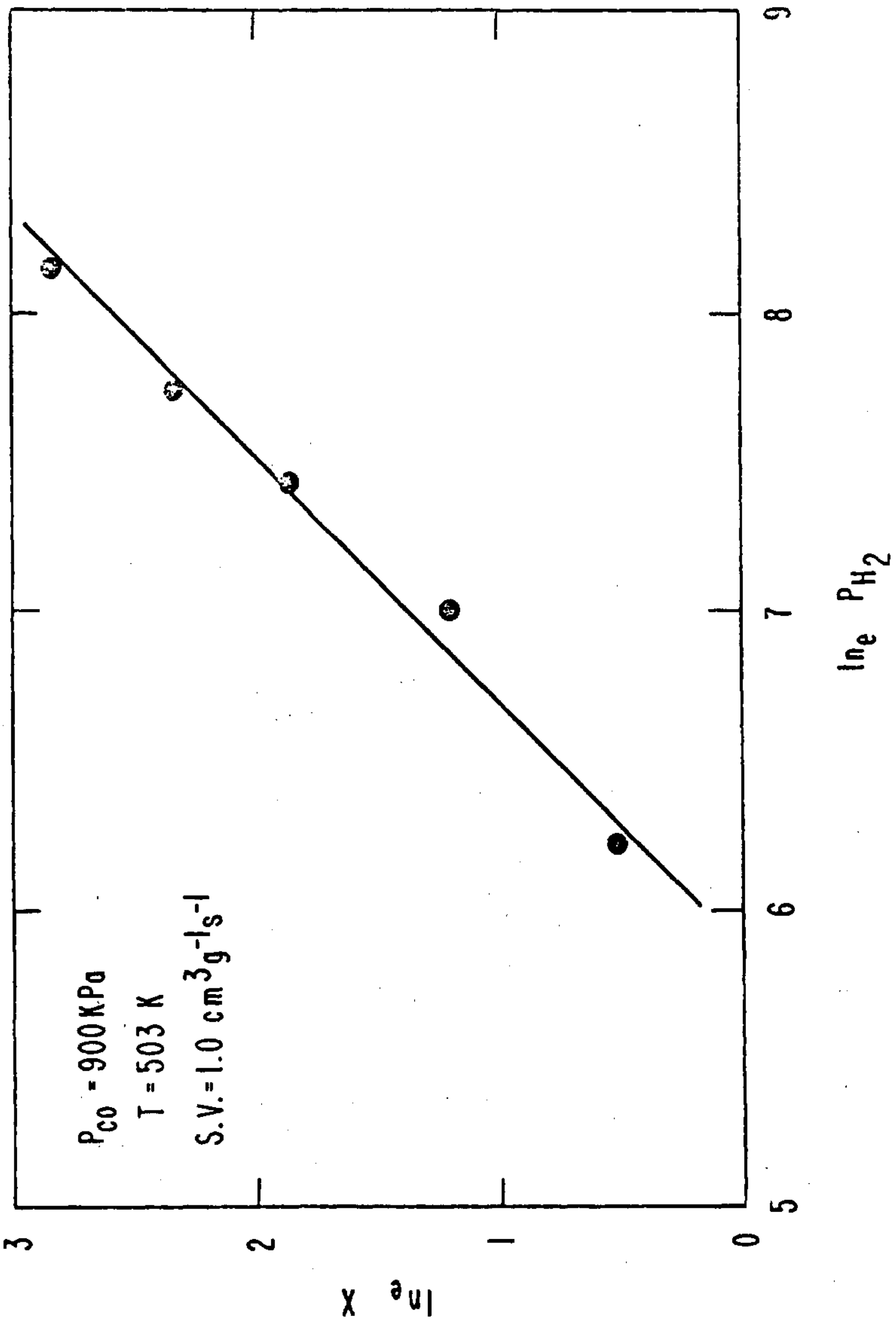

P_{H_2} = 1800 KPa
T = 503 K
S.V. = 1.0 $cm^3 g^{-1} s^{-1}$
$ln_e\ P_{H_2}$
$ln_e\ X$
6
7
8
9
0
1
2
3

Figure I-2

Dependence of Carbon Monoxide Conversion on

Hydrogen Partial Pressure at Fixed

Carbon Monoxide Partial Pressure



P_CO = 900 KPa
T = 503 K
S.V. = 1.0 cm3g-1s-1
ln_e P_H2
ln_e X
5
6
7
8
9
0
1
2
3

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