

## CATALYST LIFE TESTS

Questions arising from the results of the preliminary screening studies directed efforts towards investigation of catalyst carburization, potassium impregnation, and regenerative procedures, in order to determine what effects these parameters have on catalyst stability and selectivity. The two bench-scale units that were used in the preliminary tests were reconstructed and two additional units were constructed. These new units were equipped with modern and more reliable instrumentation that provided excellent temperature control and monitoring, pressure regulation, and flow control. The flow diagram of the units is similar to that shown in Figure 1.

The catalyst used in this series of tests was a flame-sprayed, beneficiated taconite iron ore ( $\text{Fe}_2\text{O}_3 + \text{Fe}_3\text{O}_4$ ) obtained from U.S. Steel Corporation. The operation and description of the units are the same as those described in the previous section. The results of several experiments will be analyzed individually.

The tests were performed according to the following experimental procedure:

A. Catalyst Preparation:

An oxygen-hydrogen flame-spraying technique is used to apply the taconite powder to a 6-inch section along the outside surface of a 3/4-inch, schedule 80, carbon steel pipe.

B. Addition of Promoters:

To impregnate the catalyst with potassium, the flame-sprayed pipe was soaked in a 6%  $\text{K}_2\text{CO}_3$  aqueous solution for 10 minutes.

C. Reduction:

Prior to F-T synthesis, the taconite catalyst was reduced in  $H_2$  at  $400^\circ C$ , an exposure velocity of 7-14 J (J is defined as the exposure velocity for gas feed expressed as scfh of gas/square foot of geometric catalyst surface), and 50 psig to remove the oxygen from the iron oxide material. Reduction was continued (usually for 100 hours) until the theoretical amount of  $H_2O$  was collected.

D. Induction:

Induction or precarbiding of the reduced sample was conducted by passing  $2H_2 + 1CO$  over the catalyst at 24 J for 72 hours at a pressure less than 100 psig and temperatures of  $240^\circ$  or  $310^\circ C$ .

E. Catalyst Testing:

One of the objectives of this series of experiments was to determine product distribution as a function of reaction temperature, pressure, and flow rate. Therefore, the normal testing procedure was to introduce synthesis gas ( $2H_2 + 1CO$ ) at 300 psig and at the induction temperature for Period A. A period is defined as the length of time (hours) that the reactor is held at constant operating conditions. For successive periods, temperature was usually increased while pressure was maintained at 300 psig, then reactor pressure was raised to either 650 or 1000 psig. Temperature may also be varied at the higher pressures. Before a run was terminated, the pressure was reduced to 300 psig, and the data were recorded at a temperature used for an earlier period. From the drop in CO conversion between two periods at similar operating conditions, the degree or extent of catalyst deacti-

vation could be determined. For periods operated at similar conditions, CO conversion is defined as follows:

$$\text{CO conversion} = 1 - \frac{A}{B}$$

where

- A = scfh of CO in the product gas at  $t_i$
- B = scfh of CO in the feed gas at  $t_i$
- $t_i$  = time at end of a particular period

The above definition does not take into account catalyst weight or surface area and can only be used as a convenient measure of catalyst activity for a particular run.

## FT-STW-1-2

Experiment FT-STW-1-2 was operated successfully for 2233 hours. Operations were conducted at 300, 650, and 1000 psig, a flow rate of 24 J of  $2\text{H}_2 + 1\text{CO}$  gas, and temperatures of  $325^\circ\text{C}$  and  $340^\circ\text{C}$ . Twenty-nine grams of catalyst were flame-sprayed onto the tube surface. Catalyst characteristics, application technique, and activation procedure were previously described. The catalyst was carburized at  $310^\circ\text{C}$ , and no promotor was used. After 1851 hours, the catalyst was regenerated. Regeneration involved performing first a reduction in  $\text{H}_2$  at  $400^\circ\text{C}$  and then a precarbiding step using  $2\text{H}_2 + 1\text{CO}$  gas at  $310^\circ\text{C}$ . This particular regeneration required 142 hours, 71 hours for reduction and 71 hours for induction. Upon start-up, the catalyst performed satisfactorily for the two succeeding weeks. Carbon monoxide conversions were greater than 90% while operating at 300 psig and a temperature of  $325^\circ\text{C}$ . At this point, it was necessary to defer the experiment for 48 days. The catalyst was stored under hydrogen. The high activity demonstrated after the regeneration was not reached after start-up following the storage period. The experiment was then terminated without attempts at further regenerations. Visual inspection of the taconite revealed the catalyst to be completely covered by carbon. Tables 3 and 4 summarize the results of FT-STW-1-2.

Experiment FT-STW-1-2 resulted in carbon monoxide conversions in excess of 90 percent. The hydrocarbon product distribution was dominated by the lighter hydrocarbons,  $\text{C}_1$  to  $\text{C}_3$  composing 77.0% to 88.9% of the total. Oil production was maximum at operations of 650 psig, with 1.4 grams of oil produced per hour. The maximum amount recovered at 300 psig or 1000 psig was 0.51 grams per hour. The above values do not consider periods after the regeneration. Immediately following the regeneration, and while operating at 300 psig and  $325^\circ\text{C}$ , the oil production was 1.01 grams per hour.

Table 3. Results from Experiment FT-STW-1-2 (Taconite)

Period	A	B	C	D	E	F	G	H	I	J	K	L*	M	N**	O
Hours/period	43	168	121	168	168	163	163	168	168	186	168	167	166		
Exposure velocity (J)	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Temperature (°C)	252	281	301	235	341	340	341	340	340	340	338	340	324		
Pressure (psig)	300	300	300	300	300	300	650	650	650	1000	1000	300	300		
Usage Ratio: H <sub>2</sub> /CO	1.72	1.71			1.56	1.55	1.75	1.78	1.73	1.81	1.84	1.59	1.45		
H <sub>2</sub> Conversion (%)	29.6	37.1			71.0	70.7	78.6	78.9	79.2	83.4	32.2	59.5	69.1		
CO Conversion (%)	37.5	47.3			95.3	96.9	98.2	97.8	98.0	98.9	97.2	79.6	97.5		
H <sub>2</sub> +CO Conversion (%)	32.1	40.3			78.8	79.1	84.8	84.8	85.2	88.4	86.9	65.9	78.4		
Heating Value (Btu/scf)	369	390			481	499	538	532	535	579	567	432	490		
Heating Value w/o CO <sub>2</sub>	382	415			596	628	677	670	675	734	706	499	620		
Recovered Products (g/m <sup>3</sup> (H <sub>2</sub> +CO) Converted)															
CH <sub>4</sub>	87.9	99.7			70.5	77.4	80.7	81.1	32.7	99.3	94.2	85.6	79.9		
C <sub>2</sub> H <sub>4-6</sub>	21.0	23.9			18.1	20.0	15.2	14.1	13.9	13.6	13.9	17.6	19.2		
C <sub>3</sub> H <sub>6</sub>	9.8	5.0			5.1	6.8	1.9	1.5	1.5	0.1	0.1	4.4	3.6		
C <sub>3</sub> H <sub>8</sub>	11.7	17.5			9.8	11.6	10.3	9.2	8.5	6.3	6.9	7.8	14.3		
C <sub>4</sub> H <sub>8-10+</sub>	8.6	9.7			6.5	9.2	7.5	6.8	6.9	3.9	4.3	5.8	9.4		
Oil Phase	16.8	9.5			4.9	6.7	17.3	16.5	14.9	4.7	6.2	4.0	13.4		
Aqueous Phase	144.9	114.6			63.5	76.5	99.4	91.9	91.2	93.2	95.7	73.5	89.6		
H <sub>2</sub> O	133.6	106.5			61.2	73.3	94.9	86.4	85.5	87.0	86.6	69.5	86.9		
Total															
Hydrocarbons	167.0	173.3			117.2	135.0	137.3	134.9	134.0	134.1	134.7	129.1	142.5		
Hydrocarbon Product Distribution (wt %)															
C <sub>1</sub> +C <sub>2</sub>	65.2	71.3			75.6	72.2	69.8	70.6	72.1	84.2	80.2	79.9	69.5		
C <sub>3</sub>	7.0	10.1			8.4	8.6	7.5	6.9	6.4	4.7	5.1	6.0	10.1		
Gasoline (<204°C)	22.6	16.4			14.8	18.2	20.8	19.6	19.4	10.7	14.2	13.0	17.9		
Diesel (204°C-316°C)	3.2	1.4			0.8	0.9	0.6	1.7	1.8	0.4	0.4	1.0	1.5		
Fuel (316°C-450°C)	1.4	0.5			0.4	0.1	0.5	1.0	0.4	--	--	0.2	0.5		
Wax (>450°C)	0.6	0.2			0.1	< 0.1	0.8	0.3	--	--	--	--	0.6		
lb Hydrocarbon produced/1000 ft <sup>3</sup> of fresh feed gas															
	3.2	4.2			5.6	6.5	7.1	7.0	7.0	7.2	7.1	5.2	6.8		

\*Catalyst regeneration  
 \*\*Shut down for 48 days.

Table 4. Recovered Oil Product for FT-STW-1-2

Period	A	B	C	D	E	F	G	H	I	J	K	L*	M	N**	O
Pressure (psig)	300	300	300	300	300	300	650	650	650	1000	1000	300	300	300	300
Temperature (°C)	252	281	301	325	341	340	341	340	340	340	338	340	325	325	325
Oil Recovered (grams/hour)															
Heavy Product	0.01	0.01	0.02	0.03	0.02	0.03	0.24	0.23	0.20	--	--	--	0.04	0.09	0.03
Light Product	0.50	0.35	0.38	0.32	0.35	0.48	1.16	1.11	1.01	0.40	0.51	0.25	0.97	0.91	0.25
Light Oil Composition - FIA Analysis															
Saturates	56	68	71	67	44	42	63	55	59	76	71	44	49	57	65
Olefins	28	23	20	26	43	52	35	40	39	22	26	48	46	40	28
Aromatics	7	3	3	5	7	4	< 1	< 1	< 1	< 1	2	7	4	2	< 1
Heterocyclics	9	6	6	≤ 2	6	≤ 2	≤ 1	4	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1	≤ 1

\*Catalyst Regeneration

\*Shut down for 48 days

The oil product for the entire experiment was highly saturated. Regeneration of the taconite catalyst was successfully demonstrated. A level of activity was reached after the regeneration comparable to that obtained early in the test.

#### FT-STW-2-2

Experiment FT-STW-2-2 operated successfully for over 6000 hours. Forty-three grams of taconite were flame-sprayed to a thickness of 27 mils and impregnated with a 6% solution of potassium carbonate. The catalyst was carburized at 240°C. Application technique, promotion, and activation procedures were described previously. Operations were conducted at 300, 650, and 1000 psig and at temperatures of ~ 325°C and ~ 340°C. The flow rate remained constant at an exposure velocity of 24 J. Table 5 summarizes product yields and selectivities from typical experimental periods.

The effect that potassium had on CO conversion is illustrated in Figure 4. The small amount of promotor (approximately 0.4 wt%) increased CO conversion at 325°C by approximately 23%. The effect of pressure on conversion was insignificant. Potassium also shifts the hydrocarbon product selectivity toward higher molecular weight compounds. In two other bench scale tests, approximately three times the amount of oil (Table 6) was obtained from the promoted sample.

The effects of temperature and pressure on the product distributions are shown in Tables 7 and 8. An increase in temperature and pressure did not affect the total product yields. Selectivity changes that did occur were in the hydrocarbon fraction. High temperature and low pressure favored the selectivity to C<sub>1</sub>+C<sub>2</sub>, while the largest gasoline yields were obtained at either low temperatures or at high pressure operation.

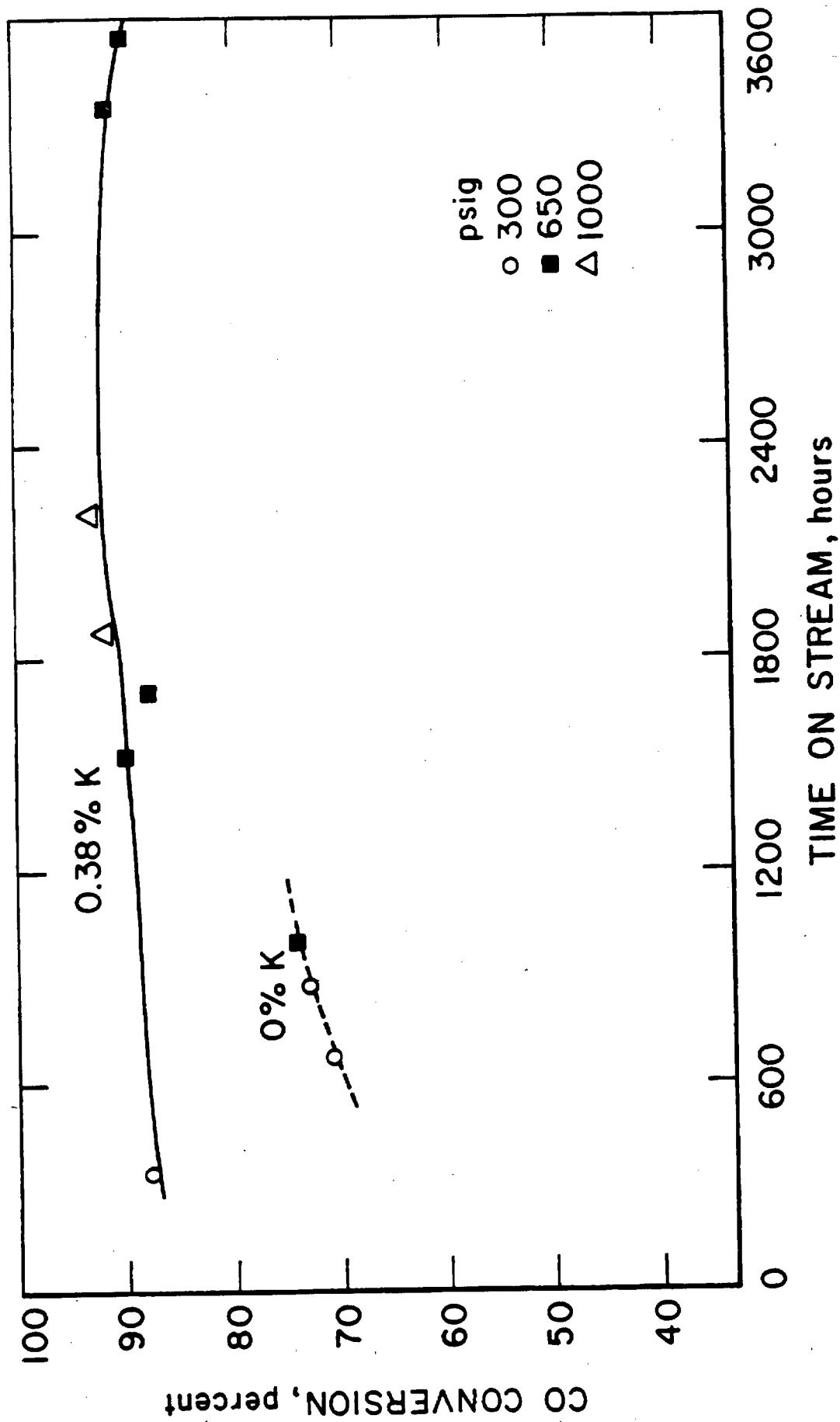


Figure 4. CO conversion at 325°C - taconite catalyst.



Table 5. Experiment FT-STW-2-2 Results

Period	A	B	C	D	E	F	G	H	I	J	K	L
Hours on Stream	189	357	525	693	861	1025	1193	1361	1529	1697	1861	2029
Exposure Velocity (J)	24	24	24	24	24	24	24	24	24	24	24	24
Temperature (°C)	325	325	340	340	340	340	340	340	325	325	327	329
Pressure (psig)	300	300	300	300	300	650	650	650	650	650	1000	1000
Usage Ratio: H <sub>2</sub> /CO	1.33	1.19	1.28	1.21	1.18	1.38	1.36	1.34	1.35	1.33	1.40	1.39
H <sub>2</sub> Conversion (%)	41.4	49.5	54.2	54.0	52.7	59.8	59.1	58.7	55.9	54.2	59.5	59.9
CO Conversion (%)	67.8	87.8	91.9	92.6	92.3	94.1	93.6	93.1	90.5	87.7	92.2	93.3
H <sub>2</sub> + CO Conversion (%)	49.7	61.8	66.1	66.5	65.6	70.6	70.0	69.7	66.8	64.8	69.8	70.4
Heating Value (Btu/scf)	403	437	460	461	446	475	468	464	449	443	469	467
Heating Value w/o CO <sub>2</sub>	453	530	569	572	549	589	579	574	550	536	578	579

Recovered Products (g/m<sup>3</sup> (H<sub>2</sub> + CO) converted)

CH <sub>4</sub>	79.3	88.8	104.2	106.2	88.0	90.0	90.1	88.4	90.3	95.9	106.9	103.0
C <sub>2</sub> H <sub>4-6</sub>	27.2	29.8	31.4	31.0	27.2	25.0	23.8	23.4	23.9	24.0	24.3	23.0
C <sub>3</sub> H <sub>6</sub>	16.7	17.4	15.6	14.7	13.1	9.6	7.5	6.7	5.5	4.3	1.0	0.3
C <sub>3</sub> H <sub>8</sub>	13.3	13.0	13.6	12.0	15.5	16.5	17.4	17.3	18.3	18.6	18.2	18.4
C <sub>4</sub> H <sub>8-10+</sub>	17.0	16.3	12.5	11.4	14.6	14.4	14.3	14.5	14.2	12.0	9.6	9.9
Oil Phase	25.6	17.1	7.2	7.4	20.1	29.3	27.2	27.1	26.1	21.7	15.3	15.0
Aqueous Phase	131.8	126.5	96.3	93.1	101.7	124.7	120.5	116.7	111.9	108.6	116.6	109.8
H <sub>2</sub> O	128.8	118.4	93.8	89.9	99.1	116.9	110.6	106.5	99.0	92.2	95.2	84.4
Total Hydrocarbons	187.1	190.5	188.2	186.0	181.1	192.7	190.2	187.6	191.2	192.8	196.7	196.1

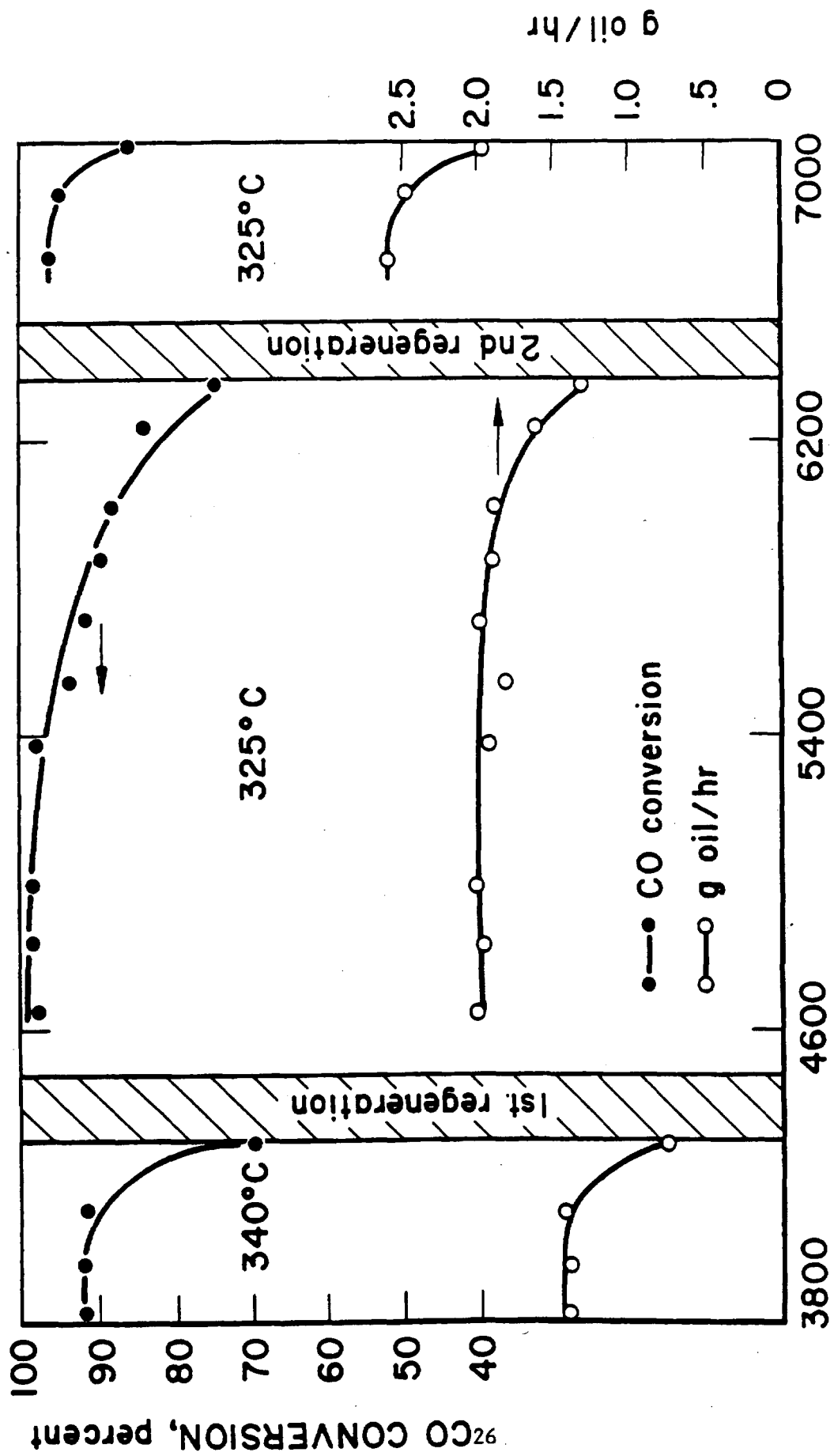
Table 5. Experiment FT-STW-2-2 Results (Continued)

Product Distribution (weight percent)	56.9	62.2	72.0	73.8	63.6	59.7	59.9	59.6	59.7	62.2	66.7	64.8
C <sub>1</sub> + C <sub>2</sub>	56.9	62.2	72.0	73.8	63.6	59.7	59.9	59.6	59.7	62.2	66.7	64.8
C <sub>3</sub>	7.1	6.8	7.2	6.5	8.5	8.6	9.1	9.2	9.6	9.6	9.2	9.4
Gasoline (<204°C)	32.4	28.1	19.3	18.4	25.3	28.3	27.8	28.5	27.5	25.1	22.4	24.2
Diesel (204°-316°C)	2.8	2.2	1.0	0.9	1.9	2.5	2.4	2.2	2.7	2.5	1.4	1.3
Fuel (316°-450°C)	0.7	0.7	0.3	0.3	0.6	0.8	0.8	0.4	0.5	0.5	0.2	0.3
Wax (>450°C)	0.2	0.1	0.2	0.2	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
lb Hydrocarbons/1000 ft <sup>3</sup> of fresh feed gas	5.7	7.2	7.6	7.6	7.3	8.3	8.1	8.0	7.8	7.6	8.4	8.4

The oxygenates, mainly C<sub>1</sub> to C<sub>4</sub> alcohols, are included in the gasoline fraction (Table 8). At 340°C and 650 psig, the alcohols represented 4% of the hydrocarbon product or 14% of the gasoline fraction. Selectivity to oxygenates increased as pressure was increased.

Data from period A of run FT-STW-2-2 are compared to available SASOL data in Table 9. The selectivity to gasoline from PETC's bench-scale reactor is similar to gasoline yields from SASOL's commercial ARGE unit (15). PETC's high yield to C<sub>1</sub>+C<sub>2</sub> would decrease if synthesis were conducted at SASOL's conditions (i.e., 240°C). SASOL's high selectivity to the heavier hydrocarbons (diesel and fuel oil) can be attributed to the high contents of potassium promotor in the catalyst and to the relatively low operating temperatures.

One of the criteria for a flame-sprayed catalyst to be commercially acceptable is that it must have a useful life of 6 to 12 months or be regenerable. During experiment FT-STW-2-2, two regenerations were carried out within a period of 8.5 months. After 4292 hours (6 months) of operation, the flame-sprayed catalyst used in this test was subjected to its first regeneration treatment -- 100 hours reduction in H<sub>2</sub> at 400°C and atmospheric pressure plus 71 hours induction at 240°C and atmospheric pressure. Following the regeneration, CO conversion at 325°C and 650 psig remained above the 90% level for 2 months. The corresponding oil yield was steady at 2 grams/hour. Over the next 3 weeks of operation, CO conversion dropped to 75% and the oil production to 1.3 grams/hour. A second regeneration restored catalyst activity for only 2 weeks, after which a rapid decline in CO conversion and oil yield was observed. Data collected before and after the two regeneration treatments are illustrated in Figure 5. Since a satisfactory CO conversion and oil yield were not maintained following the second



SYNTHESIS TIME, hours

Figure 5. Regeneration data of FT-STW-2-2

Table 6. Effect of Potassium on Oil Production

Run	FT-STW-1-1	FT-STW-1-3
K <sup>+</sup> (wt %)	0	0.38
Temperature (°C)	325	325
Pressure (psig)	300	300
Time (hours)	571	569
CO Conv. (%)	80	84
g Oil/m <sup>3</sup> Feed	3.59	9.45

Table 7. Effect of Temperature and Pressure on  
Total Product Distribution...(FT-STW-2-2)

Period	B	I	K	D	F
Temperature (°C)	325	325	325	340	340
Pressure (psig)	300	650	1000	300	650
CO Conv. (%)	88	90	92	93	94
<u>Total Product (wt %)</u>					
Hydrocarbons	30	33	34	31	33
H <sub>2</sub> O	19	17	17	16	20
CO <sub>2</sub>	51	50	49	53	47

Table 8. Effect of Temperature and Pressure on  
Hydrocarbon Product Distribution... (FT-STW-2-2)

Period	B	D	F	H
Time (hours)	357	693	1197	1365
Temperature (°C)	325	340	340	340
Pressure (psig)	300	300	650	650
CO Conv. (%)	88	93	94	93
<u>Hydrocarbons (wt %)</u>				
C <sub>1</sub> + C <sub>2</sub>	62	74	60	60
C <sub>3</sub>	7	7	9	9
Gasoline	28	18	28	29
Diesel	2	1	2	2
Fuel Oil	1	0.3	1	0.4
Wax	0.1	0.2	0.1	0.1

Table 9. Comparison of Arge Sasol Data with TWR Results

	<u>This Study</u>	<u>SASOL(15)</u>
Reactor	TWR	Fixed Bed
Temperature (°C)	325°	230-250°
Pressure (psig)	300	368
Catalyst	Fe + K*	Fe + K + Cu**
CO Conv. (%)	68	70
<u>Product Distribution (wt %)</u>		
C <sub>1</sub> + C <sub>2</sub>	58	12
C <sub>3</sub>	7	3
Gasoline	28	23
Diesel	3	19
Fuel Oil	0.2	22
Wax	--	17
Oxygenates	4	4

\*0.30 wt % of K

\*\*3.8 wt % of K + 3.8 wt % of Cu



regeneration, it appears that only one regeneration can be made before the catalyst has to be replaced. Based on one regeneration, catalyst life in the bench-scale tube wall reactor is approximately 6000 hours or 8.3 months.

#### FT-STW-1-3

Experiment FT-STW-1-3 lasted 1,939 hours. The catalyst for this experiment was a taconite ore flame-sprayed onto a 3/4-inch schedule 80 carbon steel pipe. The thickness of the catalyst coating was 0.025 inch, and its weight was 33.4 grams. The catalyst was immersed in a 6%  $K_2CO_3$  solution for 10 minutes, air-dried, and placed in the reactor. Reduction was conducted using  $H_2$  at  $396^\circ C$  for 114 hours. Precarbiding (induction) immediately followed. The catalyst was exposed to syn gas ( $2H_2 + 1CO$ ) at a flow rate of 20 J, a pressure of 80 psig, and a temperature of  $310^\circ C$  rather than the  $240^\circ C$  induction of FT-STW-2-2. The induction period lasted 71 hours. Table 10 summarizes the parameters used in the experiment, product results, and FIA analysis.

Some observations from this test include the following: The production of gaseous hydrocarbons ( $g/m^3$  of  $H_2 + CO$  converted) was greatest at a temperature of  $340^\circ C$ . Oil production was the largest at 300 psig,  $327^\circ C$ , and a flow rate of 20 J. At a flow of 24 J, maximum production was reached at 650 psig and  $318^\circ C$ . The maximum quantity of oxygenated hydrocarbons generated occurred at 650 psig and  $318^\circ C$ . Also at this period, a significant drop in the amount of  $CO_2$  produced was noted. Furthermore, at these conditions, the greatest amount of hydrocarbons per cubic meter of synthesis gas feed were produced. The hydrocarbons produced were dominated by the light fraction  $C_1 - C_3$ , composing 64-81% of the total product.

Table 10. Parameters for FT-STW-1-3, Product Results, and FIA Analysis

Period	A	B	C	D	E	F	G	H	I	J	K	L
Pressure (psig)	300	300	300	300	650	650	650	650	650	1000	1000	300
Temperature (°C)	327	325	325	340	318	325	296	342	341	342	340	339
Flow Rate (scfh)	2.89	2.88	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
Total Exposure												
Time at End												
of Period (hours)	167	330	498	666	834	1002	1122	1291	2459	1627	1771	1939
Period	A	B	C	D	E	F	G	H	I	J	K	L
Oil Recovered												
wt (grams/hour)	1.36	1.08	0.92	0.54	1.41	0.70	0.31	0.04	0.07	0.01	0.04	0.24
Aqueous Product Recovered												
(grams/hour)	5.47	5.67	5.49	5.95	8.43	7.74	7.02	6.75	6.67	8.53	8.46	4.45
Hydrocarbon Gas Production												
scfh	0.26	0.32	0.35	0.43	0.45	0.51	0.38	0.61	0.60	0.64	0.64	0.45
CO <sub>2</sub> (scfh)	0.27	0.31	0.34	0.37	0.33	0.35	0.21	0.37	0.37	0.34	0.34	0.36
CO Conversion (%)	85.5	82.5	84.0	90.8	95.7	95.5	65.7	96.7	96.6	98.3	98.0	85.3

Table 10. Parameters for FT-STW-1-3, Product Results, and FIA Analysis (Continued)

Period	A	B	C	D	E	F	G	H	I	J	K	L
FIA Analysis												
Saturates (%)	35	35	33	28	37	43	66	38	*	*	*	59
Olefins (%)	63	64	64	63	57	55	30	25	*	*	*	30
Aromatics (%)	1	1	2	8	2	1	1	2	*	*	*	3
Heterocyclics												
and/or H <sub>2</sub> O (%)	≤ 1	≤ 1	≤ 1	≤ 1	4	1	3	35	*	*	*	8

\*Insufficient sample for analysis

The FIA analysis of Table 10 shows that operations at 300 psig produce an oil that is more olefinic than oil produced at higher pressure. As the experiment progressed, the composition of the oil became mostly saturates.

Reviewing Table 10, CO conversions are greater than 90% at the following conditions: 300 psig and 340°C, 650 psig and 325°C or 340°C, and 1,000 psig and 340°C. Very poor activity, CO conversion of 65.7% (Period G), occurred when the temperature was dropped below 315°C. The CO conversion level dropped to 85% when the pressure was reduced to 300 psig (Period L) after 1,771 hours. Oil production reported as grams recovered per hour maximized at 650 psig and 318°C (Period E). Aqueous phase products were the largest at 1,000 psig and 340°C. Generally, as the experiment progressed, oil production decreased and the fraction of gaseous hydrocarbons increased. The amount of CO<sub>2</sub> produced remained nearly constant throughout the experiment.

The taconite catalyst impregnated with potassium and induced at 310°C exhibited high activity; however, the product distribution was not satisfactory with respect to liquid fuels production. Minimal oil production and large gaseous hydrocarbon yields were recovered. The maximum oil production was obtained at 300 psig, 325°C, and a flow of 20 J, while the maximum hydrocarbon yield per cubic meter of entering gas was attained at 650 psig, 320°C, and a flow 24 J. This catalyst, activated as described, would be more suitable in the production of light hydrocarbons.

As a result of these tests, the conclusions can be summarized as follows:

1. Addition of K<sup>+</sup> as a promotor increased CO conversion and oil selectivity.
2. The following process conditions affected the hydrocarbon selectivity: