

TABLE 1
CATALYST CHARACTERISTICS

Catalyst	Ruhchemie	UCI Catalysts			
		O	A	B	Start-up
UOP Run Number	31	44 & 48	50	51	53
Elemental Analyses (wt%)					
Fe	43.8	46.0	60.4	58.9	53.6
Cu	2.2	2.3	0.8	0.8	4.0
K	4.8	5.3	1.2	2.5	2.3
Si	1.4	4.1	0.7	0.8	1.4
Surface Area, m ² /g	313	232	167	169	136
Pore Volume, cc/g	0.53	0.50	0.18	0.20	0.30
					Composite
					54
					54.9
					4.0
					5.3
					3.7
					95
					0.28

TABLE 2
MATERIAL BALANCE FOR RUN 31 AT 240 HOS

Run No:	31	HOS:	240	Catalyst:	RUHR CHEMIE
Catalyst Composition, g/100 g Fe		Operating Conditions		H2/CO Ratios, mole/mole	
Copper	5.07	Rx T, C	265	Inlet, i	0.703
Potassium	3.08	K	538	Outlet, O	0.750
Silicon	10.96	Rx P, psig	290	Usage, U	0.681
		kPa	2101		
Wt of catalyst in Rx, g		72.70	Conversion and Selectivity		
Wt of Fe in Rx, g		41.20	CO Conversion	71.0	
Wt % Fe in catalyst		56.66	H2 Conversion	69.1	
Wt of start-up oil, g		290.00	H2+CO Conversion	70.2	
Wt of Slurry, g		362.70	Selectivity to CO2	43.0	
Vol. of Slurry, cm ³		458.69	Selectivity to CH4	5.2	
Wt % Solids in Rx		20.04	Selectivity to C2H6	2.5	
Solids Conc., g/cm ³		0.1584945			
Syngas Feed Rate,		Material Balances, mol/hr			
nL/h/gFe	2.256		In	Out	Converted
1E-5 mole/s/gFe	2.796	CO	2.439	0.707	1.732
mol/hr	4.146	H2	1.707	0.528	1.179
L/h/gFe	0.214	H2 + CO	4.146	1.236	2.911
Water-Gas Shift Equilibrium Calculations					
Equm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T - 4.33]$					
K = 65.141		H2O cut = 0.009		mol/hr	
mol/hr		Atomic Balance, mol/hr			
CO to CO2	0.745	C, in	2.439	H, in	3.415
CO to HC	0.987	Out	2.439	Out	3.415
CO to CH4	0.051	as CO2	0.745	as H2O	0.017
CO to C2H6	0.049	as HC	0.987	as HC	2.341
H2 to H2O	0.009	as CO	0.707	as H2	1.057
H2 to HC	1.171			as CO	0.707
				as HCO	0.234
Mass Balance In g/hr			HCs Distribution, g/hr		
	IN		OUT	Methane	0.823
CO	68.320	CO	19.813	Ethane	0.742
H2	3.442	H2	1.065	Others	16.393
		CO2	32.772	Total	17.958
		H2O	0.154		
		HCs	17.958	Product H/C ratio	2.372
TOTAL IN	71.762	OUT	71.762	O/C ratio	0.237
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr	42	
g/h/gFe	0.436	0.038	Syngas Converted, Nm ³ /hr/m ³ Rx	142	
g/nL syn	0.193	0.017	STY of C3+ in 24 hrs, kg/m ³ Rx	858	

TABLE 3
MATERIAL BALANCE FOR RUN 44 AT 475 HOS

Run No:	44	HOS:	475	Catalyst:	UCI "C"
Catalyst Composition, g/100 g Fe		Operating Conditions		H ₂ /CO Ratios, mole/mole	
Copper	4.32	Rx T, C	265	Inlet, I	0.700
Potassium	8.63	K	538	Outlet, O	0.840
Silicon	7.92	Rx P, psig	290	Usage, U	0.619
		kPa	2101		
Wt of catalyst in Rx, g	72.70	Conversion and Selectivity			
Wt of Fe in Rx, g	41.37	CO Conversion	63.0		
Wt % Fe in catalyst	56.91	H ₂ Conversion	55.7		
Wt of start-up oil, g	290.00	H ₂ +CO Conversion	60.0		
Wt of Slurry, g	362.70	Selectivity to CO ₂	48.0		
Vol. of Slurry, cm ³	458.69	Selectivity to CH ₄	4.1		
Wt % Solids in Rx	20.04	Selectivity to C ₂ H ₆	1.0		
Solids Conc., g/cm ³	0.1584945				
Syngas Feed Rate,		Material Balances, mol/hr			
nL/h/gFe	2.256		In	Out	Converted
1E-5 mole/s/gFe	2.796	CO	2.450	0.906	1.543
mol/hr	4.164	H ₂	1.715	0.759	0.955
L/h/gFe	0.214	H ₂ + CO	4.164	1.666	2.499
Water-Gas Shift Equilibrium Calculations					
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
	K = 65.141	H ₂ O out =		0.010	mol/hr
	mol/hr	Atomic Balance, mol/hr			
CO to CO ₂	0.741	C, in	2.450	H, in	3.429
CO to HC	0.802	Out	2.450	Out	3.429
CO to CH ₄	0.033	as CO ₂	0.741	as H ₂ O	0.019
CO to C ₂ H ₆	0.016	as HC	0.802	as HC	1.892
H ₂ to H ₂ O	0.010	as CO	0.906	as H ₂	1.519
H ₂ to HC	0.946			as HCC	0.052
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN	OUT	Methane	0.528	
CO	68.614	CO	25.987	Ethane	0.241
H ₂	3.457	H ₂	1.531	Others	11.611
		CO ₂	32.600	Total	12.381
		H ₂ O	0.172		
		HCs	12.381	Product H/C ratio	2.357
TOTAL IN	72.071	OUT	72.071	O/C ratio	0.065
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr		
g/h/gFe	0.295	0.019	37		
g/nL syn	0.133	0.008	Syngas Converted, Nm ³ /hr/m ³ Rx		
			122		
			STY of C ₃ + in 24 hrs, kg/m ³ Rx		
			608		

TABLE 4
ANALYSIS OF FEED FOR RUN 44

Component	Feed A	Feed B
CO, mole %	56	56
H ₂ , mole %	37	37
A, mole %	6	6
N ₂ , mole %	0.17	0.32
Total S, wppm	<1	<1

TABLE 5
MATERIAL BALANCE FOR RUN 48 AT 140 HOS

Run No:	48	HOS:	140	Catalyst:	UCI "O"
Catalyst Composition, g/100 g Fe	Operating Conditions			H ₂ /CO Ratios, mole/mole	
		Rx T, C	265		
Copper	4.32	K	538	Inlet, I	0.700
Potassium	8.53	Rx P, psig	290	Outlet, O	0.890
Silicon	7.92	kPa	2101	Usage, U	0.590
Wt of catalyst in Rx, g	72.70	Conversion and Selectivity			
Wt of Fe in Rx, g	41.37	CO Conversion		62.0	
Wt % Fe in catalyst	56.91	H ₂ Conversion		52.3	
Wt of start-up oil, g	290.00	H ₂ +CO Conversion		58.0	
Wt of Slurry, g	362.70	Selectivity to CO ₂		43.5	
Vol. of Slurry, cm ³	458.69	Selectivity to CH ₄		6.5	
Wt % Solids in Rx	20.04	Selectivity to C ₂ H ₆		2.8	
Solids Conc., g/cm ³	0.1584945				
Syngas Feed Rate,	Material Balances, mol/hr				
nL/h/gFe	2.256		In	Out	Converted
1E-5 mole/s/gFe	2.796	CO	2.450	0.931	1.519
mol/hr	4.164	H ₂	1.715	0.818	0.897
L/h/gFe	0.214	H ₂ + CO	4.164	1.749	2.415
Water-Gas Shift Equilibrium Calculations					
Equm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
	K = 65.141	H ₂ O out =		0.009	mol/hr
	mol/hr	Atomic Balance, mol/hr			
CO to CO ₂	0.661	C, in	2.450	H, in	3.429
CO to HC	0.858	Out	2.450	Out	3.429
CO to CH ₄	0.056	as CO ₂	0.661	as H ₂ O	0.018
CO to C ₂ H ₆	0.048	as HC	0.858	as HC	1.775
H ₂ to H ₂ O	0.009	as CO	0.931	as H ₂	1.636
H ₂ to HC	0.388				as H ₂ O
					0.009
					1.321
					0.931
					0.189
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN	OUT			
CO	68.614	CO	26.073	Methane	0.895
H ₂	3.457	H ₂	1.649	Ethane	0.722
		CO ₂	29.075	Others	13.495
		H ₂ O	0.161	Total	15.112
		HCs	15.112	Product H/C ratio	2.069
TOTAL IN	72.071	OUT	72.071	O/C ratio	0.220
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr		
g/h/gFe	0.365	0.039	37		
g/nL syn	0.162	0.017	Syngas Converted, Nm ³ /hr/m ³ Rx		
			118		
			STY of C ₃ + in 24 hrs, kg/m ³ Rx		
			706		

TABLE 6
MATERIAL BALANCE FOR RUN 48 AT 180 HOS

Run No:	48	HOS:	180	Catalyst:	UCI "O"		
Catalyst Composition,		Operating Conditions		H ₂ /CO Ratios,			
g/100 g Fe		Rx T, C	265	mole/mole			
Copper	4.32	K	558	Inlet, I	0.700		
Potassium	3.33	Rx P, psig	290	Outlet, O	1.100		
Silicon	7.92	kPa	2101	Usage, U	0.603		
Wt of catalyst in Rx, g			72.70	Conversion and Selectivity			
Wt of Fe in Rx, g			41.37	CO Conversion	80.8		
Wt % Fe in catalyst			56.91	H ₂ Conversion	69.4		
Wt of start-up oil, g			290.00	H ₂ +CO Conversion	78.0		
Wt of Slurry, g			362.70	Selectivity to CO ₂	45.0		
Vol. of Slurry, cm ³			458.69	Selectivity to CH ₄	7.7		
Wt % Solids in Rx			20.04	Selectivity to C ₂ H ₆	3.2		
Solids Conc., g/cm ³			0.1584945				
Syngas Feed Rate,			Material Balances, mol/hr				
nL/h/gFe	2.258			In	Out	Converted	
1E-5 mole/s/gFe	2.796	CO	2.450	0.475	1.974		
mol/hr	4.164	H ₂	1.715	0.524	1.190		
L/h/gFe	0.222	H ₂ + CO	4.164	0.999	3.165		
Water-Gas Shift Equilibrium Calculations							
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$							
K = 48.026			H ₂ O out =		0.020	mol/hr	
mol/hr			Atomic Balance, mol/hr				
CO to CO ₂	0.888	C, in	2.450	H, in	3.429	O, in	2.450
CO to HC	1.086	Out	2.450	Out	3.429	Out	
CO to CH ₄	0.084	as CO ₂	0.888	as H ₂ O	0.041	as H ₂ O	0.020
CO to C ₂ H ₆	0.069	as HC	1.085	as HC	2.340	as CO ₂	1.777
H ₂ to H ₂ O	0.020	as CO	0.475	as H ₂	1.048	as CO	0.475
H ₂ to HC	1.170					as HCO	0.177
Mass Balance in g/hr				HCs Distribution, g/hr			
	IN		OUT	Methane	1.341		
CO	68.614	CC	13.311	Ethene	1.045		
H ₂	3.457	H ₂	1.057	Others	15.848		
		CO ₂	39.101	Total	18.234		
		H ₂ O	0.365				
		HCs	18.234	Product	H/C ratio	2.155	
TOTAL IN	72.071	OUT	72.071		O/C ratio	0.163	
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr	48			
g/h/gFe	0.441	0.055	Syngas Converted, Nm ³ /hr/m ³ Rx	155			
g/nL syn	0.195	0.026	STY of C3+ in 24 hrs, kg/m ³ Rx	829			

TABLE 7
SUMMARY PERFORMANCE DATA FOR RUHRCHEMIE AND UCI CATALYSTS

CONDITIONS:

200 OR 290 PSIG
 265°C

2.4 M/hr/g Fe
 $H_2:CO$ (FEED) = 0.7

Catalyst	Run Number	Conversion, %		$H_2:CO$ Usage Ratio	Selectivity, %			
		CO	CO+H ₂		C ₁	C ₂	C ₃	CO ₂
Ruhrchemie	31'	70	68	0.70	4.0	1.8	1.9	43
UCI "O"	44'	78	70	0.58	3.6	0.90	2.4	48
UCI "O"	48'	76	63	0.62	5.4'	3.4	3.5	45
UCI "A"	50'	70	63	0.56	2.7	0.75	2.2	46
UCI "H"	51'	56	57	0.65	3.1'	1.8	2.8	45
Start-up	53'	70	60	0.54	3.6	1.3	3.3	50
Composite	54'	89	75	0.55	3.2	0.6	2.3	47

1. 290 psig
2. 200 psig
3. Ultimate fine-out selectivity = 6.5%
4. Ultimate fine-out selectivity = 6.0%

TABLE 3
MATERIAL BALANCE FOR RUN 50 AT 250 EOS

Run No:	50	HOS:	250	Catalyst:	UCI "A"
Catalyst Composition, g/100 g Fe		Operating Conditions		H ₂ /CO Ratios, mole/mole	
Copper	2.00	Rx T, C	265	Inlet, I	0.700
Potassium	1.73	K	538	Outlet, O	0.850
Silicon	2.99	Rx P, psig	290	Usage, U	0.574
		kPa	2101		
Wt of catalyst in Rx, g	72.70	Conversion and Selectivity			
Wt of Fe in Rx, g	47.22	CO Conversion		54.0	
Wt % Fe in catalyst	64.95	H ₂ Conversion		44.3	
Wt of start-up oil, g	290.00	H ₂ +CO Conversion		50.0	
Wt of Slurry, g	362.70	Selectivity to CO ₂		48.0	
Vol. of Slurry, cm ³	458.59	Selectivity to CH ₄		2.9	
Wt % Solids in Rx	20.04	Selectivity to C ₂ H ₆		0.8	
Solids Conc., g/cm ³	0.1584945				
Syngas Feed Rate,		Material Balances, mol/hr			
nL/h/gFe	2.256		In	Out	Converted
1E-5 mole/s/gFe	2.796	CO	2.796	1.286	1.510
mol/hr	4.753	H ₂	1.957	1.090	0.867
L/h/gFe	0.214	H ₂ + CO	4.753	2.376	2.376
Water-Gas Shift Equilibrium Calculations					
Equim. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp\{4577.8/T - 4.33\}$					
	K = 65.141	H ₂ O cut =		0.009	mol/hr
mol/hr		Atomic Balances, mol/hr			
CO to CO ₂	0.725	C, in	2.796	H, in	3.914
CO to HC	0.785	Out	2.796	Out	3.914
CO to CH ₄	0.023	as CO ₂	0.725	as H ₂ O	0.019
CO to C ₂ H ₆	0.014	as HC	0.785	as HC	1.715
H ₂ to H ₂ O	0.009	as CO	1.285	as H ₂	2.181
H ₂ to HC	0.857			as HCO	0.051
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN		OUT	Methane	0.365
CO	78.313	CO	36.024	Ethane	0.212
H ₂	3.945	H ₂	2.198	Others	11.395
		CO ₂	31.893	Total	11.973
		H ₂ O	0.170		
		HCs	11.973	Product	H/C ratio
TOTAL IN	82.258	OUT	82.258		O/C ratio
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr	32	
g/h/gFe	0.254	0.012	Syngas Converted, Nm ³ /hr/m ³ Rx	116	
g/nL syn	0.112	0.005	STY of C ₃ + in 24 hrs, kg/m ³ Rx	596	

TABLE 9
MATERIAL BALANCE FOR RUN 51 AT 320 HOS

Run No:	51	HOS:	320	Catalyst:	UCI "B"
Catalyst Composition, g/100 g Fe		Operating Conditions			H₂/CO Ratios, mole/mole
Copper	1.34	Rx T, C	265	Inlet, I	0.700
Potassium	1.32	K	538	Outlet, O	0.750
Silicon	4.23	Rx P, psig	290	Usage, U	0.672
		kPa	2101		
Wt of catalyst in Rx, g			72.70	Conversion and Selectivity	
Wt of Fe in Rx, g			46.82	CO Conversion	80.0
Wt % Fe in catalyst			64.40	H ₂ Conversion	57.6
Wt of start-up oil, g			260.00	H ₂ +CO Conversion	68.0
Wt of Slurry, g			362.70	Selectivity to CO ₂	47.6
Vol. of Slurry, cm ³			458.69	Selectivity to CH ₄	5.9
Wt % Solids in Rx			20.04	Selectivity to C ₂ H ₆	3.3
Solids Conc., g/cm ³			0.1584945		
Syngas Feed Rate,			Material Balances, mol/hr		
nL/h/gFe	2.256		In	Out	Converted
1E-5 mole/s/gFe	2.796	CO	2.772	1.109	1.663
mol/hr	4.712	H ₂	1.940	0.323	1.117
L/h/gFe	0.214	H ₂ + CO	4.712	1.932	2.780
Water-Gas Shift Equilibrium Calculations					
Equm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
	K = 65.141		H ₂ O out = 0.009	mol/hr	
mol/hr		Atomic Balance, mol/hr			
CO to CO ₂	0.792	C, in	2.772	H, in	3.881
CO to HC	0.871	Out	2.772	Out	3.881
CO to CH ₄	0.051	as CO ₂	0.792	as H ₂ O	0.018
CO to C ₂ H ₆	0.058	as HC	0.871	as HC	2.216
H ₂ to H ₂ O	0.009	as CO	1.109	as H ₂	1.546
H ₂ to HC	1.108			as H ₂ O	0.009
				as CO ₂	1.583
				as CO	1.109
				as H ₂ C	0.071
Mass Balance in g/hr			H₂Cs Distribution, g/hr		
	IN		OUT	Methane	0.825
CO	77.641	CO	31.056	Ethane	0.365
H ₂	3.912	H ₂	1.660	Others	12.144
		CO ₂	34.840	Total	13.834
		H ₂ O	0.163		
		H ₂ Cs	13.834	Product H/C ratio	2.543
TOTAL IN	81.552	OUT	81.552	O/C ratio	0.081
HC Yield	H ₂ Cs	C ₁ +C ₂ (p)	CO Conversion Rate, gmole/kg Fe/hr		36
g/h/gFe	0.295	0.036	Syngas Converted, Nm ³ /hr/m ³ Rx		136
g/nL syn	0.131	0.016	STY of C ₃ + in 24 hrs, kg/m ³ Rx		635

TABLE 10
MATERIAL BALANCE FOR RUN 53 AT 140 HOS

Run No:	53	HOS:	140	Catalyst:		UCI "START-UP"	
Catalyst Composition,		Operating Conditions			H₂/CO Ratios,		
g/100 g Fe		Rx T, C	265		mole/mole		
Copper	7.52	K		538	Inlet, I	0.700	
Potassium	2.57	Rx P, psig		200	Outlet, O	0.770	
Silicon	4.29	kPa		1450	Usage, U	0.621	
Wt of catalyst in Rx, g		72.70		Conversion and Selectivity			
Wt of Fe in Rx, g		44.15		CO Conversion		49.5	
Wt % Fe in catalyst		50.73		H₂ Conversion		43.9	
Wt of start-up oil, g		290.00		H₂+CO Conversion		47.2	
Wt of Slurry, g		362.70		Selectivity to CO₂		49.0	
Vol. of Slurry, cm³		456.69		Selectivity to CH₄		3.8	
Wt % Solids in Rx		20.04		Selectivity to C₂H₆		1.2	
Solids Conc., g/cm³		0.1584945					
Syngas Feed Rate,		Material Balances, mol/hr					
nL/h/gFe	2.256			In	Out	Converted	
1E-5 mole/s/gFe	2.796	CO		2.614	1.320	1.294	
mol/hr	4.444	H₂		1.830	1.026	0.804	
L/h/gFe	0.304	H₂ + CO		4.444	2.346	2.098	
Water-Gas Shift Equilibrium Calculations							
Eqm. Cons. K =		$[CO_2][H_2]/[CO][H_2O] = \exp[4577.6/T-4.33]$					
	K = 55.14	H₂O out =		0.008		mol/hr	
mol/hr		Atomic Balance, mol/hr					
CO to CO₂	0.634	C, in	2.614	H, in	3.660	O, in	2.614
CO to HC	0.560	Out	2.614	Out	3.660	Out	
CO to CH₄	0.025	as CO₂	0.634	as H₂O	0.015	as H₂O	0.008
CO to C₂H₆	0.016	as HC	0.660	as HC	1.592	as CO₂	1.268
H₂ to H₂O	0.008	as CO	1.320	as H₂	2.053	as CO	1.320
H₂ to HC	0.796					as HCO	0.018
Mass Balance in g/hr				H₂Cs Distribution, g/hr			
	IN		OUT	Methane	0.402		
CO	73.222	CO	36.977	Ethane	0.238		
H₂	3.589	H₂	2.069	Others	3.184		
		CO₂	27.905	Total	9.824		
		H₂O	0.136				
		H₂Cs	9.824	Product H/C ratio	2.412		
TOTAL IN	76.911	OUT	76.911	O/C ratio	0.028		
HC Yield	H₂Cs	C₁+C₂(p)	CO Conversion Rate, gmole/kg Fe/hr		29		
g/h/gFe	0.223	0.015	Syngas Converted, Nm³/hr/m³ Rx		102		
g/nL syn	0.099	0.006	STY of C₃+ in 24 hrs, kg/m³ Rx		481		

TABLE 11
MATERIAL BALANCE FOR RUN 53 AT 220 HOS

Run No:	53	HOS:	220	Catalyst:		UCI "START-UP"	
Catalyst Composition, g/100 g Fe		Operating Conditions			H2/CO Ratios, mole/mole		
Copper	7.52	Rx T, C		265			
Potassium	2.57	K		538	Inlet, I		0.700
Silicon	4.29	Rx P, psig		400	Outlet, O		0.820
		kPa		2859	Usage, U		0.573
Wt of catalyst in Rx, g		72.70	Conversion and Selectivity				
Wt of Fe in Rx, g		44.15	CO Conversion				42.0
Wt % Fe in catalyst		60.73	H2 Conversion				39.3
Wt of start-up oil, g		290.00	H2+CO Conversion				44.4
Wt of Slurry, g		362.70	Selectivity to CO2				47.0
Vol. of Slurry, cm ³		458.69	Selectivity to CH4				2.9
Wt % Solids in Rx		20.94	Selectivity to C2H6				0.6
Solids Conc., g/cm ³		0.1584945					
Syngas Feed Rate,		Material Balances, mol/hr					
nL/hr/gFe	4.700			In	Out	Converted	
1E-5 mole/s/gFe	5.825	CO		5.446	2.832	2.614	
mol/hr	9.253	H2		3.812	2.315	1.497	
L/h/gFe	0.328	H2 + CO		9.258	5.148	4.111	
Water-Gas Shift Equilibrium Calculations							
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$							
	K =	65.141	H2O out =	0.015	mol/hr		
		Atomic Balance, mol/hr					
CO to CO2	1.229	C, in	5.446	H, in	7.625	O, in	5.446
CO to HC	1.385	Out	5.446	Out	7.625	Out	
CO to CH4	0.040	as CO2	1.229	as H2O	0.031	as H2O	0.015
CO to C2H6	0.017	as HC	1.385	as HC	2.962	as CO2	2.457
H2 to H2O	0.015	as CO	2.832	as H2	4.531	as CO	2.832
H2 to HC	1.481					as HCO	0.141
Mass Balance in g/hr				HCs Distribution, g/hr			
	IN		OUT	Methane			0.645
CO	152.547	CO	79.324	Ethane			0.250
H2	7.686	H2	4.668	Others			20.935
		CO2	54.072	Total			21.630
		H2O	0.278				
		HCs	21.890	Product	H/C ratio		2.138
TOTAL IN	160.232	OUT	160.232		O/C ratio		0.102
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr				59
g/h/gFe	0.496	0.020	Syngas Converted, Nm ³ /hr/m ³ Rx				201
g/nL syn	0.105	0.004	STY of C3+ in 24 hrs. kg/m ³ Rx				1099

TABLE 12
MATERIAL BALANCE FOR RUN 53 AT 360 HOS

Run No:	53	HOS:	360	Catalyst:	UCI "START-UP"
Catalyst Composition, g/100 g Fe		Operating Conditions		H ₂ /CO Ratios, mole/mole	
Copper	7.52	Rx T, C	265	Inlet, I	0.700
Potassium	2.57	K	538	Outlet, O	0.800
Silicon	4.28	Rx P, psig	290	Usage, U	0.630
		kPa	2101		
Wt of catalyst in Rx, g	72.70	Conversion and Selectivity			
Wt of Fe in Rx, g	44.15	CO Conversion		61.0	
Wt % Fe in catalyst	60.73	H ₂ Conversion		54.9	
Wt of start-up oil, g	290.00	H ₂ +CO Conversion		58.5	
Wt of Slurry, g	362.70	Selectivity to CO ₂		48.0	
Vol. of Slurry, cm ³	458.69	Selectivity to CH ₄		3.0	
Wt % Solids in Rx	20.04	Selectivity to C ₂ H ₆		0.7	
Solids Conc., g/cm ³	0.1584945				
Syngas Feed Rate, nL/h/gFe		Material Balances, mol/hr			
	2.256		In	Out	Converted
1E-5 mole/s/gFe	2.796	CO	2.614	1.020	1.595
mol/hr	4.444	H ₂	1.830	0.825	1.005
L/h/gFe	0.214	H ₂ + CO	4.444	1.844	2.600
Water-Gas Shift Equilibrium Calculations					
Equm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
K = 65.141		H ₂ O out =		0.010 mol/hr	
mol/hr		Atomic Balance, mol/hr			
CO to CO ₂	0.765	C, in	2.614	H, in	3.660
CO to HC	0.829	Out	2.614	Out	3.660
CO to CH ₄	0.025	as CO ₂	0.765	as H ₂ O	0.019
CO to C ₂ H ₆	0.012	as HC	0.829	as HC	1.991
H ₂ to H ₂ O	0.010	as CO	1.020	as H ₂	1.650
H ₂ to HC	0.996			as HCO	0.054
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN		OUT	Methane	0.399
CO	73.222	CO	28.557	Ethane	0.175
H ₂	3.689	H ₂	1.663	Others	12.261
		CO ₂	33.686	Total	12.835
		H ₂ O	0.171		
		HCs	12.835	Product H/C ratio	2.401
TOTAL IN	76.911	OUT	76.911	O/C ratio	0.065
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr		
g/h/gFe	0.291	0.013	36		
g/nL syn	0.129	0.006	Syngas Converted, Nm ³ /m ³ Rx		
			127		
			STY of C ₃ + in 24 hrs, kg/m ³ Rx		
			642		

TABLE 13
MATERIAL BALANCE FOR RUN 54 AT 175 HOS

Run No:	54	HOS:	175	Catalyst:	UCI "COMPOSITE"
Catalyst Composition, g/100 g Fe		Operating Conditions		H ₂ /CO Ratios, mole/mole	
Copper	7.86	Rx T, C	285	Inlet, i	0.700
Potassium	7.86	K	538	Outlet, O	1.250
Silicon	11.02	Rx P, psig	200	Usage, U	0.559
		kPa	1480		
Wt of catalyst in Rx, g			72.70	Conversion and Selectivity	
Wt of Fe in Rx, g			39.12	CO Conversion	79.6
Wt % Fe in catalyst			53.81	H ₂ Conversion	63.5
Wt of start-up oil, g			290.00	H ₂ +CO Conversion	73.0
Wt of Slurry, g			362.70	Selectivity to CO ₂	47.0
Vol. of Slurry, cm ³			456.69	Selectivity to CH ₄	3.5
Wt % Solids in Rx			20.04	Selectivity to C ₂ H ₆	0.7
Solids Conc., g/cm ³			0.1584945		
Syngas Feed Rate,		Material Balances, mol/hr			
nL/h/gFe	2.322		In	Out	Converted
1E-5 mole/s/gFe	2.677	CO	2.384	0.486	1.897
mol/hr	4.052	H ₂	1.668	0.608	1.061
L/h/gFe	0.313	H ₂ + CO	4.052	1.094	2.958
Water-Gas Shift Equilibrium Calculations					
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
	K = 65.141	H ₂ O out =		0.017	mol/hr
mol/hr		Atomic Balance, mol/hr			
CO to CO ₂	0.892	C, in	2.384	H, in	3.337
CO to HC	1.006	Out	2.384	Out	3.337
CO to CH ₄	0.035	as CO ₂	0.892	as H ₂ O	0.034
CO to C ₂ H ₆	0.014	as HC	1.006	as HC	2.097
H ₂ to H ₂ O	0.017	as CO	0.486	as H ₂	1.216
H ₂ to HC	1.044			as CO	0.486
				as HCO	0.097
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN		OUT	Methane	0.565
CO	66.764	CO	13.620	Ethane	0.212
H ₂	3.364	H ₂	1.225	Others	14.953
		CO ₂	39.245	Total	15.729
		H ₂ O	0.308		
		HCs	15.729	Product H/C ratio	2.076
TOTAL IN	70.128	OUT	70.128	O/C ratio	0.036
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr		49
g/h/gFe	0.402	0.020	Syngas Converted, Nm ³ /hr/m ³ Rx		144
g/nL syn	0.173	0.009	STY of C ₃ + in 24 hrs, kg/m ³ Rx		782

TABLE 14
MATERIAL BALANCE FOR RUN 54 AT 240 HOS

Run No: 54		HOS: 240		Catalyst: UCI "COMPOSITE"	
Catalyst Composition, g/100 g Fe		Operating Conditions		H2/CO Ratios, mole/mole	
		Rx T, C	265	Inlet, I	0.700
Copper	7.86	K	538	Outlet, O	0.750
Potassium	7.86	Rx P, psig	200	Usage, U	0.640
Silicon	11.02	kPa	1480		
Wt of catalyst in Rx, g		65.70	Conversion and Selectivity		
Wt of Fe in Rx, g		35.35	CO Conversion	45.0	
Wt % Fe in catalyst		53.81	H2 Conversion	41.1	
Wt of start-up oil, g		290.03	H2+CO Conversion	43.4	
Wt of Slurry, g		355.70	Selectivity to CO2	48.0	
Vol. of Slurry, cm ³		456.43	Selectivity to CH4	3.9	
Wt % Solids in Rx		18.47	Selectivity to C2H6	0.2	
Solids Conc., g/cm ³		0.1439423			
Syngas Feed Rate,		Material Balances, mol/hr			
nL/h/gFe	5.201		in	Out	Converted
1E-5 mole/s/gFe	6.445	CO	4.825	2.654	2.171
mol/hr	8.202	H2	3.377	1.989	1.389
L/h/gFe	0.701	H2 + CO	8.202	4.643	3.560
Water-Gas Shift Equilibrium Calculations					
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
K = 65.141		H2O out = 0.012		mol/hr	
mol/hr		Atomic Balance, mol/hr			
CO to CO2	1.042	C, in	4.825	H, in	6.755
CO to HC	1.129	Out	4.825	Out	6.755
CO to CH4	0.044	as CO2	1.042	as H2O	0.024
CO to C2H6	0.005	as HC	1.129	as HC	2.753
H2 to H2O	0.012	as CO	2.654	as H2	3.978
H2 to HC	1.377			as HCO	0.075
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN		OUT	Methane	0.706
CO	135.150	CO	74.332	Ethane	0.068
H2	6.809	H2	4.010	Others	16.760
		CO2	45.867	Total	17.534
		H2O	0.216		
		HCs	17.534	Product H/C ratio	2.439
TOTAL IN	141.959	OUT	141.959	O/C ratio	0.066
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/hr		
g/h/gFe	0.496	0.022	61		
g/nL syn	0.095	0.004	Syngas Converted, Nm ³ /hr/m ³ Rx		
			175		
			STY of C3+ in 24 hrs, kg/m ³ Rx		
			881		

TABLE 15
MATERIAL BALANCE FOR RUN 54 AT 360 HOS

Run No:	54	HOS:	360	Catalyst:	UCI "COMPOSITE"
Catalyst Composition, g/100 g Fe		Operating Conditions		H₂/CO Ratios, mole/mole	
Copper	7.88	Rx T, C	265	Inlet, I	0.700
Potassium	7.88	K	538	Outlet, O	0.780
Silicon	11.02	Rx P, psig	400	Usage, U	0.631
		kPa	2859		
Wt of catalyst in Rx, g		61.15	Conversion and Selectivity		
Wt of Fe in Rx, g		32.90	CO Conversion	54.2	
Wt % Fe in catalyst		53.61	H ₂ Conversion	48.9	
Wt of start-up oil, g		290.00	H ₂ +CO Conversion	52.0	
Wt of Slurry, g		351.15	Selectivity to CO ₂	37.5	
Vol. of Slurry, cm ³		454.97	Selectivity to CH ₄	2.6	
Wt % Solids in Rx		17.41	Selectivity to C ₂ H ₆	0.5	
Solids Conc., g/cm ³		0.1344059			
Syngas Feed Rate,		Material Balances, mol/hr			
nL/h/gFe	2.626		In	Out	Converted
1E-5 mole/s/gFe	3.255	CO	2.268	1.039	1.229
mol/hr	3.855	H ₂	1.587	0.812	0.776
L/h/gFe	0.183	H ₂ + CO	3.855	1.850	2.005
Water-Gas Shift Equilibrium Calculations					
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.8/T-4.33]$					
K = 65.141		H ₂ O out =		0.006 mol/hr	
mol/hr		Atomic Balance, mol/hr			
CO to CO ₂	0.461	C, in	2.268	H, in	3.175
CO to HC	0.768	Out	2.268	Out	3.175
CO to CH ₄	0.020	as CO ₂	0.461	as H ₂ O	0.011
CO to C ₂ H ₆	0.008	as HC	0.768	as HC	1.540
H ₂ to H ₂ O	0.006	as CO	1.039	as H ₂	1.624
H ₂ to HC	0.770			as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039
				as H ₂ O	0.006
				as CO ₂	0.922
				as CO	1.039
				as H ₂ O	0.302
				as H ₂	1.039

TABLE 16
MATERIAL BALANCE FOR RUN 54 AT 500 HOS

Run No:	E4	HOS:	500	Catalyst:	UCI "COMPOSITE"
Catalyst Composition, g/100 g Fe		Operating Conditions			H ₂ /CO Ratios, mole/mole
Copper	7.86	Rx T, C	265	Inlet, I	0.700
Potassium	7.86	K	538	Outlet, O	0.770
Silicon	11.02	Rx P, psig	200	Usage, U	0.604
		kPa	1480		
Wt of catalyst in Rx, g		61.15	Conversion and Selectivity		
Wt of Fe in Rx, g		32.90	CO Conversion	42.4	
Wt % Fe in catalyst		53.61	H ₂ Conversion	35.6	
Wt of start-up oil, g		230.00	H ₂ +CO Conversion	40.0	
Wt of Slurry, g		351.15	Selectivity to CO ₂	44.0	
Vol. of Slurry, cm ³		454.97	Selectivity to CH ₄	3.9	
Wt % Solids in Rx		17.41	Selectivity to C ₂ H ₆	0.6	
Solids Conc., g/cm ³		0.134-0.059			
Syngas Feed Rate, nL/h/gFe		2.794	Material Balances, mol/hr		
1E-5 mole/s/gFe		3.463		In	Out
mcl/hr		4.101	CO	2.412	1.390
L/h/gFe		0.377	H ₂	1.689	1.071
			H ₂ + CO	4.101	2.461
				Converted	1.023
					0.618
					1.640
Water-Gas Shift Equilibrium Calculations					
Eqm. Cons. K = $\frac{[CO_2][H_2]}{[CO][H_2O]} = \exp[4577.3/T-4.33]$					
K =		65.141	H ₂ O out =		0.005 mol/hr
mol/hr			Atomic Balance, mol/hr		
CO to CO ₂	0.450	C, in	2.412	H, in	3.377
CO to HC	0.573	Out	2.412	Out	3.377
CO to CH ₄	0.022	as CO ₂	0.450	as H ₂ O	0.011
CO to C ₂ H ₆	0.007	as HC	0.573	as HC	1.225
H ₂ to H ₂ O	0.005	as CO	1.390	as H ₂	2.142
H ₂ to HC	0.612			as HCO	0.117
Mass Balance in g/hr			HCs Distribution, g/hr		
	IN	OUT			
CO	67.575	CO	38.923	Methane	0.358
H ₂	3.405	H ₂	2.159	Ethane	0.103
		CO ₂	19.808	Others	9.531
		H ₂ O	0.096	Total	9.993
		HCs	9.993	Product	H/C ratio
TOTAL IN	70.979	OUT	70.979		2.138
				O/C ratio	0.205
HC Yield	HCs	C1+C2(p)	CO Conversion Rate, gmole/kg Fe/h:		
g/h/gFe	0.304	0.014	31		
g/nL syn	0.109	0.005	Syngas Converted, Nm ³ /hr/m ³ Rx		
			81		
			STY of C ₃ + in 24 hrs, kg/m ³ Rx		
			503		

TABLE 17
KINETIC PARAMETERS FROM RUN 54 (175 HOS)

Run No.: 54 HOS: 175
Catalyst: UCI "COMPOSITE"

Catalyst Composition, g/100 g Fe		Operating Conditions	
Copper	7.55	Reactor T, C	265
Potassium	7.86	K	538
Silicon	11.02	Reactor P, psig	200
		kPa	1480
Wt of catalyst, g	72.70	Syngas Feed Rate,	
Wt of Fe in Rx, g	39.12	nL/h/gFe	2.322
Wt % Fe in catalyst	53.91	1E-5 mole/s/gFe	2.677
Wt of start-up oil, g	290.00	mol/hr	4.052
Volume of Slurry, cm ³	458.69	L/h/gFe	0.313
Wt % Solids in Rx	20.04		
Volume % Solids in Rx	5.11		
H ₂ /CO Ratios, mole/mole		Conversion and Selectivity	
Inlet, I	0.700	CO Conversion	79.6
Outlet, O	1.250	H ₂ Conversion	53.6
Usage, U	0.559	H ₂ +CO Conversion	73.0
		Selectivity to CO ₂	47.0
		Selectivity to CH ₄	3.5
		Selectivity to C ₂ H ₆	0.7

Alpha	-0.500
Alpha*	-0.574
Da	3.090
Henry's Constant, Pa*m ³ /mol	25979
Rate Parameter, kp 1E-11 mol/s/g Fe/Pa	6.01
Reaction Rate, -r(CO+H ₂) 1E-5 mol/s/gFe	2.10
1E-5 mol/s	82.17
Rate Constant, 1E-3 m ³ /kg Fe/s	0.5596

TABLE 18
KINETIC PARAMETERS FROM RUN 54 (240 HOS)

Run No.: 54 HOS: 240
Catalyst: UCI "COMPOSITE"

Catalyst Composition, g/100 g Fe		Operating Conditions	
Copper	7.86	Reactor T, C	265
Potassium	7.86	K	538
Silicon	11.02	Reactor P, psig	200
		kPa	1480
Wt of catalyst, g	65.70	Syngas Feed Rate,	
Wt of Fe in Rx, g	35.35	nL/h/gFe	5.201
Wt % Fe in catalyst	53.81	1E-5 mole/s/gFe	6.445
Wt of start-up oil, g	290.00	mol/hr	8.202
Volume of Slurry, cm ³	456.43	L/h/gFe	0.701
Wt % Solids in Rx	18.47		
Volume % Solids in Rx	4.64		
H ₂ /CO Ratios, mole/mole		Conversion and Selectivity	
Inlet, i	0.700	CO Conversion	45.0
Outlet, O	0.750	H ₂ Conversion	41.1
Usage, U	0.640	H ₂ + CO Conversion	43.4
		Selectivity to CO ₂	48.0
		Selectivity to CH ₄	3.9
		Selectivity to C ₂ H ₆	0.2

Alpha	-0.500
Alpha*	-0.528
Da	1.401
Henry's Constant, Pa*m ³ /mol	25979
Rate Parameter, kp 1E-11 mol/s/g Fe/Pa	6.10
Reaction Rate, -r(CO+H ₂) 1E-5 mol/s/gFe	2.80
1E-5 mol/s	98.89
Rate Constant, 1E-3 m ³ /kg Fe/s	0.6184

TABLE 19
KINETIC PARAMETERS FROM RUN 54 (360 HOS)

Run No.: **54** HOS: **360**
Catalyst: **UCI "COMPOSITE"**

Catalyst Composition, g/100 g Fe		Operating Conditions	
Copper	7.86	Reactor T, C	265
Potassium	7.86	K	538
Silicon	11.02	Reactor P, psig	400
		kPa	2859
Wt of catalyst, g	51.15	Syngas Feed Rate,	
Wt of Fe in Rx, g	32.90	nL/n/gFe	5.588
Wt % Fe in catalyst	53.81	1E-5 mole/s/gFe	6.925
Wt of start-up oil, g	290.00	mol/hr	8.202
Volume of Slurry, cm ³	454.97	L/n/gFe	0.390
Wt % Solids in Rx	17.41		
Volume % Solids in Rx	4.34		
H ₂ /CO Ratios, mole/mole		Conversion and Selectivity	
Inlet, I	0.700	CO Conversion	54.2
Outlet, O	0.789	H ₂ Conversion	48.9
Usage, U	0.631	H ₂ +CO Conversion	52.0
		Selectivity to CO ₂	37.5
		Selectivity to CH ₄	2.6
		Selectivity to C ₂ H ₆	0.5

Alpha	-0.500
Alpha*	-0.532
Da	1.827
Henry's Constant, Pa*m ³ /mol	25979
Rate Parameter, kp 1E-11 mol/s/g Fe/Pa	4.43
Reaction Rate, -r(CO+H ₂) 1E-5 mol/s/gFe	3.60
1E-5 mol/s	116.48
Rate Constant, 1E-3 m ³ /kg Fe/s	0.4448

TABLE 20
KINETIC PARAMETERS FROM RUN 54 (500 HOS)

Run No.: 54 HOS: 500
Catalyst: UCI "COMPOSITE"

Catalyst Composition, g/100 g Fe		Operating Conditions	
Copper	7.86	Reactor T, C	265
Potassium	7.86	K	538
Silicon	11.02	Reactor P, psig	200
		kPa	1480
Wt of catalyst, g	51.15	Syngas Feed Rate,	
Wt of Fe in Rx, g	32.90	nL/h/gFe	2.794
Wt % Fe in catalyst	53.81	1E-5 mole/s/gFe	3.463
Wt of start-up oil, g	290.00	mol/hr	4.101
Volume of Slurry, cm ³	454.97	L/h/gFe	0.377
Wt % Solids in Rx	17.41		
Volume % Solids in Rx	4.34		
H ₂ /CO Ratios, mole/mole		Conversion and Selectivity	
Inlet, i	0.700	CO Conversion	42.4
Outlet, O	0.770	H ₂ Conversion	36.6
Usage, U	0.604	H ₂ +CO Conversion	40.0
		Selectivity to CO ₂	44.0
		Selectivity to CH ₄	3.9
		Selectivity to C ₂ H ₆	0.6

Alpha	-0.500
Alpha*	-0.547
Da	1.225
Henry's Constant, Pa*m ³ /mol	25979
Rate Parameter, kp 1E-11 mol/s/g Fe/Pa	2.87
Reaction Rate, -r(CO+H ₂) 1E-5 mol/s/gFe	1.39
1E-5 mol/s	45.57
Rate Constant, 1E-3 m ³ /kg Fe/s	0.2803

TABLE 21
COMPARISON WITH LAPORTE SBCR RUN AF-R6.1A

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	18.8	83.4	100
Density, g/cm ³	3.100	0.688	0.766
Volume % Solids	4.10	95.90	100.00
Viscosity, g/cm/s	-	0.0225	0.0308
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	809.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.40
Catalyst Weight, kg	178.6
Cat. Loading, kg/m ³	127.2

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.0
Feed Rate, am ³ /hr	36.8
nm ³ /hr	271.3
SV, am ³ /hr/m ³	26.1
nm ³ /hr/m ³	193.2
nm ³ /h/kg Fe	2.82
Corr. factor for kLa	0.587
H ₂ Diffusivity, cm ² /s	0.0057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-A		
	Plant	MODEL 1	MODEL 2
H ₂ Conversion, %	61.9	60.5	57.0
U _g , cm/sec		2.6	2.7
Gas hold-up, eps-g	0.15	0.101	0.103
kLa (uncorr), 1/s		0.257	0.292
kLa (corr), 1/s		0.168	0.171
kr, epsl, 1/s		0.038	0.038
KR (=kr, epsl, R.T./H ₂)		0.007	0.007
KM (=k _L , a, R.T./H ₂)		0.029	0.029
K (=KR.KM/(KR+KM))		0.005	0.005
H ₂ +CO Conversion, %	72.4	69.5	65.5
CO Conversion, %	80.2	75.8	71.4
STY, nm ³ /h/m ³		134.2	126.5
STY, nm ³ /h/kg Fe		1.66	1.85
Mass Transfer Res., %		18.55	18.27
CO Conv., gmole/kg Fe/h	55.3	56.14	52.91
-CH ₂ produced, g/kg Fe/h		417.35	383.38
g/nm ³ syngas		147.80	139.32

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 22
COMPARISON WITH LAPORTE SBCK RUN AF-R6.1B

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	18.2	83.8	100
Density, g/cm ³	3.100	0.866	0.783
Volume % Solids	3.99	96.01	100.00
Viscosity, g/cm/s	-	0.0225	0.0305
Surface Tension, N/m	-	19.5	-
Part. Size, microns	10.5	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	600.6
Slurry Level, fraction	0.68
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.37
Catalyst Weight, kg	189.3
Cat. Loading, kg/m ³	123.7

OPERATING CONDITIONS	
Rx Temperature, K	338
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.0
Feed Rate, am ³ /hr	36.8
nm ³ /hr	271.3
SV, am ³ /hr/m ³	26.7
nm ³ /hr/m ³	187.9
nm ³ /hr/kg Fe	2.97
Corr. factor for kLa	0.589
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-B		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	60.8	58.5	55.4
Ug, cm/sec		2.6	2.7
Gas hold-up, eps-g	0.15	0.102	0.104
kLa (uncon), 1/s		0.259	0.294
kLa (corr), 1/s		0.170	0.173
kr, epsl, 1/s		0.037	0.037
KR(=kr,epsl.R.T./He)		0.006	0.006
KM(=kLa.R.T./He)		0.029	0.030
K(=KR.KM/(KR+KM))		0.005	0.005
H2+CO Conversion, %	68.4	87.2	63.7
CO Conversion, %	73.8	73.2	69.4
STY, nm ³ /h/m ³		132.9	125.0
STY, nm ³ /h/kg Fe		2.00	1.89
Mass Transfer Res., %		17.83	17.70
CO Conv., gmole/kg Fe/h	55.8	57.16	54.17
CH2 produced, g/kg Fe/h		424.94	402.73
g/nm ³ syngas		142.92	135.45

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 23
COMPARISON WITH LAPORTE SBCR RUN AF-R6.1C

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	15.43	84.57	100
Density, g/cm ³	3.100	0.808	0.758
Volume % Solids	5.77	96.23	100.00
Viscosity, g/cm/s	-	0.0225	0.0300
Surface Tension, N/m	-	16.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	909.8
Slurry Level, fraction	0.80
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	164.6
Cat. Loading, kg/m ³	117.0

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1430
Inlet Gas Vel., cm/s	4.0
Feed Rate, cm ³ /hr	36.6
nm ³ /hr	271.3
SV, cm ³ /hr/m ³	25.0
nm ³ /hr/m ³	192.8
nm ³ /h/kg Fe	3.06
Corr. factor for kLa	0.593
H ₂ Diffusivity, cm ² /s	0.00057

RUN	AF-R6.1-C		
	Plant	MODEL 1	MODEL 2
H ₂ Conversion, %	53.0	57.7	54.8
U _g , cm/sec		2.7	2.7
Gas hold-up, eps-g	0.134	0.103	0.104
kLa (uncon), 1/s		0.250	0.295
kLa (corr), 1/s		0.172	0.175
kr, eps, 1/s		0.035	0.035
KR (= kr, eps, R.T./He)		0.006	0.006
KM (= kLa, R.T./He)		0.030	0.030
K (= KR, KM / (KR + KM))		0.005	0.005
H ₂ + CO Conversion, %	58.7	66.2	62.7
CO Conversion, %	52.7	72.2	68.4
STY, nm ³ /h/m ³		127.7	120.6
STY, nm ³ /h/kg Fe		2.03	1.92
Mass Transfer P _{CO} , %		16.99	16.77
CO Conv., gmo ₂ /kg _{Fe} /h	49.1	58.04	54.98
CH ₂ produced, g/kg Fe/h		431.47	408.76
g/nm ³ syngas		140.86	133.45

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 24
COMPARISON WITH LAPORTE SBCR RUN AF-R6.1D

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	14.35	85.65	100
Density, g/cm ³	3.100	0.625	0.751
Volume % Solids	3.48	96.52	100.00
Viscosity, g/cm/s	-	0.0225	0.0293
Surface Tension, N/m	-	15.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	608.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	151.7
Cat. Loading, kg/m ³	107.9

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	3.7
Feed Rate, m ³ /hr	33.8
nm ³ /hr	250.5
SV, m ³ /hr/m ³	24.0
nm ³ /hr/m ³	178.0
nm ³ /h/kg Fe	3.07
Corr. factor for kLa	0.597
H ₂ Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-D		
	Plant	MODEL 1	MODEL 2
H ₂ Conversion, %	54.7	57.8	64.8
U _g , cm/sec		2.4	2.5
Gas hold-up, eps-g	0.121	0.098	0.099
kLa (uncorr), 1/s		0.276	0.280
kLa (corr), 1/s		0.165	0.168
kr, epsl, 1/s		0.032	0.032
KR (= kr, epsl, R.T./He)		0.005	0.006
KM (= kLa, R.T./He)		0.023	0.029
K (= KR, KM / (KR + KM))		0.005	0.005
H ₂ + CO Conversion, %	60.7	66.4	62.7
CO Conversion, %	65.0	72.4	63.4
STY, nm ³ /h/m ³		118.2	111.7
STY, nm ³ /h/kg Fe		2.04	1.93
Mass Transfer Res., %		16.45	16.23
CO Conv., gmole/kg Fe/h	50.8	68.34	55.11
CH ₂ produced, g/kg Fe/h		433.74	409.72
g/nm ³ syngas		141.30	133.48

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed

TABLE 25
COMPARISON WITH LAPORTE SBGR RUN AF-R6.1E

PROPERTIES OF SOLID AND LIQUID			
	Solid	Liquid	Slurry
Wt% Solids in Slurry	14.00	85.97	100
Density, g/cm ³	3.100	0.668	0.749
Volume % Solids	3.39	96.61	100.00
Viscosity, g/cm/s	-	0.0225	0.0291
Surface Tension, N/m	-	18.5	-
Part. Size, microns	10.0	-	-

BUBBLE COLUMN DIMENSIONS	
	LaPorte
ID of Rx, cm	57.2
L of Rx, cm	608.6
Slurry Level, fraction	0.90
Rx X-section, m ²	0.26
Slurry Volume, m ³	1.41
Catalyst Weight, kg	147.9
Cat. Loading, kg/m ³	105.1

OPERATING CONDITIONS	
Rx Temperature, K	538
Rx Pressure, kPa	1480
Inlet Gas Vel., cm/s	4.3
Feed Rate, am ³ /hr	39.4
nm ³ /hr	292.2
SV, am ³ /hr/m ³	25.0
nm ³ /hr/m ³	207.6
nm ³ /hr/kg Fe	3.67
Corr. factor for kLa	0.599
H2 Diffusivity, cm ² /s	0.00057

BUBBLE COLUMN MODEL CALCULATIONS			
RUN	AF-R6.1-E		
	Plant	MODEL 1	MODEL 2
H2 Conversion, %	46.0	51.2	49.1
Ug, cm/sec		3.0	3.1
Gas hold-up, eps-g	0.137	0.110	0.111
kLa (uncorr), 1/s		0.314	0.317
kLa (corr), 1/s		0.188	0.190
kr,eps1, 1/s		0.032	0.032
KR(=kr,eps1.R.T/He)		0.005	0.005
KM(=kLa.R.T/He)		0.032	0.033
K(=KR.KM/(KR+KM))		0.005	0.005
H2+CO Conversion, %	50.5	58.8	56.4
CO Conversion, %	53.7	64.1	61.5
STY, nm ³ /h/m ³		122.1	117.0
STY, nm ³ /h/kg Fe		2.16	2.07
Mass Transfer Res., %		14.42	14.29
CO Conv., gmoles/kg Fe/h	50.5	61.80	59.24
-CH2 produced, g/kg Fe/h		459.45	440.45
g/nm ³ syngas		125.08	119.91

Model 1: Both gas and liquid in plug flow

Model 2: Gas in plug flow and liquid completely mixed