B. Computerized Run Sheets For Catalyst Screening Studies

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 194-95

CATALYST NUMBER : 197-16 DATE : 1/7/80
ATOMIC FORMULA : $CuCrCoZn_{.5}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.24 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5*
TEST CONDITIONS :					
FEED H2/CO RATIO	3.60	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	238.0	248.0	259.0	272.0	364.0
HOT SPOT, C	239.0	249.0	261.0	274.0	364.0
PRESSURE, psig	905.0	905.0	900.0	900.0	900.0
VHSV, l/hr/kgm cat.	3359.0	3449.0	3361.0	3458.0	3398.0
HOURS on STREAM	2.2	3.7	5.0	6.4	6.9
RPM	.0	.0	.0	.0	.0
CONVERSION :					
CO to Prods., vol%	6.44	5.88	8.40	15.84	99.50
CO to CO2, vol%	2.26	2.22	3.50	10.16	.00
CO, gm mol/hr/kgm cat.	2.23	2.12	3.04	6.82	25.90
STY of oxygenates(2) gm mol/hr/kgm cat.	.57	.46	.69	1.24	.00
STOICHIOM. H2/CO converted	1.96	3.52	3.21	2.66	3.41
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	4.29	7.35	7.51	8.04	.00
C2-C6 ALCOHOLS	24.97	20.63	22.53	20.68	.00
C2-C6 ALD.&ESTERS	5.58	2.29	2.27	1.15	.00
CH4	30.92	40.78	41.38	45.62	91.00
C2-C3 HYDROCARBONS	15.55	17.37	15.31	14.74	6.00
C4+ HYDROCARBONS	16.77	11.66	11.20	9.88	3.00
APPROACH TO(3) WGS Equilibrium, C					
CARBON ACCOUNTABILITY, % (4)	93.2	88.7	112.1	122.6	94.7

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

* Temperature Runaway.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-1

CATALYST NUMBER : 197-17 DATE : 1/14/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.26 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	3.50	3.50
FEED CO2	12.00	12.00
AVE. TEMP., C	227.0	239.0
HOT SPOT, C	228.0	240.0
PRESSURE, psig	905.0	905.0
VHSV, l/hr/kgm cat.	3156.0	3154.0
HOURS on STREAM	1.6	2.5
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	9.30	9.60
CO to CO2, vol%	.00	.80
CO, gm mol/hr/kgm cat.	2.27	2.53
STY of oxygenates(2) gm mol/hr/kgm cat.	.28	.46
STOICHIOM. H2/CO converted	.93	.78
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	.30	2.28
C2-C6 ALCOHOLS	3.40	12.68
C2-C6 ALD.&ESTERS	8.60	4.66
CH4	25.60	29.47
C2-C3 HYDROCARBONS	25.50	26.54
C4+ HYDROCARBONS	22.50	24.38
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	38.1	67.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-6

CATALYST NUMBER : 197-20 DATE : 1/22/80

ATOMIC FORMULA : $CuCr_{.18}Co_{.5}Zn_{.49}K_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.42 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	3.60	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	239.0	249.0	261.0	273.0	285.0
HOT SPOT, C	240.0	250.0	262.0	275.0	289.0
PRESSURE, psig	905.0	905.0	905.0	905.0	905.0
VHSV, l/hr/kgm cat.	3060.0	3089.0	3046.0	3056.0	3005.0
HOURS on STREAM	5.8	6.4	7.1	8.2	9.0
RPM	.0	.0	.0	.0	.0
CONVERSION :					
CO to Prods., vol%	2.90	5.30	8.20	11.81	18.23
CO to CO2, vol%	.00	.00	.60	2.99	7.77
CO, gm mol/hr/kgm cat.	.67	1.22	2.03	3.43	5.91
STY of oxygenates(2) gm mol/hr/kgm cat.	.10	.18	.23	.29	.59
STOICHIOM. H2/CO converted	1.91	1.49	1.48	1.61	1.46
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	.00	.60	1.18	1.13	1.14
C2-C6 ALCOHOLS	3.40	6.80	5.79	7.27	8.56
C2-C6 ALD.&ESTERS	11.50	7.20	5.47	2.01	4.56
CH4	48.90	44.60	47.10	48.63	48.34
C2-C3 HYDROCARBONS	23.50	25.20	25.75	25.19	23.39
C4+ HYDROCARBONS	12.70	14.30	14.70	15.67	14.12
APPROACH TO(3) WGS Equilibrium, C					
CARBON ACCOUNTABILITY, % (4)	59.9	61.7	62.5	70.8	82.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-9

CATALYST NUMBER : 197-19 DATE : 1/28/80

ATOMIC FORMULA : $CuCr_{.18}Zn_{.49}K_{.07}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.99 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	3.60	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	279.0	299.0	317.0	335.0	336.0
HOT SPOT, C	280.0	300.0	318.0	337.0	337.0
PRESSURE, psig	910.0	910.0	900.0	900.0	900.0
VHSV, l/hr/kgm cat.	2062.0	2089.0	2092.0	2063.0	3978.0
HOURS on STREAM	3.1	3.8	4.5	5.1	5.6
RPM	.0	.0	.0	.0	.0
CONVERSION : *					
CO_2 to Prods., vol%	.81	1.32	1.43	2.89	2.14
CO_2 to CO , vol%	4.49	5.58	6.37	7.41	8.36
CO_2 gm mol/hr/kgm cat.	.60	.80	.90	1.18	2.33
STY of oxygenates(2) gm mol/hr/kgm cat.	.09	.15	.16	.30	.44
STOICHIOM. $H2/CO_2$ converted	1.74	1.75	1.25	1.58	1.33
CARBON SELECTIVITY (Normalized Mol% on CO -free Basis) :					
CH3OH	97.37	94.79	93.44	89.68	91.67
C2-C6 ALCOHOLS	.00	.00	.00	.00	.00
C2-C6 ALD.&ESTERS	.00	.00	.00	.00	.00
CH4	1.32	2.08	3.28	6.05	4.41
C2-C3 HYDROCARBONS	1.32	3.13	3.28	4.27	3.92
C4+ HYDROCARBONS	.00	.00	.00	.00	.00
APPROACH TO(3) WGS Equilibrium, C					
CARBON ACCOUNTABILITY, % (4)	97.3	97.6	115.2	98.1	109.9

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * $\%CO_2$ in feed/100 * $\%CO_2$ conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

* no CO was converted but CO_2 was hydrogenated to CO and H_2O.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-11

CATALYST NUMBER : 197-22 DATE : 1/31/80

ATOMIC FORMULA : $CuCr_{.18}Zn_{.49}K_{.07}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.08 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	3.60	3.60	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	248.0	249.0	278.0	297.0	318.0	336.0
HOT SPOT, C	249.0	250.0	279.0	299.0	319.0	340.0
PRESSURE, psig	930.0	920.0	910.0	905.0	900.0	900.0
VHSV, l/hr/kgm cat.	3814.0	9000.0	3752.0	3748.0	3805.0	3826.0
HOURS on STREAM	1.2	2.0	3.0	3.7	4.3	5.1
RPM	.0	.0	.0	.0	.0	.0
CONVERSION :*						
CO_2 to Prods., vol%	1.24	.19	1.33	1.46	2.29	3.30
CO_2 to CO , vol%	2.86	2.51	4.57	5.84	6.91	7.50
CO_2 gm mol/hr/kgm cat.	.87	1.36	1.23	1.53	1.96	2.31
STY of oxygenates(2) gm mol/hr/kgm cat.	.25	.09	.27	.28	.44	.59
STOICHIOM. H2/CO_2 converted	1.57	.25	1.18	1.22	1.19	1.38
CARBON SELECTIVITY (Normalized Mol% on CO -free Basis) :						
CH3OH	95.70	94.37	97.78	91.00	89.16	82.68
C2-C6 ALCOHOLS	.00	.00	.00	.00	.00	.00
C2-C6 ALD.&ESTERS	.00	.00	.00	.00	.00	.00
CH4	4.30	1.41	.89	.50	7.23	12.75
C2-C3 HYDROCARBONS	.00	4.23	1.33	8.50	3.61	4.58
C4+ HYDROCARBONS	.00	.00	.00	.00	.00	.00
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	69.1	101.0	77.8	90.2	85.1	77.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * $\%CO_2$ in feed/100 * $\%CO_2$ conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

* No CO was converted but CO_2 was hydrogenated to CO and H_2O

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-13

CATALYST NUMBER : 197-27 DATE : 2/5/80

ATOMIC FORMULA : $CuAl_{.21}Zn_{.36}K_{.07}$

CATALYST SUPPORT : NONE

PREP METHOD: Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.04 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00
AVE. TEMP., C	239.0	250.0	261.0	273.0
HOT SPOT, C	240.0	251.0	262.0	274.0
PRESSURE, psig	925.0	920.0	910.0	905.0
VHSV, l/hr/kgm cat.	3898.0	4238.0	4652.0	4249.0
HOURS on STREAM	1.5	2.5	2.9	3.5
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	13.47	18.65	20.91	24.00
CO to CO2, vol%	-3.47	-4.35	-4.01	-5.00
CO, gm mol/hr/kgm cat.	2.95	4.59	5.96	6.12
STY of oxygenates(2) gm mol/hr/kgm cat.	2.95	4.59	5.91	6.10
STOICHIOM. H2/CO converted	2.69	2.34	2.39	2.25
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	99.41	98.94	98.60	98.50
C2-C6 ALCOHOLS	.00	.00	.00	.00
C2-C6 ALD.&ESTERS	.59	1.00	.48	1.11
CH4	.00	.08	.89	.40
C2-C3 HYDROCARBONS	.00	.00	.00	.00
C4+ HYDROCARBONS	.00	.00	.00	.00
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	81.1	66.6	102.5	50.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition,
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-15

CATALYST NUMBER : 197-28 DATE : 2/12/80

ATOMIC FORMULA : $CuCo_{.32}Al_{.21}Zn_{.36}K_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.78 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00
AVE. TEMP., C	251.0	260.0	271.0	282.0
HOT SPOT, C	252.0	262.0	273.0	283.0
PRESSURE, psig	930.0	920.0	905.0	900.0
VHSV, l/hr/kgm cat.	2261.0	2289.0	2519.0	2555.0
HOURS on STREAM	.8	2.5	3.0	3.5
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	6.15	6.48	7.60	10.70
CO to CO2, vol%	.25	.72	.00	2.30
CO, gm mol/hr/kgm cat.	1.09	1.24	1.44	2.50
STY of oxygenates(2) gm mol/hr/kgm cat.	.21	.20	.67	.49
STOICHIOM. H2/CO converted	1.92	1.63	1.98	1.73
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	1.35	.44	10.10	3.16
C2-C6 ALCOHOLS	3.64	12.22	11.90	14.34
C2-C6 ALD.&ESTERS	14.57	5.44	24.20	6.44
CH4	26.43	35.66	26.70	40.82
C2-C3 HYDROCARBONS	19.77	26.11	15.60	17.01
C4+ HYDROCARBONS	34.13	20.22	11.50	13.24
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	60.9	60.4	88.6	72.7

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-17

CATALYST NUMBER : 197-29 DATE : 2/23/80

ATOMIC FORMULA : $CuCr_{.14}Co_{.75}Zn_{.5}K_{.12}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.29 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	3.60	3.60	3.60	3.60	3.60
FEED CO2	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	242.0	252.0	263.0	274.0	285.0
HOT SPOT, C	244.0	253.0	265.0	276.0	287.0
PRESSURE, psig	910.0	905.0	900.0	900.0	900.0
VHSV, l/hr/ksm cat.	3214.0	3280.0	3325.0	3355.0	3428.0
HOURS on STREAM	.8	1.4	2.4	3.2	3.7
RPM	.0	.0	.0	.0	.0
CONVERSION :					
CO to Prods., vol%	8.45	8.24	10.29	12.64	19.27
CO to CO2, vol%	.45	.96	2.11	4.06	9.73
CO, gm mol/hr/ksm cat.	2.17	2.29	3.13	4.25	7.54
STY of oxygenates(2) gm mol/hr/ksm cat.	.20	.34	.35	.61	.78
STOICHIOM. H2/CO converted	1.55	1.49	1.56	1.46	1.26
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	.00	.22	1.20	1.32	1.20
C2-C6 ALCOHOLS	2.74	12.94	7.83	10.97	8.58
C2-C6 ALD.&ESTERS	6.74	3.35	4.58	6.61	5.72
CH4	37.41	45.42	39.04	42.68	46.94
C2-C3 HYDROCARBONS	33.41	17.19	23.86	24.31	23.32
C4+ HYDROCARBONS	19.60	20.98	23.49	14.01	13.24
APPROACH TO(3) WGS Equilibrium, C					
CARBON ACCOUNTABILITY, % (4)	42.2	50.0	68.1	77.1	83.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-22

CATALYST NUMBER : 197-1 DATE : 2/29/80

ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.46 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	3.60	3.60	3.60	3.60	2.00	2.00
FEED CO2	12.00	12.00	12.00	12.00	5.00	5.00
AVE. TEMP., C	251.0	254.0	260.0	261.0	260.0	260.0
HOT SPOT, C	251.0	254.0	260.0	261.0	260.0	260.0
PRESSURE, psig	885.0	885.0	885.0	885.0	885.0	885.0
VHSV, l/hr/kgm cat.	2604.0	688.0	2840.0	779.0	2881.0	746.0
HOURS on STREAM	3.1	5.3	7.6	11.1	13.7	17.0
RPM	1710.0	1720.0	1700.0	1700.0	1700.0	1700.0
CONVERSION :						
CO to Prods., vol%	18.36	36.76	14.53	47.64	4.46	16.24
CO to CO2, vol%	5.24	9.54	3.27	15.96	2.14	9.26
CO, gm mol/hr/kgm cat.	4.70	2.40	3.80	4.30	2.40	2.40
STY of oxygenates(2) gm mol/hr/kgm cat.	.33	.27	.46	.38	.34	.31
STOICHIOM. H2/CO converted	1.80	1.63	1.54	1.56	.91	1.15
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	2.19	2.14	4.41	3.87	7.69	6.91
C2-C6 ALCOHOLS	6.81	11.71	10.17	8.41	13.61	13.66
C2-C6 ALD.&ESTERS	.00	.00	.00	.00	.00	.00
CH4	40.87	35.01	48.15	58.74	44.08	40.50
C2-C3 HYDROCARBONS	25.06	30.48	23.52	20.16	21.01	27.47
C4+ HYDROCARBONS	25.06	20.65	12.74	8.81	13.61	11.46
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	84.2	102.3	86.9	104.1	90.5	94.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

SUMMARY FOR RUN # 201-22

CHEM SYSTEMS INC.

CATALYST NUMBER : 197-1 DATE : 2/29/80

ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.46 gm/cc REACTOR TYPE: Berty

TEST NUMBER	7	8	9	10
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00
AVE. TEMP., C	260.0	259.0	259.0	258.0
HOT SPOT, C	260.0	259.0	259.0	258.0
PRESSURE, psig	885.0	885.0	885.0	885.0
VHSV, l/hr/kgm cat.	2619.0	2644.0	2643.0	2722.0
HOURS on STREAM	18.3	19.5	20.7	22.1
RPM	2000.0	1700.0	1400.0	1000.0
CONVERSION :				
CO to Prods., vol%	4.10	3.93	4.04	4.28
CO to CO2, vol%	1.90	1.77	1.66	1.32
CO, gm mol/hr/kgm cat.	2.00	1.90	1.90	1.90
STY of oxygenates(2) gm mol/hr/kgm cat.	.30	.29	.35	.42
STOICHIOM. H2/CO converted	.89	.99	.86	1.07
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	7.61	8.56	8.76	9.54
C2-C6 ALCOHOLS	14.64	13.78	17.37	19.61
C2-C6 ALD.&ESTERS	.00	.00	.00	.00
CH4	47.87	49.18	47.03	44.05
C2-C3 HYDROCARBONS	20.20	20.46	19.07	18.56
C4+ HYDROCARBONS	9.73	8.12	7.77	8.24
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	96.3	90.7	89.4	85.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-32

DATE : 3/19/80

CATALYST NUMBER : 197-30
ATOMIC FORMULA : $CuCo_{.65}Al_{.21}Zn_{.36}K_{.1}$
CATALYST SUPPORT : NONE

PREP METHOD: Impregnation

REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.69 gm/cc

REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	220.0	241.0	263.0
HOT SPOT, C	220.0	242.0	265.0
PRESSURE, psis	925.0	920.0	920.0
VHSV, l/hr/ksm cat.	2328.0	2355.0	2391.0
HOURS on STREAM	1.6	2.5	3.4
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	.90	2.62	6.55
CO to CO2, vol%	1.00	1.98	5.65
CO, gm mol/hr/kgm cat.	.54	1.34	3.60
STY of oxygenates(2) gm mol/hr/kgm cat.	.02	.10	.47
STOICHIOM. H2/CO converted	1.19	1.22	.80
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	1.06	1.75	1.86
C2-C6 ALCOHOLS	[4.88	3.51	10.61
C2-C6 ALD.&ESTERS	.00]	7.72	11.73
CH4	40.71	32.11	28.86
C2-C3 HYDROCARBONS	31.80	28.25	23.28
C4+ HYDROCARBONS	22.05	26.67	23.65
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	60.0	80.1	89.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

SUMMARY FOR RUN # 201-34

CHEM SYSTEMS INC.

CATALYST NUMBER : 197-2 DATE : 3/20/80
ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1); 1.69 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	250.0	248.0	261.0	260.0	262.0	262.0
HOT SPOT, C	251.0	250.0	263.0	262.0	262.0	263.0
PRESSURE, psig	890.0	890.0	890.0	895.0	895.0	885.0
VHSV, l/hr/kgm cat.	2475.0	3915.0	2314.0	2354.0	2351.0	4098.0
HOURS on STREAM	1.1	3.7	6.4	7.6	8.6	10.3
RPM	1690.0	1700.0	1740.0	700.0	1420.0	1690.0
CONVERSION :						
CO to Prods., vol%	1.59	.99	2.73	2.40	2.15	1.85
CO to CO2, vol%	.51	.11	.97	1.00	.85	.35
CO, gm mol/hr/kgm cat.	.65	.55	1.05	.97	.87	1.13
STY of oxygenates(2) gm mol/hr/kgm cat.	.09	.13	.12	.16	.15	.24
STOICHIOM. H2/CO converted	1.89	.65	.83	.02	.14	.23
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	.00	.00	.81	.85	1.12	.36
C2-C6 ALCOHOLS	3.97	8.24	3.80	1.84	1.68	1.67
C2-C6 ALD.&ESTERS	14.68	18.82	11.12	19.82	21.95	23.11
CH4	45.50	44.54	41.37	49.41	46.69	55.86
C2-C3 HYDROCARBONS	18.92	16.15	33.64	18.41	17.48	17.63
C4+ HYDROCARBONS	16.93	12.25	9.36	9.77	11.18	7.38
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	102.8	94.0	102.1	86.4	97.4	66.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-34

DATE : 3/20/80

CATALYST NUMBER : 197-2
ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation

REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.69 gm/cc

REACTOR TYPE: Berty

TEST NUMBER	7	8	9	10
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00
AVE. TEMP., C	269.0	271.0	272.0	269.0
HOT SPOT, C	270.0	271.0	273.0	271.0
PRESSURE, psig	900.0	895.0	895.0	895.0
VHSV, l/hr/kgm cat.	3715.0	2132.0	795.0	766.0
HOURS on STREAM	11.5	12.6	14.5	15.5
RPM	1700.0	1700.0	1710.0	700.0
CONVERSION :				
CO to Prods., vol%	2.27	4.03	15.18	12.52
CO to CO2, vol%	.53	1.77	11.02	8.78
CO, gm mol/hr/kgm cat.	1.31	1.54	2.58	2.12
STY of oxygenates(2) gm mol/hr/kgm cat.	.29	.26	.36	.32
STOICHIOM. H2/CO converted	1.07	1.45	1.63	1.54
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	4.07	5.47	5.35	4.93
C2-C6 ALCOHOLS	10.97	9.64	12.42	13.10
C2-C6 ALD.&ESTERS	12.20	9.20	5.87	7.65
CH4	49.93	51.49	51.76	44.22
C2-C3 HYDROCARBONS	16.64	17.55	17.60	21.09
C4+ HYDROCARBONS	6.29	6.76	6.90	9.01
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	89.2	83.6	85.1	99.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-37

CATALYST NUMBER : 197-32 DATE : 3/27/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.58 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	249.0	249.0	250.0	266.0	268.0	269.0
HOT SPOT, C	249.0	249.0	250.0	266.0	268.0	269.0
PRESSURE, psig	895.0	895.0	1375.0	895.0	895.0	895.0
VHSV, l/hr/kgm cat.	2505.0	661.0	680.0	4900.0	2470.0	712.0
HOURS on STREAM	2.1	4.5	6.5	4.5	8.1	10.0
RPM	1700.0	1920.0	1900.0	1680.0	1700.0	1700.0
CONVERSION :						
CO to Prods., vol%	1.41	4.80	5.65	1.49	2.76	8.02
CO to CO2, vol%	.19	2.10	2.55	.21	.74	6.08
CO, gm mol/hr/kgm cat.	.50	.80	.69	1.04	1.08	1.57
STY of oxygenates(2) gm mol/hr/kgm cat.	.11	.12	.12	.24	.23	.21
STOICHIOM. H2/CO converted	1.03	1.50	1.46	.51	1.10	1.05
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	.45	.57	.44	.00	.76	1.58
C2-C6 ALCOHOLS	3.40	5.31	4.35	5.49	7.48	6.33
C2-C6 ALD.&ESTERS	22.11	17.09	19.16	20.46	18.51	15.29
CH4	46.03	41.07	40.06	46.76	40.95	42.71
C2-C3 HYDROCARBONS	14.40	16.95	17.27	14.86	14.33	17.22
C4+ HYDROCARBONS	13.61	19.10	18.72	15.43	16.86	16.87
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	63.6	74.8	77.7	55.4	65.8	74.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition,
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-37

CATALYST NUMBER : 197-32 — DATE : 3/27/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation — REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.58 gm/cc — REACTOR TYPE: Berty

TEST NUMBER	7	8	9	10	11	12
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	271.0	270.0	266.0	287.0	283.0	288.0
HOT SPOT, C	271.0	270.0	266.0	287.0	283.0	288.0
PRESSURE, psig	1275.0	1275.0	425.0	915.0	915.0	910.0
VHSV, 1/hr/kgm cat.	691.0	2498.0	655.0	2713.0	2666.0	716.0
HOURS on STREAM	11.7	12.2	13.1	14.9	16.0	18.1
RPM	1690.0	1700.0	1720.0	1720.0	600.0	1720.0
CONVERSION :						
CO to Prods., vol%	10.96	4.09	5.02	4.51	4.11	18.71
CO to CO2, vol%	7.94	2.21	3.98	2.09	1.69	13.39
CO, gm mol/hr/kgm cat.	1.63	1.96	.73	2.23	1.93	2.86
STY of oxygenates(2) gm mol/hr/kgm cat.	.18	.32	.12	.31	.29	.44
STOICHIOM. H2/CO converted	1.02	1.01	.87	1.23	1.34	.96
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	1.72	2.31	1.43	.00	.00	.00
C2-C6 ALCOHOLS	4.48	6.93	7.71	20.04	21.47	26.24
C2-C6 ALD.&ESTERS	12.41	15.72	20.43	.00	.00	.00
CH4	46.38	42.53	44.44	50.75	49.86	44.25
C2-C3 HYDROCARBONS	19.83	17.57	9.14	18.58	19.21	18.01
C4+ HYDROCARBONS	15.17	14.95	9.86	10.53	9.46	11.49
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	81.9	74.1	74.1	85.3	88.8	92.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-37

CATALYST NUMBER : 197-32 DATE : 3/27/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.58 gm/cc REACTOR TYPE: Berty

TEST NUMBER	13
TEST CONDITIONS :	
FEED H2/CO RATIO	2.00
FEED CO2	5.00
AVE. TEMP., C	243.0
HOT SPOT, C	243.0
PRESSURE, psig	910.0
VHSV, l/hr/kgm cat.	2422.0
HOURS on STREAM	20.0
RPM	1700.0
CONVERSION :	
CO to Prods., vol%	.68
CO to CO2, vol%	.02
CO, gm mol/hr/kgm cat.	.21
STY of oxygenates(2) gm mol/hr/kgm cat.	.06
STOICHIOM. H2/CO converted	2.61
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	.00
C2-C6 ALCOHOLS	.00
C2-C6 ALD.&ESTERS	28.79
CH4	45.10
C2-C3 HYDROCARBONS	14.86
C4+ HYDROCARBONS	11.25
APPROACH TO(3) WGS Equilibrium, C	
CARBON ACCOUNTABILITY, % (4)	86.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-40

CATALYST NUMBER : 197-2 DATE : 3/31/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.69 sm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	3.50	3.50	3.50	3.50	3.50	3.50
FEED CO2	12.00	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	261.0	267.0	280.0	283.0	280.0	280.0
HOT SPOT, C	262.0	268.0	281.0	286.0	281.0	281.0
PRESSURE, psig	920.0	940.0	940.0	940.0	920.0	920.0
VHSV, l/hr/ksm cat.	2275.0	2195.0	2217.0	2284.0	2251.0	2099.0
HOURS on STREAM	.5	25.8	73.5	75.5	80.0	98.5
RPM	.0	.0	.0	.0	.0	.0
CONVERSION :						
CO to Prods., vol%	3.67	7.01	11.14	16.47	13.20	13.61
CO to CO2, vol%	1.53	1.99	4.26	4.83	1.80	2.59
CO, sm mol/hr/ksm cat.	1.40	1.60	2.88	3.80	2.60	2.60
STY of oxygenates(2) sm mol/hr/ksm cat.	.14	.38	.50	.76	.66	.65
STOICHIOM. H2/CO converted	1.56	1.45	1.11	1.51	1.75	1.62
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	.14	2.32	2.77	3.10	2.73	3.10
C2-C6 ALCOHOLS	2.27	2.70	3.04	8.02	5.11	4.88
C2-C6 ALD.&ESTERS	10.92	25.67	19.08	14.87	20.91	21.31
CH4	46.81	40.05	43.14	41.39	31.48	38.21
C2-C3 HYDROCARBONS	21.84	17.20	19.77	18.62	25.23	18.33
C4+ HYDROCARBONS	18.01	12.07	12.31	14.10	14.43	14.17
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	84.4	99.5	91.4	92.8	79.3	86.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-45

CATALYST NUMBER : 200-27-2 DATE : 4/8/80

ATOMIC FORMULA : $CuCoFe_{.5}Th_{.5}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.51 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.10	2.10	2.10	2.10	2.10	2.10
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	249.0	248.0	243.0	238.0	248.0	247.0
HOT SPOT, C	250.0	249.0	245.0	239.0	248.0	248.0
PRESSURE, psig	895.0	895.0	440.0	885.0	1480.0	885.0
VHSV, l/hr/kgm cat.	2975.0	2824.0	1526.0	3116.0	4985.0	2857.0
HOURS on STREAM	5.6	10.8	14.9	17.5	19.1	21.4
RPM	1700.0	1700.0	1700.0	1700.0	1700.0	1700.0
CONVERSION :						
CO to Prods., vol%	36.56	28.69	19.47	17.59	21.11	21.78
CO to CO2, vol%	30.43	26.63	10.92	14.68	16.54	19.68
CO, gm mol/hr/kgm cat.	24.60	19.30	5.70	12.40	23.50	14.80
STY of oxygenates(2) gm mol/hr/kgm cat.	3.51	2.28	.84	1.75	3.65	1.97
STOICHIOM. H2/CO converted	.81	.79	1.00	.88	.88	.90
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	2.02	1.89	2.86	1.80	2.51	2.23
C2-C6 ALCOHOLS	18.51	15.04	14.98	14.73	16.25	17.45
C2-C6 ALD.&ESTERS	5.50	5.96	5.03	9.43	8.93	5.67
CH4	20.41	21.58	23.79	17.76	21.26	21.22
C2-C3 HYDROCARBONS	24.11	26.42	27.58	25.68	27.14	27.71
C4+ HYDROCARBONS	29.78	29.12	22.13	30.64	23.93	25.64
APPROACH TO(3) WGS Equilibrium, C	95.00	120.00	173.00	178.00	178.00	149.00
CARBON ACCOUNTABILITY, % (4)	88.6	82.6	83.0	78.2	79.6	80.1

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

SUMMARY FOR RUN # 201-48

CHEM SYSTEMS INC.

CATALYST NUMBER : 197-1 DATE : 4/22/80

ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.46 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	9.00	13.50	13.50	9.00	9.00	9.00
AVE. TEMP., C	258.0	258.0	259.0	269.0	269.0	269.0
HOT SPOT, C	258.0	258.0	259.0	269.0	269.0	269.0
PRESSURE, psig	920.0	920.0	920.0	920.0	915.0	915.0
VHSV, l/hr/kgm cat.	3152.0	2679.0	700.0	2719.0	677.0	1345.0
HOURS on STREAM	4.1	6.5	8.6	10.6	12.8	14.5
RPM	1700.0	1700.0	1720.0	1700.0	1700.0	1700.0
CONVERSION :						
CO to Prods., vol%	6.25	4.48	13.79	4.33	18.29	9.44
CO to CO2, vol%	2.25	1.25	8.51	2.07	11.21	4.86
CO, gm mol/hr/kgm cat.	3.10	1.72	1.76	2.01	2.31	2.22
STY of oxygenates(2) gm mol/hr/kgm cat.	.43	.26	.30	.38	.47	.50
STOICHIOM. H2/CO converted	1.15	1.13	1.10	1.04	1.08	.85
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	9.39	8.95	9.54	14.03	11.77	13.48
C2-C6 ALCOHOLS	9.39	10.23	17.63	14.18	20.81	20.61
C2-C6 ALD.&ESTERS	.00	.00	.00	.00	.00	.00
CH4	43.39	35.69	36.71	40.62	39.84	38.94
C2-C3 HYDROCARBONS	20.41	20.72	20.86	18.02	18.23	18.18
C4+ HYDROCARBONS	14.83	16.50	15.36	13.15	9.35	8.79
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	84.2	72.8	87.3	91.7	91.8	93.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-48

CATALYST NUMBER : 197-1 DATE : 4/22/80

ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.46 gm/cc REACTOR TYPE: Berty

TEST NUMBER	7	8	9
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	9.00	13.50	13.50
AVE. TEMP., C	255.0	257.0	257.0
HOT SPOT, C	255.0	257.0	257.0
PRESSURE, psig	1200.0	1190.0	1485.0
VHSV, l/hr/kgm cat.	3570.0	3596.0	4322.0
HOURS on STREAM	16.6	19.0	20.8
RPM	1700.0	1700.0	1700.0
CONVERSION :			
CO to Prods., vol%	2.90	3.20	2.40
CO to CO2, vol%	.60	.00	.00
CO, gm mol/hr/kgm cat.	1.44	1.30	1.17
STY of oxygenates(2) gm mol/hr/kgm cat.	.30	.36	.38
STOICHIOM. H2/CO converted	1.92	2.54	2.36
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	16.40	15.10	19.10
C2-C6 ALCOHOLS	9.04	13.00	13.40
C2-C6 ALD.&ESTERS	.00	.00	.00
CH4	44.25	48.80	9.40
C2-C3 HYDROCARBONS	20.14	12.20	14.00
C4+ HYDROCARBONS	10.37	10.90	9.40
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	59.5	51.1	69.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-51

CATALYST NUMBER : 197-57 DATE : 5/2/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Mech. Blending of Oxides REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.9 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	252.0	263.0	292.0
HOT SPOT, C	252.0	263.0	293.0
PRESSURE, psig	900.0	900.0	915.0
VHSV, l/hr/kgm cat.	3192.0	2024.0	2346.0
HOURS on STREAM	2.8	5.5	8.4
RPM	1700.0	1720.0	1730.0
CONVERSION :			
CO to Prods., vol%	2.17	3.93	14.44
CO to CO2, vol%	1.03	1.87	10.46
CO, gm mol/hr/kgm cat.	1.26	1.46	7.22
STY of oxygenates(2) gm mol/hr/kgm cat.	.03	.32	1.41
STOICHIOM. H2/CO converted	.97	1.39	1.03
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.00	1.48	2.07
C2-C6 ALCOHOLS	.00	2.36	10.52
C2-C6 ALD.&ESTERS	31.37	28.51	21.03
CH4	31.66	31.91	35.86
C2-C3 HYDROCARBONS	19.59	21.71	18.28
C4+ HYDROCARBONS	17.38	14.03	12.24
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	63.1	85.0	86.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

SUMMARY FOR RUN # 201-54

CHEM SYSTEMS INC.

CATALYST NUMBER : 200-32 DATE : 5/6/80

ATOMIC FORMULA : $CuCoFe_{.14}Th_{.14}Ce_{.14}Mn_{.14}In_{.14}V_{.14}Ti_{.14}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.1 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00
AVE. TEMP., C	254.0	273.0	292.0	316.0
HOT SPOT, C	254.0	275.0	293.0	319.0
PRESSURE, psig	945.0	935.0	935.0	930.0
VHSV, 1/hr/kgm cat.	3601.0	3720.0	3642.0	3451.0
HOURS on STREAM	1.7	3.1	4.8	5.9
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	2.22	3.48	5.89	10.48
CO to CO2, vol%	.38	.82	2.11	6.12
CO, gm mol/hr/kgm cat.	1.16	1.98	3.60	7.08
STY of oxygenates(2) gm mol/hr/kgm cat.	.18	.52	.83	1.00
STOICHIOM. H2/CO converted	1.90	1.44	1.15	.92
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	1.40	6.05	9.37	11.40
C2-C6 ALCOHOLS	17.19	26.43	22.00	11.09
C2-C6 ALD.&ESTERS	.00	.00	.00	.00
CH4	35.79	30.99	32.87	41.18
C2-C3 HYDROCARBONS	26.08	22.35	23.23	26.77
C4+ HYDROCARBONS	19.53	14.08	12.63	9.66
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	67.1	82.5	93.2	89.6

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition,
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-56

CATALYST NUMBER : 197-48 DATE : 5/12/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1); 1.52 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	260.0	272.0	287.0
HOT SPOT, C	260.0	272.0	287.0
PRESSURE, psig	885.0	885.0	885.0
VHSV, l/hr/ksm cat.	2521.0	2492.0	2633.0
HOURS on STREAM	2.9	5.7	7.8
RPM	1690.0	1690.0	1700.0
CONVERSION :			
CO to Prods., vol%	.90	1.10	2.09
CO to CO2, vol%	.30	.41	.81
CO, gm mol/hr/ksm cat.	.38	.46	.95
STY of oxygenates(2) gm mol/hr/ksm cat.	.10	.13	.20
STOICHIOM. H2/CO converted	2.78	.74	1.88
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.00	.55	1.39
C2-C6 ALCOHOLS	8.95	8.36	3.61
C2-C6 ALD.&ESTERS	26.03	28.90	24.57
CH4	30.31	29.73	40.26
C2-C3 HYDROCARBONS	16.56	16.85	16.94
C4+ HYDROCARBONS	18.16	15.62	13.33
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	87.1	113.9	71.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-58

CATALYST NUMBER : 197-36 DATE : 5/11/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation w/ Oxalic Acid REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.45 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00
AVE. TEMP., C	265.0	282.0	280.0	293.0
HOT SPOT, C	267.0	285.0	287.0	296.0
PRESSURE, psig	930.0	930.0	1200.0	1200.0
VHSV, l/hr/kgm cat.	2654.0	2709.0	3616.0	3655.0
HOURS on STREAM	2.3	3.7	5.7	6.6
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	7.45	9.74	5.27	8.66
CO to CO2, vol%	.15	4.96	1.73	5.04
CO, gm mol/hr/kgm cat.	2.52	4.97	3.16	6.25
STY of oxygenates(2) gm mol/hr/kgm cat.	.30	.60	.63	.99
STOICHIOM. H2/CO converted	1.66	1.29	1.21	1.06
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	.41	1.21	3.45	3.32
C2-C6 ALCOHOLS	3.16	4.98	[22.97	[21.68
C2-C6 ALD.&ESTERS	8.77	12.08	.00]	.00]
CH4	55.90	51.18	44.08	44.79
C2-C3 HYDROCARBONS	11.12	19.33	18.32	18.20
C4+ HYDROCARBONS	12.04	11.32	13.68	10.60
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	55.7	81.9	75.5	83.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-60

CATALYST NUMBER : 200-25-1 DATE : 5/14/80

ATOMIC FORMULA : $CuCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.19 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	259.0	270.0	281.0	295.0	298.0
HOT SPOT, C	160.0	271.0	283.0	298.0	303.0
PRESSURE, psis	910.0	910.0	900.0	900.0	1140.0
VHSV, l/hr/kgm cat.	3267.0	3222.0	3247.0	3376.0	4278.0
HOURS on STREAM	2.3	3.8	5.3	6.6	7.4
RPM	.0	.0	.0	.0	.0
CONVERSION :					
CO to Prods., vol%	2.89	4.10	6.67	12.32	13.24
CO to CO2, vol%	2.91	3.40	6.03	11.78	12.46
CO, gm mol/hr/kgm cat.	2.46	3.03	5.17	10.20	13.80
STY of oxygenates(2) gm mol/hr/kgm cat.	.32	.53	.89	1.46	2.14
STOICHIOM. H2/CO converted	.91	.83	.84	.86	.85
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	2.21	3.84	4.57	4.50	5.44
C2-C6 ALCOHOLS	4.02	4.94	9.14	10.57	12.43
C2-C6 ALD.&ESTERS	19.70	23.24	19.05	12.92	12.23
CH4	31.36	30.19	30.67	34.25	21.94
C2-C3 HYDROCARBONS	22.91	22.87	22.86	24.27	35.92
C4+ HYDROCARBONS	19.90	14.82	13.71	13.50	12.04
APPROACH TO(3) WGS Equilibrium, C		-52.00	73.00	69.00	70.00
CARBON ACCOUNTABILITY, % (4)	57.9	72.9	75.0	78.5	78.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-62

CATALYST NUMBER : 197-16 DATE : 5/16/80

ATOMIC FORMULA : $CuCrCoZn_{.5}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.24 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	273.0	275.0	298.0	312.0	297.0	274.0
HOT SPOT, C	273.0	275.0	298.0	312.0	297.0	274.0
PRESSURE, psig	895.0	1350.0	930.0	920.0	915.0	920.0
VHSV, l/hr/kgm cat.	3375.0	4842.0	3420.0	6766.0	1284.0	3270.0
HOURS on STREAM	4.5	5.9	8.9	10.7	11.9	13.5
RPM	1700.0	1700.0	1720.0	1700.0	1700.0	1710.0
CONVERSION :						
CO to Prods., vol%	10.42	7.81	50.99	57.66	70.43	8.57
CO to CO2, vol%	3.88	4.09	42.31	31.05	27.57	4.03
CO, gm mol/hr/kgm cat.	6.02	7.19	39.80	74.90	15.70	5.10
STY of oxygenates(2) gm mol/hr/kgm cat.	1.05	1.43	.28	.45	.02	.73
STOICHIOM. H2/CO converted	1.43	1.43	1.49	1.45	1.70	1.05
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	4.80	7.47	.18	.15	.00	5.88
C2-C6 ALCOHOLS	19.21	22.87	1.10	.77	.14	15.29
C2-C6 ALD.&ESTERS	.00	.00	.00	.00	.00	.00
CH4	41.58	38.57	46.29	75.69	76.25	32.93
C2-C3 HYDROCARBONS	22.78	21.04	16.28	14.15	15.03	24.40
C4+ HYDROCARBONS	11.53	10.06	11.34	9.23	8.49	21.61
APPROACH TO(3) WGS Equilibrium, C	165.00	75.00	84.00	104.00	57.00	130.00
CARBON ACCOUNTABILITY, % (4)	94.1	100.2	93.5	92.9	98.8	91.9

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-65

DATE : 5/21/80

CATALYST NUMBER : 200-27-1
ATOMIC FORMULA : $CuCoZn_{.125}Cs_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation
REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.44 gm/cc
REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	272.0	284.0	297.0
HOT SPOT, C	274.0	287.0	300.0
PRESSURE, psig	900.0	900.0	900.0
VHSV, l/hr/kgm cat.	2557.0	2419.0	2579.0
HOURS on STREAM	2.9	4.6	6.4
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	4.97	7.01	10.64
CO to CO2, vol%	1.53	3.09	5.56
CO, gm mol/hr/kgm cat.	2.07	3.04	5.20
STY of oxygenates(2) gm mol/hr/kgm cat.	.30	.40	.63
STOICHIOM. H2/CO converted	1.39	1.36	1.23
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	2.23	3.75	3.96
C2-C6 ALCOHOLS	7.46	7.06	7.46
C2-C6 ALD.&ESTERS	9.42	8.36	7.01
CH4	40.71	48.99	51.17
C2-C3 HYDROCARBONS	19.24	20.46	20.71
C4+ HYDROCARBONS	20.94	11.38	9.59
APPROACH TO(3) WGS Equilibrium, C	110.00	142.00	119.00
CARBON ACCOUNTABILITY, % (4)	65.9	76.3	90.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-67

CATALYST NUMBER : 197-2 DATE : 5/22/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.69 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	270.0	271.0	293.0	294.0	292.0	266.0
HOT SPOT, C	271.0	271.0	294.0	295.0	294.0	267.0
PRESSURE, psig	895.0	1410.0	900.0	895.0	890.0	890.0
VHSV, 1/hr/kgm cat.	646.0	636.0	2541.0	730.0	700.0	622.0
HOURS on STREAM	5.3	6.6	13.6	17.1	35.7	42.8
RPM	1700.0	1700.0	1730.0	1690.0	1700.0	1700.0
CONVERSION :						
CO to Prods., vol%	16.30	20.09	9.77	35.16	27.27	8.02
CO to CO2, vol%	12.20	16.31	4.83	23.74	17.73	3.68
CO, gm mol/hr/kgm cat.	2.28	2.87	4.59	5.33	39.00	.90
STY of oxygenates(2) gm mol/hr/kgm cat.	.28	.31	.79	.79	.54	.27
STOICHIOM. H2/CO converted	.88	.90	1.13	1.01	.97	.94
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	1.75	1.99	7.03	4.69	6.11	12.40
C2-C6 ALCOHOLS	5.77	4.53	18.54	16.92	16.83	30.48
C2-C6 ALD.&ESTERS	14.16	13.04	.00	3.35	.00	.00
CH4	36.19	39.49	47.09	43.89	44.22	34.13
C2-C3 HYDROCARBONS	25.35	27.90	23.32	27.14	28.22	17.35
C4+ HYDROCARBONS	16.78	13.04	4.04	4.02	4.62	5.54
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	91.7	87.1	94.1	98.3	99.3	104.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-72

CATALYST NUMBER : 197-59 DATE : 6/5/80

ATOMIC FORMULA : $CuCoMnZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.46 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	243.0	274.0	294.0
HOT SPOT, C	245.0	275.0	296.0
PRESSURE, psig	900.0	900.0	895.0
VHSV, 1/hr/kgm cat.	2415.0	2402.0	2382.0
HOURS on STREAM	3.1	4.5	5.6
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	1.37	1.75	8.08
CO to CO2, vol%	.14	.85	4.82
CO, gm mol/hr/kgm cat.	.46	.78	3.80
STY of oxygenates(2) gm mol/hr/kgm cat.	.07	.10	.49
STOICHIOM. H2/CO converted	.92	2.52	.70
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	2.42	2.67	3.35
C2-C6 ALCOHOLS	[13.41	5.94	7.35
C2-C6 ALD.&ESTERS	.00]	9.65	9.90
CH4	43.41	44.41	42.17
C2-C3 HYDROCARBONS	21.54	26.29	30.83
C4+ HYDROCARBONS	19.23	11.14	6.39
APPROACH TO(3) WGS Equilibrium, C	73.00	114.00	82.00
CARBON ACCOUNTABILITY, % (4)	60.3	143.6	90.3

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-74

CATALYST NUMBER : 197-65 DATE : 6/12/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT :70.0% SiO_2

PREP METHOD: Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1) : .5 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	267.0	267.0	267.0
HOT SPOT, C	267.0	267.0	267.0
PRESSURE, psig	905.0	900.0	880.0
VHSV, l/hr/kgm cat.	7745.0	1744.0	964.0
HOURS on STREAM	.9	2.0	19.1
RPM	1700.0	1700.0	1700.0
CONVERSION :			
CO to Prods., vol%	.22	7.12	5.08
CO to CO2, vol%	1.88	.98	1.22
CO, gm mol/hr/kgm cat.	2.01	1.76	.75
STY of oxygenates(2) gm mol/hr/kgm cat.	.00	.52	.12
STOICHIOM. H2/CO converted	3.07	1.72	.18
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	N.A.	7.51	7.69
C2-C6 ALCOHOLS	N.A.	14.90	9.68
C2-C6 ALD.&ESTERS	N.A.	11.38	11.91
CH4	N.A.	32.76	45.15
C2-C3 HYDROCARBONS	N.A.	26.85	22.70
C4+ HYDROCARBONS	N.A.	6.60	2.98
APPROACH TO(3) WGS Equilibrium, C		73.00	139.00
CARBON ACCOUNTABILITY, % (4)	89.5	98.8	98.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-77

CATALYST NUMBER : 197-60 — DATE : 6/27/80

ATOMIC FORMULA : $CuCoVZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation — REDUCTION: in Situ Reduction

BULK DENSITY(1); 1.29 gm/cc — REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	255.0	277.0	289.0	276.0	288.0
HOT SPOT, C	256.0	279.0	293.0	278.0	292.0
PRESSURE, psig	885.0	885.0	880.0	885.0	885.0
VHSV, l/hr/kgm cat.	2965.0	3084.0	2993.0	3159.0	3135.0
HOURS on STREAM	1.8	3.0	5.4	9.0	10.9
RPM	.0	.0	.0	.0	.0
CONVERSION :					
CO to Prods., vol%	2.54	6.76	8.25	5.24	11.10
CO to CO2, vol%	.66	2.44	4.25	2.27	6.80
CO, gm mol/hr/kgm cat.	1.18	3.54	4.67	2.91	6.99
STY of oxygenates(2) gm mol/hr/kgm cat.	.21	.90	1.01	.67	1.45
STOICHIOM. H2/CO converted	1.76	1.41	1.04	1.37	.97
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	4.67	6.94	6.51	7.31	6.77
C2-C6 ALCOHOLS	10.34	22.31	18.32	8.02	12.74
C2-C6 ALD.&ESTERS	7.06	5.31	7.87	17.48	14.03
CH4	42.37	36.87	35.89	36.25	36.13
C2-C3 HYDROCARBONS	22.07	19.18	19.08	19.05	19.52
C4+ HYDROCARBONS	13.49	9.39	12.42	11.89	10.81
APPROACH TO(3) WGS Equilibrium, C	83.00	107.00	-89.00	62.00	96.00
CARBON ACCOUNTABILITY, % (4)	90.8	99.4	103.2	104.7	84.7

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-79

CATALYST NUMBER : 197-66 DATE : 6/26/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT :45.0% TiO_2

PREP METHOD: Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.14 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1
TEST CONDITIONS :	
FEED H2/CO RATIO	2.00
FEED CO2	5.00
AVE. TEMP., C	272.0
HOT SPOT, C	272.0
PRESSURE, psig	895.0
VHSV, l/hr/kgm cat.	594.0
HOURS on STREAM	9.6
RPM	1700.0
CONVERSION :	
CO to Prods., vol%	1.27
CO to CO2, vol%	.00
CO, gm mol/hr/kgm cat.	.09
STY of oxygenates(2) gm mol/hr/kgm cat.	.04
STOICHIOM. H2/CO converted	2.20
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	.50
C2-C6 ALCOHOLS	23.80
C2-C6 ALD.&ESTERS	20.50
CH4	46.00
C2-C3 HYDROCARBONS	9.10
C4+ HYDROCARBONS	.00
APPROACH TO(3) WGS Equilibrium, C	.00
CARBON ACCOUNTABILITY, % (4)	25.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-80

CATALYST NUMBER : 200-57-1 DATE : 7/2/80

ATOMIC FORMULA : $CuCoFe_{,1}Zn_{,125}K_{,11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.456 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	5.00	5.00
AVE. TEMP., C	273.0	288.0
HOT SPOT, C	274.0	289.0
PRESSURE, psig	900.0	900.0
VHSV, l/hr/kgm cat.	2700.0	638.0
HOURS on STREAM	5.6	12.3
RPM	1720.0	1730.0
CONVERSION :		
CO to Prods., vol%	2.56	7.01
CO to CO2, vol%	.95	6.99
CO, gm mol/hr/kgm cat.	1.20	1.10
STY of oxygenates(2) gm mol/hr/kgm cat.	.43	.25
STOICHIOM. H2/CO converted	.79	1.26
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	23.42	30.94
C2-C6 ALCOHOLS	19.59	9.58
C2-C6 ALD.&ESTERS	6.85	5.59
CH4	21.23	24.15
C2-C3 HYDROCARBONS	23.97	24.15
C4+ HYDROCARBONS	4.93	5.59
APPROACH TO(3) WGS Equilibrium, C		-84.00
CARBON ACCOUNTABILITY, % (4)	50.6	83.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-81

CATALYST NUMBER : 200-58-1 DATE : 7/10/80

ATOMIC FORMULA : $CuCoMoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.41 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	265.0	275.0	283.0
HOT SPOT, C	267.0	277.0	287.0
PRESSURE, psig	885.0	885.0	885.0
VHSV, l/hr/kgm cat.	3151.0	2972.0	2967.0
HOURS on STREAM	3.3	5.2	6.3
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	5.90	7.19	9.83
CO to CO2, vol%	2.64	3.91	5.57
CO, gm mol/hr/kgm cat.	3.38	4.16	5.73
STY of oxygenates(2), gm mol/hr/kgm cat.	.28	.26	.28
STOICHIOM. H2/CO converted	1.24	1.07	1.05
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	7.23	5.71	4.55
C2-C6 ALCOHOLS	2.89	2.31	1.72
C2-C6 ALD.&ESTERS	.43	.31	.16
CH4	41.08	42.44	44.67
C2-C3 HYDROCARBONS	41.08	37.50	38.09
C4+ HYDROCARBONS	7.09	11.73	10.82
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	78.8	97.2	102.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-83

CATALYST NUMBER : 197-71 DATE : 7/14/80

ATOMIC FORMULA : $CuCoFe_{,1}{}^{Th}{}_{,5}{}^{Zn}{}_{,125}{}^{K}{}_{,11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: in Situ Reduction

BULK DENSITY[1]: 1.8 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00
AVE. TEMP., C	246.0	274.0	275.0
HOT SPOT, C	247.0	275.0	276.0
PRESSURE, psig	900.0	900.0	900.0
VHSV, l/hr/kgm cat.	2063.0	2314.0	533.0
HOURS on STREAM	5.2	9.2	11.4
RPM	1760.0	1700.0	1700.0
CONVERSION :			
CO to Prods., vol%	3.39	5.90	14.38
CO to CO2, vol%	.00	.00	4.52
CO, gm mol/hr/kgm cat.	.80	1.56	1.16
STY of oxygenates[2] gm mol/hr/kgm cat.	.42	.85	.45
STOICHIOM. H2/CO converted	1.72	.30	1.33
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	21.00	19.60	17.87
C2-C6 ALCOHOLS	26.50	30.30	27.86
C2-C6 ALD.&ESTERS	.80	.60	1.31
CH4	27.10	27.70	29.56
C2-C3 HYDROCARBONS	15.70	15.40	16.42
C4+ HYDROCARBONS	8.90	6.40	6.57
APPROACH TO[3] WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	31.7	50.8	76.7

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-84

CATALYST NUMBER : 197-67 DATE : 7/18/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT :70.0% TiO_2

PREP METHOD: Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.27 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	5.10	5.10
AVE. TEMP., C	261.0	262.0
HOT SPOT, C	262.0	262.0
PRESSURE, psig	890.0	880.0
VHSV, l/hr/kgm cat.	3374.0	1000.0
HOURS on STREAM	4.0	6.0
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	.56	1.65
CO to CO2, vol%	.44	2.05
CO, gm mol/hr/kgm cat.	.42	.45
STY of oxygenates(2) gm mol/hr/kgm cat.	.03	.05
STOICHIOM. H2/CO converted	.56	.75
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	.36	.22
C2-C6 ALCOHOLS	.89	.67
C2-C6 ALD.&ESTERS	9.07	22.70
CH4	76.16	57.98
C2-C3 HYDROCARBONS	10.14	13.26
C4+ HYDROCARBONS	3.38	5.17
APPROACH TO(3) WGS Equilibrium, C	.00	.00
CARBON ACCOUNTABILITY, % (4)	69.3	89.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-85

CATALYST NUMBER : 197-71 DATE : 7/22/80

ATOMIC FORMULA : $CuCoFe_{.1}Th_{.5}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.73 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	5.10	5.10	5.10	5.10	5.10	5.10
AVE. TEMP., C	257.0	258.0	270.0	271.0	279.0	280.0
HOT SPOT, C	258.0	259.0	271.0	272.0	280.0	281.0
PRESSURE, psig	905.0	900.0	905.0	905.0	905.0	905.0
VHSV, l/hr/kgm cat.	3597.0	882.0	3351.0	976.0	3258.0	1005.0
HOURS on STREAM	4.2	5.9	10.3	12.8	16.1	19.1
RPM	1740.0	1740.0	1740.0	1740.0	1730.0	1720.0
CONVERSION :						
CO to Prods., vol%	3.90	10.43	5.50	13.04	4.92	14.61
CO to CO2, vol%	.00	2.67	.80	4.46	1.48	5.79
CO, gm mol/hr/kgm cat.	1.70	1.39	2.60	2.13	2.61	2.57
STY of oxygenates(2) gm mol/hr/kgm cat.	.85	.54	1.12	.70	.94	.75
STOICHIOM. H2/CO converted	1.33	1.44	.82	.70	.85	.76
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	14.80	13.44	17.41	13.69	17.82	13.69
C2-C6 ALCOHOLS	32.00	33.17	29.55	28.19	27.05	24.44
C2-C6 ALD.&ESTERS	3.30	2.26	2.41	2.15	2.21	2.93
CH4	24.40	26.88	28.75	33.15	32.51	35.89
C2-C3 HYDROCARBONS	16.10	17.34	16.27	18.26	16.38	18.02
C4+ HYDROCARBONS	9.40	6.91	5.61	4.56	4.03	5.03
APPROACH TO(3) WGS Equilibrium, C	147.00	176.00	134.00	169.00	67.00	148.00
CARBON ACCOUNTABILITY, % (4)	73.3	91.1	80.3	91.5	97.5	98.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-87

CATALYST NUMBER : 197-73 DATE : 7/31/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.28 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.10	5.10	5.10
AVE. TEMP., C	260.0	260.0	272.0
HOT SPOT, C	260.0	261.0	273.0
PRESSURE, psig	935.0	930.0	935.0
VHSV, l/hr/kgm cat.	3406.0	892.0	877.0
HOURS on STREAM	4.0	6.0	9.3
RPM	1720.0	1720.0	1720.0
CONVERSION :			
CO to Prods., vol%	3.81	9.14	18.68
CO to CO2, vol%	1.79	6.76	10.42
CO, gm mol/hr/kgm cat.	2.41	1.79	3.22
STY of oxygenates(2) gm mol/hr/kgm cat.	.48	.28	.56
STOICHIOM. H2/CO converted	.34	.62	.52
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	3.82	3.65	6.23
C2-C6 ALCOHOLS	11.62	11.83	18.85
C2-C6 ALD.&ESTERS	13.97	11.30	1.87
CH4	42.94	43.13	46.26
C2-C3 HYDROCARBONS	19.12	20.52	19.47
C4+ HYDROCARBONS	8.53	9.57	7.32
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	68.2	99.8	93.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-89

CATALYST NUMBER : 197-72 DATE : 8/6/80

ATOMIC FORMULA : $CuCoZrZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.3 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	5.10	5.10	5.10	5.10
AVE. TEMP., C	264.0	264.0	273.0	273.0
HOT SPOT, C	265.0	265.0	273.0	273.0
PRESSURE, psig	880.0	875.0	910.0	910.0
VHSV, l/hr/kgm cat.	3548.0	857.0	2791.0	932.0
HOURS on STREAM	4.1	6.9	10.0	14.9
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	.72	2.70	1.31	6.63
CO to CO2, vol%	.28	1.20	.09	.57
CO, gm mol/hr/kgm cat.	.45	.42	.49	.83
STY of oxygenates(2) gm mol/hr/kgm cat.	.11	.12	.20	.34
STOICHIOM. H2/CO converted	1.60	.89	.78	.96
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	22.42	22.54	25.80	23.78
C2-C6 ALCOHOLS	9.33	13.01	12.10	18.35
C2-C6 ALD.&ESTERS	2.51	5.20	5.67	4.34
CH4	48.47	41.47	38.01	33.33
C2-C3 HYDROCARBONS	12.81	11.85	14.99	14.66
C4+ HYDROCARBONS	4.46	5.92	3.43	5.54
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	96.6	106.1	95.8	55.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-90

CATALYST NUMBER : 197-76 DATE : 8/4/80

ATOMIC FORMULA : $CuCrCoZn_{,125}K_{,11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.35 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	4.90	4.90	4.90	4.90
AVE. TEMP., C	271.0	273.0	238.0	246.0
HOT SPOT, C	272.0	273.0	238.0	246.0
PRESSURE, psig	935.0	930.0	1600.0	1600.0
VHSV, l/hr/kgm cat.	3509.0	854.0	322.0	309.0
HOURS on STREAM	3.0	6.0	8.5	12.1
RPM	1730.0	1750.0	1720.0	1720.0
CONVERSION :				
CO to Prods., vol%	3.07	14.39	6.39	10.94
CO to CO2, vol%	1.73	10.21	2.21	6.16
CO, gm mol/hr/kgm cat.	2.07	2.61	.34	.65
STY of oxygenates(2) gm mol/hr/kgm cat.	.36	.36	.07	.10
STOICHIOM. H2/CO converted	.61	.51	1.00	.67
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	5.32	4.62	7.94	5.78
C2-C6 ALCOHOLS	7.98	7.86	8.34	7.97
C2-C6 ALD.&ESTERS	14.24	10.77	11.44	11.41
CH4	45.70	46.32	43.20	43.59
C2-C3 HYDROCARBONS	18.62	20.85	19.38	19.84
C4+ HYDROCARBONS	8.14	9.57	9.69	11.41
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	112.9	100.0	98.3	101.7

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-91

CATALYST NUMBER : 197-73 DATE : 8/11/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.47 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1
TEST CONDITIONS :	
FEED H2/CO RATIO	2.10
FEED CO2	5.20
AVE. TEMP., C	271.0
HOT SPOT, C	272.0
PRESSURE, psig	915.0
VHSV, l/hr/kgm cat.	918.0
HOURS on STREAM	9.2
RPM	1720.0
CONVERSION :	
CO to Prods., vol%	13.82
CO to CO2, vol%	7.38
CO, gm mol/hr/kgm cat.	2.40
STY of oxygenates(2) gm mol/hr/kgm cat.	.46
STOICHIOM. H2/CO converted	.49
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	8.59
C2-C6 ALCOHOLS	19.79
C2-C6 ALD.&ESTERS	.92
CH4	44.48
C2-C3 HYDROCARBONS	18.10
C4+ HYDROCARBONS	8.13
APPROACH TO(3) WGS Equilibrium, C	91.00
CARBON ACCOUNTABILITY, % (4)	103.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-92

CATALYST NUMBER : 197-78 DATE : 8/15/80

ATOMIC FORMULA : $CuCr_{.125}CoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY[1] : 1.41 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.10	5.10	5.10
AVE. TEMP., C	262.0	276.0	279.0
HOT SPOT, C	263.0	279.0	284.0
PRESSURE, psig	905.0	920.0	910.0
VHSV, l/hr/kgm cat.	3677.0	3361.0	969.0
HOURS on STREAM	3.6	6.1	9.0
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	3.42	5.89	30.03
CO to CO2, vol%	.58	2.01	20.87
CO, gm mol/hr/kgm cat.	1.82	3.20	5.94
STY of oxygenates[2] gm mol/hr/kgm cat.	.48	.83	.93
STOICHIOM. H2/CO converted	.65	.59	.56
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis)			
CH3OH	4.21	4.69	4.07
C2-C6 ALCOHOLS	7.13	8.71	15.76
C2-C6 ALD.&ESTERS	19.63	21.45	6.61
CH4	35.16	32.98	39.49
C2-C3 HYDROCARBONS	21.85	22.25	23.90
C4+ HYDROCARBONS	12.03	9.92	10.17
APPROACH TO[3] WGS Equilibrium, C	142.00	72.00	19.00
CARBON ACCOUNTABILITY, % (4)	83.9	112.8	104.6

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-93

CATALYST NUMBER : 197-77 DATE : 8/19/80

ATOMIC FORMULA : $CuCoTh_{.5}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 0 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.10	2.10	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.10	5.10	5.10	5.10
AVE. TEMP., C	262.0	268.0	270.0	270.0	282.0	284.0
HOT SPOT, C	262.0	268.0	270.0	270.0	283.0	284.0
PRESSURE, psig	920.0	915.0	920.0	920.0	920.0	915.0
VHSV, l/hr/kgm cat.	3607.0	900.0	3239.0	931.0	3431.0	984.0
HOURS on STREAM	4.0	7.0	10.2	13.1	18.1	20.2
RPM	1760.0	1760.0	1720.0	1720.0	1770.0	1730.0
CONVERSION :						
CO to Prods., vol%	3.61	19.06	5.53	20.50	11.11	42.62
CO to CO2, vol%	.69	11.44	1.97	9.30	2.49	21.18
CO, gm mol/hr/kgm cat.	1.90	3.37	2.98	3.41	5.73	7.71
STY of oxygenates(2) gm mol/hr/kgm cat.	.59	.87	.75	.72	1.67	1.33
STOICHIOM. H2/CO converted	1.02	.57	.92	.61	.76	.57
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	9.64	8.80	10.45	7.70	8.94	6.29
C2-C6 ALCOHOLS	19.40	28.64	20.35	20.20	21.66	17.37
C2-C6 ALD.&ESTERS	7.98	3.68	3.12	2.62	5.02	2.10
CH4	39.88	31.68	37.72	39.83	36.96	45.81
C2-C3 HYDROCARBONS	17.50	19.36	24.83	25.29	23.75	24.40
C4+ HYDROCARBONS	5.60	7.84	3.53	4.36	3.67	4.04
APPROACH TO(3) WGS Equilibrium, C	88.00	70.00	72.00	142.00	170.00	122.00
CARBON ACCOUNTABILITY, % (4)	106.2	100.8	109.0	105.3	100.2	103.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-93

CATALYST NUMBER : 197-77 DATE : 8/19/80
ATOMIC FORMULA : $CuCoTh_{.5}Zn_{.125}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 0 gm/cc REACTOR TYPE: Berty
TEST NUMBER 7

TEST CONDITIONS :

FEED H2/CO RATIO	2.10
FEED CO2	5.00
AVE. TEMP., C	257.0
HOT SPOT, C	257.0
PRESSURE, psig	925.0
VHSV, l/hr/kgm cat.	3248.0
HOURS on STREAM	22.7
RPM	1730.0

CONVERSION :

CO to Prods., vol%	2.65
CO to CO2, vol%	.05
CO, gm mol/hr/kgm cat.	1.08
STY of oxygenates(2) gm mol/hr/kgm cat.	.35
STOICHIOM. H2/CO converted	.63

CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :

CH3OH	13.37
C2-C6 ALCOHOLS	17.14
C2-C6 ALD.&ESTERS	3.06
CH4	40.00
C2-C3 HYDROCARBONS	23.67
C4+ HYDROCARBONS	2.76
APPROACH TO(3) WGS Equilibrium, C	93.00
CARBON ACCOUNTABILITY, % (4)	101.7

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-95

DATE : 8/28/80

CATALYST NUMBER : 197-79
ATOMIC FORMULA : $CuCoThZn_{.125}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation

REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.52 gm/cc

REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	5.20	5.20	5.20
AVE. TEMP., C	260.0	261.0	273.0
HOT SPOT, C	260.0	261.0	273.0
PRESSURE, psis	920.0	1530.0	910.0
VHSV, l/hr/ksm cat.	3202.0	3237.0	3364.0
HOURS on STREAM	4.6	7.3	12.2
RPM	1710.0	1700.0	1720.0
CONVERSION :			
CO to Prods., vol%	3.48	4.69	4.27
CO to CO2, vol%	.02	2.61	.43
CO, gm mol/hr/ksm cat.	1.39	2.93	1.96
STY of oxygenates(2) gm mol/hr/ksm cat.	.52	.77	.70
STOICHIOM. H2/CO converted	1.29	.93	2.06
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	12.68	14.00	15.75
C2-C6 ALCOHOLS	23.74	25.04	22.36
C2-C6 ALD.&ESTERS	1.31	1.71	.99
CH4	32.09	30.79	37.56
C2-C3 HYDROCARBONS	24.35	22.24	20.26
C4+ HYDROCARBONS	5.84	6.22	3.08
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	90.3	89.0	104.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-97

CATALYST NUMBER : 197-73 DATE : 9/5/80

ATOMIC FORMULA : $CuCrCoZn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.38 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1
TEST CONDITIONS :	
FEED H2/CO RATIO	2.10
FEED CO2	5.10
AVE. TEMP., C	273.0
HOT SPOT, C	273.0
PRESSURE, psig	910.0
VHSV, l/hr/kgm cat.	1030.0
HOURS on STREAM	35.6
RPM	.0
CONVERSION :	
CO to Prods., vol%	5.40
CO to CO2, vol%	1.80
CO, gm mol/hr/kgm cat.	.92
STY of oxygenates(2) gm mol/hr/kgm cat.	.19
STOICHIOM. H2/CO converted	.51
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	6.40
C2-C6 ALCOHOLS	8.26
C2-C6 ALD.&ESTERS	13.33
CH4	38.79
C2-C3 HYDROCARBONS	25.19
C4+ HYDROCARBONS	8.13
APPROACH TO(3) WGS Equilibrium, C	.00
CARBON ACCOUNTABILITY, % (4)	99.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-98

CATALYST NUMBER : 197-81 DATE : 9/8/80

ATOMIC FORMULA : $CuFe_{.5}Th_{.5}Mn_{3.24}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.02 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	5.00	5.00	5.00	5.00
AVE. TEMP., C	267.0	262.0	262.0	239.0
HOT SPOT, C	268.0	262.0	263.0	242.0
PRESSURE, psig	920.0	920.0	1500.0	900.0
VHSV, l/hr/kgm cat.	1619.0	4487.0	5162.0	1797.0
HOURS on STREAM	3.8	8.2	11.1	15.1
RPM	1730.0	1730.0	1740.0	1700.0
CONVERSION :				
CO to Prods., vol%	37.84	10.21	10.41	7.91
CO to CO2, vol%	11.76	1.69	1.89	1.19
CO, gm mol/hr/kgm cat.	10.10	6.71	7.78	2.06
STY of oxygenates(2) gm mol/hr/kgm cat.	1.27	1.14	1.70	.44
STOICHIOM. H2/CO converted	.70	.87	1.06	.56
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	1.70	4.78	5.44	5.75
C2-C6 ALCOHOLS	14.15	14.10	17.38	16.46
C2-C6 ALD.&ESTERS	.66	.93	3.07	2.65
CH4	26.61	28.21	26.60	28.65
C2-C3 HYDROCARBONS	36.30	37.41	33.33	34.06
C4+ HYDROCARBONS	20.58	14.57	14.18	12.43
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	101.2	95.3	114.4	90.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 201-100

CATALYST NUMBER : Methanol synthesis cat. / 200-27-2 * DATE : 9/12/80
ATOMIC FORMULA : $CuAl_{.21}Zn_{.49}$ / $CuCoTh_{.5}Fe_{.5}Zn_{.125}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation (200-27-1) REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.23 sm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.10	2.10	2.10
FEED CO2	4.90	4.90	4.90
AVE. TEMP., C	182.0	193.0	209.0
HOT SPOT, C	183.0	193.0	219.0
PRESSURE, psig	920.0	920.0	920.0
VHSV, 1/hr/ksm cat.	3402.0	3388.0	3669.0
HOURS on STREAM	4.0	5.8	10.4
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	1.40	1.80	27.45
CO to CO2, vol%	.00	.00	.45
CO, sm mol/hr/ksm cat.	.58	.75	12.50
STY of oxygenates(2) sm mol/hr/ksm cat.	.40	.58	11.60
STOICHIOM. H2/CO converted	.86	7.60	1.06
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	68.90	71.90	92.38
C2-C6 ALCOHOLS	2.10	1.70	1.42
C2-C6 ALD.&ESTERS	6.70	3.50	.30
CH4	10.60	9.90	1.63
C2-C3 HYDROCARBONS	7.90	9.90	2.54
C4+ HYDROCARBONS	3.80	3.10	1.73
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	87.2	121.3	88.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

* 12.5g of MeOH catalyst in first stage, 12.5g 200-27-2 in second stage.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-2

CATALYST NUMBER : Methanol synthesis cat. / 200-27-2* DATE : 9/17/80

ATOMIC FORMULA : $CuAl_{.21}Zn_{.49}$ / $CuCoTh_{.5}Fe_{.5}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation (200-27-1) REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.23 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	2.10	2.10	2.10	2.10	2.10
FEED CO2	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	225.0	225.0	208.0	208.0	250.0
HOT SPOT, C	225.0	225.0	208.0	208.0	250.0
PRESSURE, psig	910.0	905.0	905.0	905.0	910.0
VHSV, l/hr/kgm cat.	3632.0	1251.0	673.0	3521.0	3972.0
HOURS on STREAM	3.8	7.7	11.3	14.1	19.4
RPM	1740.0	1735.0	1740.0	1745.0	1715.0
CONVERSION :					
CO to Prods., vol%	28.37	50.71	38.57	16.56	26.72
CO to CO2, vol%	5.93	14.89	13.93	.74	9.48
CO, gm mol/hr/kgm cat.	14.80	9.81	4.30	7.40	17.40
STY of oxygenates(2) gm mol/hr/kgm cat.	10.10	5.71	2.45	6.50	8.31
STOICHIOM. H2/CO converted	1.50	1.51	1.53	2.18	1.50
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	77.25	64.42	73.22	87.88	53.12
C2-C6 ALCOHOLS	5.20	10.48	4.36	3.76	10.57
C2-C6 ALD.&ESTERS	.00	.39	.00	.00	.68
CH4	4.96	8.02	6.40	2.82	14.63
C2-C3 HYDROCARBONS	6.53	9.44	9.12	3.24	13.82
C4+ HYDROCARBONS	6.17	7.24	6.81	2.30	7.18
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	100.6	90.6	95.1	95.5	103.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

* Random mixture of 12.5g Methanol synthesis catalyst and 12.5g 200-27-2

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-4

CATALYST NUMBER : 197-85 DATE : 9/24/80

ATOMIC FORMULA : $CuCoFe_{.1}Th_{.5}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.04 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4*	
TEST CONDITIONS :					
FEED H2/CO RATIO	2.10	2.10	2.10	2.10	
FEED CO2	4.80	4.80	4.80	4.80	
AVE. TEMP., C	263.0	263.0	245.0	267.0	
HOT SPOT, C	263.0	263.0	245.0	267.0	
PRESSURE, psig	910.0	905.0	910.0	920.0	
VHSV, l/hr/kgm cat.	3574.0	1092.0	3262.0	3763.0	
HOURS on STREAM	3.7	6.3	11.6	18.1	
RPM	1740.0	1735.0	1715.0	1700.0	
CONVERSION :					
CO to Prods., vol%	13.68	35.72	4.07	9.11	(11.1 MeOH Conv.)
CO to CO2, vol%	4.32	20.18	1.13	4.39	(1.36 MeOH Conv.)
CO, gm mol/hr/kgm cat.	7.60	7.21	2.09	5.06	
STY of oxygenates(2) gm mol/hr/kgm cat.	1.91	1.28	.59	.87	
STOICHIOM. H2/CO converted	.91	1.09	1.74	1.45	
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	5.13	4.69	8.18	.00	
C2-C6 ALCOHOLS	22.37	20.34	22.12	18.37	
C2-C6 ALD.&ESTERS	5.53	2.82	5.37	1.63	
CH4	22.89	34.59	28.64	44.89	
C2-C3 HYDROCARBONS	29.21	25.98	27.11	26.37	
C4+ HYDROCARBONS	14.87	11.58	8.57	8.74	
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	
CARBON ACCOUNTABILITY, % (4)	103.0	102.9	105.9	97.9	

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

* 7 mole % MeOH added to feed gas

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-9

DATE : 10/6/80

CATALYST NUMBER : 197-84
ATOMIC FORMULA : $CuCoRu_{.1}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation

REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.67 gm/cc

REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	11.90	11.90	11.90
AVE. TEMP., C	263.0	264.0	280.0
HOT SPOT, C	264.0	265.0	280.0
PRESSURE, psig	930.0	925.0	925.0
VHSV, l/hr/kgm cat.	2954.0	917.0	3357.0
HOURS on STREAM	4.9	6.7	11.6
RPM	1690.0	1680.0	1700.0
CONVERSION :			
CO to Prods., vol%	3.66	10.91	5.48
CO to CO2, vol%	1.84	8.99	3.92
CO, gm mol/hr/kgm cat.	1.77	1.99	3.36
STY of oxygenates(2) gm mol/hr/kgm cat.	.40	.30	.59
STOICHIOM. H2/CO converted	1.41	1.18	1.57
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	3.45	3.10	3.09
C2-C6 ALCOHOLS	1.95	4.38	4.63
C2-C6 ALD.&ESTERS	28.53	20.06	22.28
CH4	32.88	33.37	35.31
C2-C3 HYDROCARBONS	23.27	25.71	24.68
C4+ HYDROCARBONS	9.91	13.49	10.11
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	96.0	90.8	85.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-11

CATALYST NUMBER : 200-78-1 DATE : 10/9/80

ATOMIC FORMULA : $CuCo_{.5}Al_{.18}Zn_{.33}K_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Detergent Dispersion REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.3 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	11.50	11.50	11.50
AVE. TEMP., C	250.0	271.0	283.0
HOT SPOT, C	251.0	271.0	284.0
PRESSURE, psig	880.0	900.0	900.0
VHSV, l/hr/kgm cat.	3550.0	3322.0	3404.0
HOURS on STREAM	6.1	9.2	14.9
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	2.30	5.56	9.38
CO to CO2, vol%	.30	.14	.72
CO, gm mol/hr/kgm cat.	.99	2.06	3.82
STY of oxygenates(2) gm mol/hr/kgm cat.	.24	.68	1.30
STOICHIOM. H2/CO converted	4.73	1.62	.87
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	7.35	8.61	7.64
C2-C6 ALCOHOLS	13.01	20.90	24.11
C2-C6 ALD.&ESTERS	7.35	4.51	4.84
CH4	36.32	35.96	33.48
C2-C3 HYDROCARBONS	24.10	23.57	23.04
C4+ HYDROCARBONS	11.65	6.45	6.89
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	76.4	100.4	94.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-13

CATALYST NUMBER : 200-76 DATE : 10/14/80

ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced bs 2% H2 in N2

BULK DENSITY(1): 1.16 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	1.98	1.98	1.98	1.98	1.98	1.98
FEED CO2	11.52	11.52	11.52	11.52	11.52	11.52
AVE. TEMP., C	266.0	267.0	280.0	280.0	257.0	257.0
HOT SPOT, C	266.0	267.0	280.0	280.0	257.0	258.0
PRESSURE, psig	930.0	940.0	930.0	930.0	930.0	930.0
VHSV, l/hr/kgm cat.	3567.0	1050.0	4147.0	8413.0	3523.0	1036.0
HOURS on STREAM	4.2	7.4	17.3	13.7	19.3	20.9
RPM	1640.0	1640.0	1640.0	1645.0	1630.0	1635.0
CONVERSION :						
CO to Prods., vol%	13.12	29.58	8.37	5.13	3.80	12.77
CO to CO2, vol%	2.28	11.72	3.13	1.67	.00	3.23
CO, gm mol/hr/kgm cat.	5.86	4.63	5.02	6.26	1.45	1.80
STY of oxygenates(2) gm mol/hr/kgm cat.	1.28	.59	.86	1.03	.36	.35
STOICHIOM. H2/CO converted	1.44	1.19	2.25	71.78	1.23	1.52
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	4.93	3.91	8.93	9.67	11.30	10.03
C2-C6 ALCOHOLS	19.37	13.54	14.29	11.39	12.70	13.91
C2-C6 ALD.&ESTERS	1.41	.42	.41	.79	1.00	.50
CH4	31.92	37.97	49.31	46.75	46.10	46.49
C2-C3 HYDROCARBONS	25.12	26.39	21.02	22.91	21.90	21.68
C4+ HYDROCARBONS	17.25	17.87	6.04	8.48	7.00	7.39
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	91.1	108.1	135.5	95.7	100.0	95.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-14

CATALYST NUMBER : 200-76 DATE : 10/23/80
ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.14 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.06	2.06	2.06	2.06	2.06	2.06
FEED CO2	11.70	11.70	11.70	11.70	11.70	11.70
AVE. TEMP., C	257.0	259.0	273.0	274.0	292.0	295.0
HOT SPOT, C	257.0	259.0	273.0	278.0	292.0	295.0
PRESSURE, psig	925.0	900.0	935.0	930.0	930.0	930.0
VHSV, l/hr/kgm cat.	4021.0	968.0	3516.0	1007.0	3290.0	3589.0
HOURS on STREAM	12.9	14.6	17.8	20.8	76.9	100.0
RPM	.0	.0	.0	.0	.0	.0
CONVERSION :						
CO to Prods., vol%	3.54	8.75	3.93	10.51	6.46	8.23
CO to CO2, vol%	.66	3.05	.97	3.79	.54	1.47
CO, gm mol/hr/kgm cat.	1.86	1.26	1.92	1.61	2.48	3.75
STY of oxygenates(2) gm mol/hr/kgm cat.	.65	.19	.43	.29	.80	.99
STOICHIOM. H2/CO converted	13.86	1.35	1.60	1.36	2.07	1.86
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	8.06	7.82	10.85	8.71	17.33	14.84
C2-C6 ALCOHOLS	28.79	11.06	15.33	14.69	16.47	15.43
C2-C6 ALD.&ESTERS	4.27	2.02	1.99	1.22	.98	.71
CH4	34.12	45.86	46.37	48.98	44.96	47.83
C2-C3 HYDROCARBONS	16.59	24.01	19.32	20.41	17.66	18.61
C4+ HYDROCARBONS	8.18	8.63	6.23	5.99	2.60	2.47
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	66.6	88.4	98.2	104.3	101.5	98.3

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-14

DATE : 10/23/80

CATALYST NUMBER : 200-76
ATOMIC FORMULA : $CuCr_{.8}CoK_{.09}$
CATALYST SUPPORT : NONE

PREP METHOD: Evaporation

REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.14 gm/cc

REACTOR TYPE: Plug Flow

TEST NUMBER	7
TEST CONDITIONS :	
FEED H2/CO RATIO	2.06
FEED CO2	11.70
AVE. TEMP., C	297.0
HOT SPOT, C	297.0
PRESSURE, psig	930.0
VHSV, l/hr/kgm cat.	3496.0
HOURS on STREAM	122.8
RPM	.0
CONVERSION :	
CO to Prods., vol%	7.52
CO to CO2, vol%	2.78
CO, gm mol/hr/kgm cat.	3.90
STY of oxygenates(2) gm mol/hr/kgm cat.	.90
STOICHIOM. H2/CO converted	2.05
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	13.56
C2-C6 ALCOHOLS	16.30
C2-C6 ALD.&ESTERS	1.64
CH4	44.79
C2-C3 HYDROCARBONS	17.95
C4+ HYDROCARBONS	5.75
APPROACH TO(3) WGS Equilibrium, C	.00
CARBON ACCOUNTABILITY, % (4)	118.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-16

CATALYST NUMBER : 200-78-2 DATE : 10/27/80

ATOMIC FORMULA : $CuCo_{,5}Al_{,18}Zn_{,33}$

CATALYST SUPPORT : NONE

PREP METHOD: Detergent Dispersion REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.08 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1
TEST CONDITIONS :	
FEED H2/CO RATIO	2.00
FEED CO2	10.00
AVE. TEMP., C	270.0
HOT SPOT, C	272.0
PRESSURE, psig	870.0
VHSV, l/hr/kgm cat.	4628.0
HOURS on STREAM	7.4
RPM	1510.0
CONVERSION :	
CO to Prods., vol%	9.54
CO to CO2, vol%	2.86
CO, gm mol/hr/kgm cat.	6.16
STY of oxygenates(2) gm mol/hr/kgm cat.	.52
STOICHIOM. H2/CO converted	1.93
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	2.34
C2-C6 ALCOHOLS	8.32
C2-C6 ALD.&ESTERS	.26
CH4	45.77
C2-C3 HYDROCARBONS	30.56
C4+ HYDROCARBONS	12.74
APPROACH TO(3) WGS Equilibrium, C	
CARBON ACCOUNTABILITY, % (4)	113.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-19

CATALYST NUMBER : 200-89-1 DATE : 10/30/80

ATOMIC FORMULA : $CuCr_{.8}Co_{.3}K_{.09}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.47 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1
TEST CONDITIONS :	
FEED H2/CO RATIO	2.00
FEED CO2	12.00
AVE. TEMP., C	282.0
HOT SPOT, C	283.0
PRESSURE, psig	915.0
VHSV, l/hr/kgm cat.	876.0
HOURS on STREAM	6.9
RPM	1590.0
CONVERSION :	
CO to Prods., vol%	2.88
CO to CO2, vol%	.02
CO, gm mol/hr/kgm cat.	.27
STY of oxygenates(2) gm mol/hr/kgm cat.	.18
STOICHIOM. H2/CO converted	2.41
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	60.83
C2-C6 ALCOHOLS	5.44
C2-C6 ALD.&ESTERS	.00
CH4	22.96
C2-C3 HYDROCARBONS	8.06
C4+ HYDROCARBONS	2.62
APPROACH TO(3) WGS Equilibrium, C	
CARBON ACCOUNTABILITY, % (4)	68.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-20

CATALYST NUMBER : 200-93 DATE : 11/5/80

ATOMIC FORMULA : $CuCo_{.13}Al_{.18}Zn_{.33}K_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.04 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	11.90	11.90	11.90	11.90
AVE. TEMP., C	307.0	304.0	297.0	303.0
HOT SPOT, C	310.0	305.0	298.0	304.0
PRESSURE, psig	950.0	950.0	9500.0	950.0
VHSV, l/hr/kgm cat.	3531.0	3379.0	1010.0	6995.0
HOURS on STREAM	5.2	13.0	18.0	20.5
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	14.26	9.63	17.54	6.25
CO to CO2, vol%	4.34	1.97	8.66	.55
CO, gm mol/hr/kgm cat.	7.34	4.33	2.84	5.08
STY of oxygenates(2) gm mol/hr/kgm cat.	.97	1.42	.55	1.60
STOICHIOM. H2/CO converted	1.41	1.65	1.38	1.63
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	3.65	17.83	15.84	17.85
C2-C6 ALCOHOLS	1.17	10.97	6.42	10.77
C2-C6 ALD.&ESTERS	12.39	10.85	6.87	5.55
CH4	41.08	32.78	41.53	36.24
C2-C3 HYDROCARBONS	26.74	18.44	22.11	20.89
C4+ HYDROCARBONS	14.87	9.04	7.32	8.71
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	95.1	106.3	102.8	82.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-21

DATE : 11/8/80

CATALYST NUMBER : 200-96
ATOMIC FORMULA : $CuCo_{.01}Al_{.18}Zn_{.33}K_{.05}$
CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.08 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.10	2.10
FEED CO2	12.40	12.40
AVE. TEMP., C	298.0	298.0
HOT SPOT, C	299.0	298.0
PRESSURE, psig	920.0	920.0
VHSV, l/hr/kgm cat.	3361.0	877.0
HOURS on STREAM	6.7	13.1
RPM	1590.0	1540.0
CONVERSION :		
CO to Prods., vol%	2.20	5.40
CO to CO2, vol%	.00	.00
CO, gm mol/hr/kgm cat.	.82	.28
STY of oxygenates(2) gm mol/hr/kgm cat.	.70	.25
STOICHIOM. H2/CO converted	3.76	2.02
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	83.80	85.30
C2-C6 ALCOHOLS	2.00	2.30
C2-C6 ALD.&ESTERS	.00	.00
CH4	11.40	9.10
C2-C3 HYDROCARBONS	1.80	2.10
C4+ HYDROCARBONS	.80	1.20
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	97.8	91.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-22

CATALYST NUMBER : 200-88-1 DATE : 11/10/80

ATOMIC FORMULA : $Cu_{.5}Co_{.2}ZnK_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1); 1.7 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1
TEST CONDITIONS :	
FEED H2/CO RATIO	2.05
FEED CO2	11.70
AVE. TEMP., C	272.0
HOT SPOT, C	273.0
PRESSURE, psig	950.0
VHSV, l/hr/kgm cat.	3122.0
HOURS on STREAM	3.5
RPM	.0
CONVERSION :	
CO to Prods., vol%	5.26
CO to CO2, vol%	1.24
CO, gm mol/hr/kgm cat.	2.17
STY of oxygenates(2) gm mol/hr/kgm cat.	.52
STOICHIOM. H2/CO converted	1.64
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :	
CH3OH	3.96
C2-C6 ALCOHOLS	5.94
C2-C6 ALD.&ESTERS	20.16
CH4	27.70
C2-C3 HYDROCARBONS	19.54
C4+ HYDROCARBONS	11.01
APPROACH TO(3) WGS Equilibrium, C	.00
CARBON ACCOUNTABILITY, % (4)	88.3

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-23

CATALYST NUMBER : 200-83-1 DATE : 11/11/80

ATOMIC FORMULA : $CuCoK_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: in Situ Reduction

BULK DENSITY[1]: 1.22 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	12.10	12.10
AVE. TEMP., C	290.0	288.0
HOT SPOT, C	290.0	289.0
PRESSURE, psig	920.0	920.0
VHSV, l/hr/kgm cat.	3778.0	6964.0
HOURS on STREAM	6.4	8.4
RPM	1505.0	1505.0
CONVERSION :		
CO to Prods., vol%	33.65	14.48
CO to CO2, vol%	20.25	7.12
CO, gm mol/hr/kgm cat.	21.90	16.20
STY of oxygenates[2] gm mol/hr/kgm cat.	3.47	3.52
STOICHIOM. H2/CO converted	1.27	1.27
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	3.68	4.33
C2-C6 ALCOHOLS	15.70	10.89
C2-C6 ALD.&ESTERS	5.93	17.16
CH4	40.68	33.86
C2-C3 HYDROCARBONS	23.86	22.23
C4+ HYDROCARBONS	10.25	11.64
APPROACH TO[3] WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	103.3	103.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-24

CATALYST NUMBER : 200-99 DATE : 11/12/80

ATOMIC FORMULA : $CuCo_{.25}Al_{.18}Zn_{.33}K_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): .93 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	2.10	2.10	2.10	2.10	2.10
FEED CO2	12.10	12.10	12.10	12.10	12.10
AVE. TEMP., C	273.0	273.0	302.0	302.0	302.0
HOT SPOT, C	273.0	273.0	302.0	302.0	302.0
PRESSURE, psig	920.0	920.0	915.0	915.0	915.0
VHSV, l/hr/kgm cat.	3220.0	3220.0	3760.0	3760.0	2050.0
HOURS on STREAM	4.5	6.0	10.5	10.5	12.5
RPM	1480.0	1490.0	1500.0	1500.0	1500.0
CONVERSION :					
CO to Prods., vol%	7.49	5.74	5.80	5.74	11.00
CO to CO2, vol%	2.61	2.56	1.30	1.36	3.80
CO, gm mol/hr/kgm cat.	3.50	2.90	3.00	2.70	3.40
STY of oxygenates(2) gm mol/hr/kgm cat.	1.05	.78	1.09	.96	1.07
STOICHIOM. H2/CO converted	1.39	1.31	2.09	2.23	1.61
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	6.88	9.54	22.28	23.12	21.40
C2-C6 ALCOHOLS	29.41	27.60	19.95	19.78	19.25
C2-C6 ALD.&ESTERS	3.78	1.59	1.35	.74	.67
CH4	21.58	24.71	33.41	34.25	35.53
C2-C3 HYDROCARBONS	19.56	19.65	16.03	15.45	16.82
C4+ HYDROCARBONS	18.89	16.91	6.98	6.06	6.33
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	103.1	101.8	135.6	127.9	107.6

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-25

CATALYST NUMBER : 200-79 DATE : 11/20/80

ATOMIC FORMULA : $CuCoZn_{.5}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Evaporation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 0 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.10	2.10	2.10	2.10
FEED CO2	12.10	12.10	12.10	12.10
AVE. TEMP., C	262.0	298.0	287.0	287.0
HOT SPOT, C	264.0	300.0	288.0	288.0
PRESSURE, psig	945.0	950.0	950.0	950.0
VHSV, l/hr/kgm cat.	2820.0	2820.0	3100.0	3100.0
HOURS on STREAM	3.3	5.2	7.7	9.2
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	4.47	19.11	10.79	11.13
CO to CO2, vol%	2.03	14.39	6.61	6.07
CO, gm mol/hr/kgm cat.	2.00	10.40	5.90	5.80
STY of oxygenates(2) gm mol/hr/kgm cat.	.39	1.09	.97	1.39
STOICHIOM. H2/CO converted	2.30	1.19	1.33	1.23
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	3.49	2.28	4.52	8.50
C2-C6 ALCOHOLS	5.23	7.36	8.39	14.37
C2-C6 ALD.&ESTERS	20.77	8.76	13.55	13.91
CH4	32.54	43.64	30.48	29.52
C2-C3 HYDROCARBONS	22.08	25.94	27.74	21.02
C4+ HYDROCARBONS	15.69	11.92	15.32	12.67
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	105.7	92.0	105.6	114.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-26

CATALYST NUMBER : 217-3 DATE : 11/26/80

ATOMIC FORMULA : $CuCo_{.3}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: in Situ Reduction

BULK DENSITY(1): 0 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.10	2.10	2.10	2.10
FEED CO2	12.00	12.00	12.00	12.00
AVE. TEMP., C	267.0	286.0	293.0	293.0
HOT SPOT, C	268.0	287.0	294.0	294.0
PRESSURE, psig	925.0	925.0	950.0	950.0
VHSV, l/hr/kgm cat.	3950.0	3950.0	3975.0	3975.0
HOURS on STREAM	2.0	3.6	8.0	9.2
RPM	1500.0	1490.0	1490.0	1500.0
CONVERSION :				
CO to Prods., vol%	1.62	6.33	8.25	8.51
CO to CO2, vol%	1.88	4.68	4.55	3.79
CO, gm mol/hr/kgm cat.	1.50	4.80	5.50	5.30
STY of oxygenates(2) gm mol/hr/kgm cat.	.28	.99	1.26	1.33
STOICHIOM. H2/CO converted	3.11	1.70	1.67	1.49
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	4.31	4.87	6.36	6.65
C2-C6 ALCOHOLS	4.53	6.96	10.71	11.56
C2-C6 ALD.&ESTERS	30.17	24.00	17.54	17.34
CH4	29.96	32.52	33.53	32.80
C2-C3 HYDROCARBONS	17.03	19.30	20.02	19.51
C4+ HYDROCARBONS	14.01	12.35	11.64	12.14
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	217.0	127.9	113.7	105.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

SUMMARY FOR RUN # 213-28 CHEM SYSTEMS INC.

CATALYST NUMBER : 200-86 DATE : 12/12/80
ATOMIC FORMULA : $CuCoZn_{.5}K_{.11}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 0 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.10	2.10
FEED CO2	12.00	12.00
AVE. TEMP., C	281.0	302.0
HOT SPOT, C	282.0	302.0
PRESSURE, psig	960.0	960.0
VHSV, l/hr/kgm cat.	4740.0	4740.0
HOURS on STREAM	3.7	4.5
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	1.49	3.16
CO to CO2, vol%	.41	.74
CO, gm mol/hr/kgm cat.	.97	2.00
STY of oxygenates(2) gm mol/hr/kgm cat.	.17	.32
STOICHIOM. H2/CO converted	3.12	4.45
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	5.60	4.94
C2-C6 ALCOHOLS	5.85	5.92
C2-C6 ALD.&ESTERS	11.19	8.76
CH4	39.05	39.61
C2-C3 HYDROCARBONS	24.55	25.91
C4+ HYDROCARBONS	13.86	15.05
APPROACH TO(3) WGS Equilibrium, C	.00	.00
CARBON ACCOUNTABILITY, % (4)	133.0	144.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition,
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

SUMMARY FOR RUN # 213-29 CHEM SYSTEMS INC.

CATALYST NUMBER : 200-91 DATE : 12/10/80

ATOMIC FORMULA : $CuCoFe_{.1}Th_{.5}Zn_{.125}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.2 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	2.10	2.10	2.10	2.10	2.10
FEED CO2	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	263.0	252.0	222.0	232.0	245.0
HOT SPOT, C	264.0	253.0	223.0	233.0	246.0
PRESSURE, psig	920.0	920.0	945.0	945.0	945.0
VHSV, l/hr/ksm cat.	3800.0	3250.0	3780.0	3950.0	7670.0
HOURS on STREAM	2.0	3.3	8.0	9.5	10.5
RPM	1480.0	1480.0	1510.0	1500.0	1490.0
CONVERSION :					
CO to Prods., vol%	75.37	71.22	7.36	10.87	12.00
CO to CO2, vol%	17.33	14.78	1.84	3.93	4.00
CO, gm mol/hr/ksm cat.	37.40	30.00	3.77	6.34	13.30
STY of oxygenates(2) gm mol/hr/ksm cat.	.64	1.53	.87	1.30	2.68
STOICHIOM. H2/CO converted	1.78	1.68	2.99	2.55	2.37
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	.00	.24	5.12	5.04	5.20
C2-C6 ALCOHOLS	.98	4.47	20.24	19.88	18.94
C2-C6 ALD.&ESTERS	1.11	1.45	3.37	3.00	2.67
CH4	28.91	25.48	25.74	26.41	29.08
C2-C3 HYDROCARBONS	33.83	33.21	28.62	27.91	27.08
C4+ HYDROCARBONS	35.18	35.26	17.00	17.97	16.94
APPROACH TO(3) WGS Equilibrium, C	.00	.00	.00	.00	.00
CARBON ACCOUNTABILITY, % (4)	120.1	138.4	94.7	100.9	108.3

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-31

DATE : 12/12/80

CATALYST NUMBER : 217-5
ATOMIC FORMULA : $CuCo_{.3}K_{.077}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation

REDUCTION: in Situ Reduction

BULK DENSITY[1] : 1.2 gm/cc

REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.10	2.10	2.10
FEED CO2	12.00	12.00	12.00
AVE. TEMP., C	279.0	289.0	298.0
HOT SPOT, C	280.0	290.0	299.0
PRESSURE, psig	920.0	920.0	920.0
VHSV, l/hr/kgm cat.	3540.0	3660.0	3660.0
HOURS on STREAM	4.3	5.5	6.5
RPM	1500.0	1500.0	1500.0
CONVERSION :			
CO to Prods., vol%	8.62	11.91	16.46
CO to CO2, vol%	3.48	5.79	9.74
CO, gm mol/hr/kgm cat.	4.69	7.09	10.50
STY of oxygenates[2] gm mol/hr/kgm cat.	1.25	1.74	2.13
STOICHIOM. H2/CO converted	1.22	1.42	1.20
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	4.21	4.61	4.94
C2-C6 ALCOHOLS	6.04	10.55	13.69
C2-C6 ALD.&ESTERS	27.24	21.25	13.69
CH4	29.76	31.95	34.55
C2-C3 HYDROCARBONS	19.23	19.32	21.17
C4+ HYDROCARBONS	13.62	12.63	12.26
APPROACH TO[3] WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	93.9	100.5	107.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-32

CATALYST NUMBER : 217-6 DATE : 12/16/80

ATOMIC FORMULA : $CuCo_{.07}Al_{.18}Zn_{.33}K_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1): .96 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	11.68	11.68	11.68	11.68
AVE. TEMP., C	271.0	273.0	300.0	300.0
HOT SPOT, C	272.0	273.0	301.0	301.0
PRESSURE, psig	950.0	950.0	950.0	950.0
VHSV, l/hr/kgm cat.	3787.0	910.0	3605.0	3605.0
HOURS on STREAM	4.3	6.7	10.7	10.7
RPM	1500.0	1500.0	1490.0	1500.0
CONVERSION :				
CO to Prods., vol%	1.90	5.19	3.10	8.34
CO to CO2, vol%	.00	1.01	.00	1.26
CO, gm mol/hr/kgm cat.	.78	.61	1.38	1.05
STY of oxygenates(2) gm mol/hr/kgm cat.	.38	.29	.86	.51
STOICHIOM. H2/CO converted	7.65	2.61	3.80	2.04
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	40.50	40.02	51.90	44.54
C2-C6 ALCOHOLS	8.70	16.01	10.50	11.05
C2-C6 ALD.&ESTERS	.00	.00	.00	.00
CH4	32.30	16.13	24.90	26.13
C2-C3 HYDROCARBONS	16.40	16.13	10.00	13.12
C4+ HYDROCARBONS	2.00	2.51	2.70	5.06
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	84.1	100.1	89.2	108.3

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-33

CATALYST NUMBER : 217-1 DATE : 1/6/81

ATOMIC FORMULA : $CuAl_{.18}Zn_{.33}K_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.36 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	11.94	11.94
AVE. TEMP., C	270.0	297.0
HOT SPOT, C	273.0	299.0
PRESSURE, psig	960.0	965.0
VHSV, l/hr/kgm cat.	2869.0	2670.0
HOURS on STREAM	2.0	3.3
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	29.52	20.25
CO to CO2, vol%	.18	.65
CO, gm mol/hr/kgm cat.	9.30	6.10
STY of oxygenates(2) gm mol/hr/kgm cat.	9.10	5.70
STOICHIOM. H2/CO converted	2.12	2.12
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	97.28	92.67
C2-C6 ALCOHOLS	.80	2.68
C2-C6 ALD.&ESTERS	.00	.72
CH4	1.11	1.65
C2-C3 HYDROCARBONS	.70	.52
C4+ HYDROCARBONS	.60	1.75
APPROACH TO(3) WGS Equilibrium, C	.00	.00
CARBON ACCOUNTABILITY, % (4)	98.3	104.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-34

CATALYST NUMBER : 217-7-1 DATE : 12/22/80
ATOMIC FORMULA : $CuCoK_{.05}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: in Situ Reduction

BULK DENSITY(1): 0 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	11.80	11.80	11.80	11.80
AVE. TEMP., C	272.0	273.0	281.0	291.0
HOT SPOT, C	273.0	274.0	281.0	292.0
PRESSURE, psig	955.0	955.0	955.0	905.0
VHSV, l/hr/kgm cat.	3630.0	1139.0	8538.0	6760.0
HOURS on STREAM	4.9	6.8	12.3	14.6
RPM	1700.0	1770.0	1730.0	1750.0
CONVERSION :				
CO to Prods., vol%	11.87	37.58	4.49	7.63
CO to CO2, vol%	5.13	23.82	1.41	3.67
CO, gm mol/hr/kgm cat.	6.74	7.64	5.57	8.35
STY of oxygenates(2) gm mol/hr/kgm cat.	1.72	1.34	1.59	1.90
STOICHIOM. H2/CO converted	1.29	1.07	1.92	1.24
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	5.01	4.08	4.20	5.04
C2-C6 ALCOHOLS	9.31	17.97	5.65	9.78
C2-C6 ALD.&ESTERS	22.21	6.54	27.60	18.52
CH4	30.80	31.37	32.72	36.74
C2-C3 HYDROCARBONS	21.35	27.12	18.79	21.18
C4+ HYDROCARBONS	11.32	12.91	11.04	8.44
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	98.0	98.6	102.6	110.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-36

DATE : 1/7/81

CATALYST NUMBER : 200-83-2
ATOMIC FORMULA : CuCo

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation

REDUCTION: in Situ Reduction

BULK DENSITY[1]: 0 gm/cc

REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00	2.00
FEED CO2	12.00	12.00	12.00	12.00	12.00	12.00
AVE. TEMP., C	271.0	271.0	291.0	291.0	290.0	251.0
HOT SPOT, C	271.0	271.0	291.0	291.0	290.0	251.0
PRESSURE, psig	908.0	907.0	908.0	910.0	910.0	910.0
VHSV, l/hr/kgm cat.	1930.0	3780.0	3565.0	5000.0	5060.0	2040.0
HOURS on STREAM	2.5	4.0	5.7	8.8	10.3	11.8
RPM	1510.0	1510.0	1520.0	1490.0	1480.0	1520.0
CONVERSION :						
CO to Prods., vol%	23.00	12.58	43.49	18.19	17.14	2.95
CO to CO2, vol%	19.20	10.62	29.51	10.11	9.56	3.55
CO, gm mol/hr/kgm cat.	9.10	9.80	29.20	15.90	15.20	1.49
STY of oxygenates[2] gm mol/hr/kgm cat.	1.23	1.90	3.33	2.96	2.81	.37
STOICHIOM. H2/CO converted	.95	1.02	1.07	1.10	1.61	1.61
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	3.85	3.69	2.18	4.51	4.36	5.42
C2-C6 ALCOHOLS	9.36	16.41	13.76	11.05	10.59	4.23
C2-C6 ALD.&ESTERS	12.29	15.49	3.19	13.38	13.86	28.70
CH4	42.94	30.43	46.99	36.56	35.83	28.17
C2-C3 HYDROCARBONS	21.10	21.21	24.00	23.81	23.68	20.22
C4+ HYDROCARBONS	10.46	13.28	10.07	10.89	11.68	13.24
APPROACH TO[3] WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	89.8	119.4	101.1	108.7	110.2	166.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-38

CATALYST NUMBER : 217-15 DATE : 1/16/81
ATOMIC FORMULA : $CoK_{.11}$
CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: Coprecipitation Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.16 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	1.96	1.96	1.96
FEED CO2	11.92	11.92	11.92
AVE. TEMP., C	249.0	268.0	289.0
HOT SPOT, C	250.0	269.0	290.0
PRESSURE, psig	915.0	915.0	915.0
VHSV, l/hr/kgm cat.	2080.0	4070.0	7080.0
HOURS on STREAM	1.5	3.0	5.0
RPM	1500.0	1500.0	1500.0
CONVERSION :			
CO to Prods., vol%	14.79	17.55	28.21
CO to CO2, vol%	9.91	9.15	14.89
CO, gm mol/hr/kgm cat.	5.57	11.80	33.10
STY of oxygenates(2) gm mol/hr/kgm cat.	1.02	2.61	5.96
STOICHIOM. H2/CO converted	1.08	.88	.99
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.33	.30	.31
C2-C6 ALCOHOLS	1.84	3.35	4.43
C2-C6 ALD.&ESTERS	28.40	29.97	22.77
CH4	23.56	25.41	16.81
C2-C3 HYDROCARBONS	22.22	20.84	34.38
C4+ HYDROCARBONS	23.56	19.93	16.81
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	87.7	100.6	115.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-39

CATALYST NUMBER : 217-8 DATE : 1/19/81

ATOMIC FORMULA : $CuCo_{.13}Al_{.18}Zn_{.33}K_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.25 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	11.71	11.71	11.71
AVE. TEMP., C	270.0	302.0	302.0
HOT SPOT, C	271.0	303.0	303.0
PRESSURE, psig	955.0	955.0	965.0
VHSV, l/hr/kgm cat.	2660.0	2660.0	5170.0
HOURS on STREAM	1.1	2.7	4.1
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	3.27	9.08	2.77
CO to CO2, vol%	5.73	1.82	.13
CO, gm mol/hr/kgm cat.	2.58	3.13	.82
STY of oxygenates(2) gm mol/hr/kgm cat.	.70	.78	.62
STOICHIOM. H2/CO converted	1.74	1.77	4.23
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	3.30	9.73	15.20
C2-C6 ALCOHOLS	21.19	20.89	20.86
C2-C6 ALD.&ESTERS	2.75	2.04	3.98
CH4	27.80	32.66	33.23
C2-C3 HYDROCARBONS	23.67	20.29	17.61
C4+ HYDROCARBONS	21.19	14.29	9.12
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	187.0	80.4	140.5

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-40

CATALYST NUMBER : 200-81-1 DATE : 1/22/81

ATOMIC FORMULA : $CuCoTh_{.5}K_{.11}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.14 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.07	2.07
FEED CO2	11.41	11.41
AVE. TEMP.; C	255.0	272.0
HOT SPOT; C	256.0	273.0
PRESSURE; psig	965.0	960.0
VHSV; 1/hr/kgm cat.	4340.0	4450.0
HOURS on STREAM	1.1	2.5
RPM	.0	.0
CONVERSION :		
CO to Prods.; vol%	4.91	10.19
CO to CO2; vol%	.69	.71
CO; gm mol/hr/kgm cat.	2.60	5.14
STY of oxygenates(2) gm mol/hr/kgm cat.	.50	1.09
STOICHIOM. H2/CO converted	2.81	2.39
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	4.68	5.35
C2-C6 ALCOHOLS	12.89	14.33
C2-C6 ALD.&ESTERS	4.45	3.10
CH4	36.95	39.57
C2-C3 HYDROCARBONS	25.55	23.74
C4+ HYDROCARBONS	15.28	13.80
APPROACH TO(3) WGS Equilibrium; C		
CARBON ACCOUNTABILITY; % (4)	80.3	78.3

(1) Fresh; non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-41

CATALYST NUMBER : 217-16 DATE : 1/23/81

ATOMIC FORMULA : $CoK_{.34}$

CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: Coprecipitation Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1) : 1.19 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.02	2.02	2.02
FEED CO2	11.24	11.24	11.24
AVE. TEMP., C	269.0	279.0	289.0
HOT SPOT, C	269.0	279.0	289.0
PRESSURE, psig	915.0	918.0	918.0
VHSV, l/hr/kgm cat.	3700.0	3720.0	6980.0
HOURS on STREAM	1.1	3.1	4.0
RPM	1480.0	1490.0	1510.0
CONVERSION :			
CO to Prods., vol%	9.73	15.20	13.41
CO to CO2, vol%	6.97	8.10	6.99
CO, gm mol/hr/kgm cat.	6.50	9.10	15.00
STY of oxygenates(2) gm mol/hr/kgm cat.	1.16	1.64	2.54
STOICHIOM. H2/CO converted	1.22	1.22	1.30
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.34	.46	.46
C2-C6 ALCOHOLS	2.06	4.29	4.56
C2-C6 ALD.&ESTERS	28.15	22.84	19.93
CH4	29.52	34.79	35.90
C2-C3 HYDROCARBONS	21.63	24.06	24.80
C4+ HYDROCARBONS	18.19	14.25	14.45
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	90.3	100.7	104.1

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-42

CATALYST NUMBER : 217-9 DATE : 1/28/81
ATOMIC FORMULA : Co

CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: Coprecipitation Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.19 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	11.00	11.00
AVE. TEMP., C	259.0	259.0
HOT SPOT, C	259.0	259.0
PRESSURE, psig	925.0	925.0
VHSV, l/hr/kgm cat.	2520.0	3780.0
HOURS on STREAM	1.4	2.5
RPM	1530.0	1550.0
CONVERSION :		
CO to Prods., vol%	52.72	20.86
CO to CO2, vol%	8.08	1.14
CO, gm mol/hr/kgm cat.	16.20	8.80
STY of oxygenates(2) gm mol/hr/kgm cat.	.29	.23
STOICHIOM. H2/CO converted	2.06	2.34
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	.12	.42
C2-C6 ALCOHOLS	1.27	1.48
C2-C6 ALD.&ESTERS	.69	.84
CH4	40.36	35.86
C2-C3 HYDROCARBONS	18.91	16.24
C4+ HYDROCARBONS	38.75	45.25
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	71.5	53.8

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition,
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-43

DATE : 1/29/81

CATALYST NUMBER : 217-2
ATOMIC FORMULA : $CuAl_{.18}Zn_{.33}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation

REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.27 gm/cc

REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	11.00	11.00
AVE. TEMP., C	269.0	297.0
HOT SPOT, C	271.0	299.0
PRESSURE, psig	965.0	965.0
VHSV, l/hr/ksm cat.	3300.0	4650.0
HOURS on STREAM	1.5	3.7
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	30.70	17.97
CO to CO2, vol%	.00	1.03
CO, gm mol/hr/ksm cat.	10.60	9.20
STY of oxygenates(2) gm mol/hr/ksm cat.	10.40	8.24
STOICHIOM. H2/CO converted	2.39	2.88
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	97.20	92.28
C2-C6 ALCOHOLS	.90	2.01
C2-C6 ALD.&ESTERS	.00	.00
CH4	.90	2.75
C2-C3 HYDROCARBONS	.00	1.06
C4+ HYDROCARBONS	.90	1.90
APPROACH TO(3) WGS Equilibrium, C	.00	.00
CARBON ACCOUNTABILITY, % (4)	84.8	72.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-44

CATALYST NUMBER : 217-10 DATE : 2/2/81
ATOMIC FORMULA : $Cu_{.5}Zn$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.46 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	11.00	11.00
AVE. TEMP., C	271.0	294.0
HOT SPOT, C	271.0	298.0
PRESSURE, psig	900.0	900.0
VHSV, 1/hr/kgm cat.	3690.0	3850.0
HOURS on STREAM	2.2	3.5
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	24.62	19.95
CO to CO2, vol%	-1.22	-.75
CO, gm mol/hr/kgm cat.	9.40	8.07
STY of oxygenates(2) gm mol/hr/kgm cat.	9.40	8.20
STOICHIOM. H2/CO converted	2.22	2.15
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	97.91	95.38
C2-C6 ALCOHOLS	.57	2.41
C2-C6 ALD.&ESTERS	.00	.00
CH4	.76	1.06
C2-C3 HYDROCARBONS	.00	.29
C4+ HYDROCARBONS	.86	.77
APPROACH TO(3) WGS Equilibrium, C	.00	.00
CARBON ACCOUNTABILITY, % (4)	110.8	106.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-45

CATALYST NUMBER : 217-18 DATE : 2/3/81

ATOMIC FORMULA : $Cu_{,5}Co_{.25}Zn$

CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.2 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	11.00	11.00
AVE. TEMP., C	270.0	270.0
HOT SPOT, C	270.0	270.0
PRESSURE, psig	910.0	910.0
VHSV, l/hr/kgm cat.	4400.0	7580.0
HOURS on STREAM	1.3	2.5
RPM	1510.0	1520.0
CONVERSION :		
CO to Prods., vol%	32.07	18.00
CO to CO2, vol%	6.33	3.20
CO, gm mol/hr/kgm cat.	18.80	17.90
STY of oxygenates(2) gm mol/hr/kgm cat.	1.64	2.45
STOICHIOM. H2/CO converted	1.84	1.97
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	1.08	1.41
C2-C6 ALCOHOLS	8.50	13.90
C2-C6 ALD.&ESTERS	.84	.82
CH4	23.83	23.32
C2-C3 HYDROCARBONS	23.83	22.61
C4+ HYDROCARBONS	38.43	38.04
APPROACH TO(3) WGS Equilibrium, C	.00	.00
CARBON ACCOUNTABILITY, % (4)	94.0	106.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-46

CATALYST NUMBER : 217-17 DATE : 2/3/81

ATOMIC FORMULA : $CoK_{.05}$

CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: Coprecipitation Impregnation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.11 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	11.00	11.00	11.00	11.00
AVE. TEMP., C	263.0	272.0	291.0	290.0
HOT SPOT, C	263.0	272.0	291.0	290.0
PRESSURE, psig	910.0	905.0	900.0	900.0
VHSV, l/hr/kgm cat.	3870.0	2251.0	6360.0	7520.0
HOURS on STREAM	1.7	2.8	4.7	5.5
RPM	1500.0	1500.0	1500.0	1500.0
CONVERSION :				
CO to Prods., vol%	8.13	18.89	20.13	15.86
CO to CO2, vol%	3.27	8.91	9.97	6.04
CO, gm mol/hr/kgm cat.	4.63	6.57	20.10	17.30
STY of oxygenates(2) gm mol/hr/kgm cat.	1.24	1.62	4.41	4.23
STOICHIOM. H2/CO converted	1.95	1.38	1.42	1.53
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	.28	.29	.45	.28
C2-C6 ALCOHOLS	2.81	4.12	4.79	4.69
C2-C6 ALD.&ESTERS	34.50	31.94	27.52	28.72
CH4	22.16	27.09	27.07	24.02
C2-C3 HYDROCARBONS	17.25	18.70	19.29	17.39
C4+ HYDROCARBONS	23.00	17.96	18.69	18.50
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	106.7	115.4	130.8	141.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-47

CATALYST NUMBER : 217-19 DATE : 2/13/81

ATOMIC FORMULA : $Cu_{.5}Co_{.25}ZnK_{.05}$

CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impresnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.23 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	10.00	10.00	10.00	10.00
AVE. TEMP., C	270.0	298.0	300.0	300.0
HOT SPOT, C	271.0	299.0	302.0	301.0
PRESSURE, psig	880.0	880.0	935.0	935.0
VHSV, l/hr/kgm cat.	2800.0	6300.0	3310.0	6200.0
HOURS on STREAM	1.2	2.0	1.3	2.8
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	4.40	8.30	9.10	3.80
CO to CO2, vol%	.00	2.80	4.20	1.00
CO, gm mol/hr/kgm cat.	1.23	7.00	.00	.00
STY of oxygenates(2) gm mol/hr/kgm cat.	.43	1.52	.89	.95
STOICHIOM. H2/CO converted	.00	.39	.95	.82
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	4.30	3.21	4.68	6.69
C2-C6 ALCOHOLS	13.20	11.37	10.38	10.74
C2-C6 ALD.&ESTERS	17.70	14.45	12.43	20.08
CH4	31.20	36.52	33.77	31.83
C2-C3 HYDROCARBONS	19.70	20.60	27.19	24.63
C4+ HYDROCARBONS	13.90	14.05	11.55	5.94
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	90.4	120.0	135.0	176.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-49

CATALYST NUMBER : 217-17 DATE : 2/24/80

ATOMIC FORMULA : $CoK_{.05}$

CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: Impregnation Coprecitation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.11 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	.00	.00
AVE. TEMP., C	272.0	290.0
HOT SPOT, C	272.0	290.0
PRESSURE, psig	935.0	935.0
VHSV, l/hr/kgm cat.	2420.0	5130.0
HOURS on STREAM	1.0	2.1
RPM	1500.0	1500.0
CONVERSION :		
CO to Prods., vol%	5.60	9.20
CO to CO2, vol%	2.50	4.90
CO, gm mol/hr/kgm cat.	2.84	10.49
STY of oxygenates(2) gm mol/hr/kgm cat.	.78	2.54
STOICHIOM. H2/CO converted	.91	.67
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	.58	.46
C2-C6 ALCOHOLS	5.50	5.56
C2-C6 ALD.&ESTERS	33.57	31.10
CH4	27.06	29.87
C2-C3 HYDROCARBONS	21.13	21.45
C4+ HYDROCARBONS	12.16	11.49
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	211.0	209.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-50

CATALYST NUMBER : 217-23 DATE : 2/27/81

ATOMIC FORMULA : $CoPd_{.05}K_{.11}$

CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: $Pd(NO_3)_2$ Impres. onto 217-15 REDUCTION: in Situ Reduction

BULK DENSITY(1): 0 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.13	2.13	2.13
FEED CO2	10.89	10.89	10.89
AVE. TEMP., C	271.0	273.0	292.0
HOT SPOT, C	272.0	274.0	293.0
PRESSURE, psig	910.0	910.0	905.0
VHSV, 1/hr/kgm cat.	4340.0	4370.0	7460.0
HOURS on STREAM	1.3	2.3	3.5
RPM	1510.0	1510.0	1470.0
CONVERSION :			
CO to Prods., vol%	15.96	19.82	24.54
CO to CO2, vol%	7.84	7.48	11.06
CO, gm mol/hr/kgm cat.	11.27	13.02	28.98
STY of oxygenates(2) gm mol/hr/kgm cat.	3.47	3.53	5.80
STOICHIOM. H2/CO converted	1.10	.92	.96
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.45	.41	.44
C2-C6 ALCOHOLS	7.75	5.92	4.35
C2-C6 ALD.&ESTERS	3.43	30.99	24.23
CH4	29.53	27.96	35.11
C2-C3 HYDROCARBONS	23.56	21.90	24.08
C4+ HYDROCARBONS	12.38	12.81	11.90
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	129.4	114.5	118.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-52

CATALYST NUMBER : 217-24 DATE : 3/9/81

ATOMIC FORMULA : $CuCoK_{.11}$

CATALYST SUPPORT :88.0% Al_2O_3

PREP METHOD: Impregnation by Evaporation REDUCTION: in Situ Reduction

BULK DENSITY(1): .91 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	11.00	11.00	11.00
AVE. TEMP., C	272.0	290.0	299.0
HOT SPOT, C	273.0	292.0	301.0
PRESSURE, psig	935.0	935.0	935.0
VHSV, l/hr/kgm cat.	2530.0	2550.0	4610.0
HOURS on STREAM	1.1	3.3	4.2
RPM	.0	.0	.0
CONVERSION :			
CO to Prods., vol%	9.82	15.34	10.85
CO to CO2, vol%	.38	.46	.15
CO, gm mol/hr/kgm cat.	2.80	4.40	5.60
STY of oxygenates(2) gm mol/hr/kgm cat.	.10	.20	.25
STOICHIOM. H2/CO converted	1.46	1.64	1.39
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	1.04	.82	1.12
C2-C6 ALCOHOLS	2.18	3.60	3.25
C2-C6 ALD.&ESTERS	.31	.21	.20
CH4	35.41	33.89	37.83
C2-C3 HYDROCARBONS	24.09	23.69	24.65
C4+ HYDROCARBONS	36.97	37.49	32.86
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	95.0	250.0	259.0

(1) Fresh, non-reduced catalyst.

(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.

(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.

(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-54

CATALYST NUMBER : 217-22 DATE : 3/11/81
ATOMIC FORMULA : $CuCoK_{.22}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.56 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4	5
TEST CONDITIONS :					
FEED H2/CO RATIO	2.00	2.00	2.00	2.00	2.00
FEED CO2	11.00	11.00	11.00	11.00	11.00
AVE. TEMP., C	272.0	272.0	292.0	293.0	291.0
HOT SPOT, C	272.0	272.0	292.0	293.0	291.0
PRESSURE, psig	915.0	915.0	915.0	915.0	915.0
VHSV, l/hr/kgm cat.	4650.0	6850.0	7050.0	9800.0	13400.0
HOURS on STREAM	.9	2.0	4.0	4.8	5.6
RPM	1510.0	1510.0	1510.0	1520.0	1510.0
CONVERSION :					
CO to Prods., vol%	34.50	14.89	40.92	23.73	14.47
CO to CO2, vol%	10.60	5.11	12.48	11.07	7.43
CO, gm mol/hr/kgm cat.	22.58	14.75	40.54	36.72	31.60
STY of oxygenates(2) gm mol/hr/kgm cat.	4.90	3.80	5.70	5.10	5.70
STOICHIOM. H2/CO converted	.90	.83	1.11	.96	.76
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :					
CH3OH	1.57	1.88	1.31	1.61	1.97
C2-C6 ALCOHOLS	9.54	9.81	10.44	10.41	11.05
C2-C6 ALD.&ESTERS	16.99	22.71	6.53	8.50	14.08
CH4	35.82	30.63	46.59	47.95	40.87
C2-C3 HYDROCARBONS	22.35	20.02	25.45	21.55	21.49
C4+ HYDROCARBONS	13.73	15.05	9.79	9.97	10.75
APPROACH TO(3) WGS Equilibrium, C					
CARBON ACCOUNTABILITY, % (4)	170.9	176.0	167.0	214.0	215.9

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-56

CATALYST NUMBER : 217-27 DATE : 3/17/81

ATOMIC FORMULA : $CoRu_{.016}K_{.11}$

CATALYST SUPPORT :50.0% Al_2O_3

PREP METHOD: $RuCl_3$ impres. onto 217-15 REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.22 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	11.00	11.00	11.00
AVE. TEMP., C	272.0	295.0	295.0
HOT SPOT, C	272.0	295.0	295.0
PRESSURE, psig	910.0	910.0	910.0
VHSV, l/hr/kgm cat.	4050.0	5280.0	12960.0
HOURS on STREAM	1.1	3.3	4.3
RPM	1500.0	1500.0	1500.0
CONVERSION :			
CO to Prods., vol%	34.30	61.12	22.13
CO to CO2, vol%	18.20	26.78	9.67
CO, gm mol/hr/kgm cat.	22.90	49.97	44.38
STY of oxygenates(2) gm mol/hr/kgm cat.	5.70	8.24	10.80
STOICHIOM. H2/CO converted	N.A.	N.A.	N.A.
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.46	.29	.72
C2-C6 ALCOHOLS	5.05	6.04	5.46
C2-C6 ALD.&ESTERS	28.01	16.97	28.16
CH4	30.31	42.43	32.33
C2-C3 HYDROCARBONS	21.43	25.46	22.41
C4+ HYDROCARBONS	14.85	8.92	10.92
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	105.6	107.4	106.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-55

DATE : 3/19/81

CATALYST NUMBER : 217-28
ATOMIC FORMULA : $CuCo_{.4}Al_{.18}Zn_{.33}K_{.05}$
CATALYST SUPPORT : NONE

PREP METHOD: Cobalt Carbonyl Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY[1] : 1.27 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.00	2.00	2.00	2.00
FEED CO2	11.00	11.00	11.00	11.00
AVE. TEMP., C	271.0	301.0	298.0	312.0
HOT SPOT, C	271.0	302.0	299.0	315.0
PRESSURE, psig	940.0	945.0	940.0	940.0
VHSV, l/hr/kgm cat.	3490.0	6460.0	3570.0	3550.0
HOURS on STREAM	1.7	3.3	4.5	5.6
RPM	.0	.0	.0	.0
CONVERSION :				
CO to Prods., vol%	6.14	8.44	9.52	14.30
CO to CO2, vol%	1.26	2.16	6.18	7.30
CO, gm mol/hr/kgm cat.	2.78	7.37	6.04	8.26
STY of oxygenates[2] gm mol/hr/kgm cat.	.75	2.01	1.30	1.55
STOICHIOM. H2/CO converted	N.A.	N.A.	N.A.	N.A.
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	5.90	7.54	7.75	5.29
C2-C6 ALCOHOLS	19.64	19.97	19.30	16.47
C2-C6 ALD.&ESTERS	7.11	7.16	7.92	6.19
CH4	31.08	33.79	33.00	35.35
C2-C3 HYDROCARBONS	20.24	19.97	20.46	21.90
C4+ HYDROCARBONS	16.02	11.56	12.37	14.20
APPROACH TO[3] WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	93.9	111.0	100.8	99.4

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-57

CATALYST NUMBER : UCI L-1122 DATE : 3/25/81
ATOMIC FORMULA : Proprietary Catalyst

PREP METHOD: UCI prep. REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : 1.04 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3	4
TEST CONDITIONS :				
FEED H2/CO RATIO	2.10	2.10	2.10	2.10
FEED CO2	5.00	5.00	5.00	5.00
AVE. TEMP., C	299.0	348.0	301.0	350.0
HOT SPOT, C	299.0	348.0	301.0	350.0
PRESSURE, psig	1485.0	1480.0	1480.0	1480.0
VHSV, l/hr/kgm cat.	2480.0	2425.0	5680.0	6240.0
HOURS on STREAM	.5	2.3	4.6	5.3
RPM	1500.0	1490.0	1500.0	1500.0
CONVERSION :				
CO to Prods., vol%	25.85	18.62	9.57	17.16
CO to CO2, vol%	.75	2.78	-.17	-.26
CO, gm mol/hr/kgm cat.	8.12	6.38	6.57	12.97
STY of oxygenates(2) gm mol/hr/kgm cat.	7.68	5.04	6.42	11.84
STOICHIOM. H2/CO converted	1.99	1.49	2.01	1.66
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :				
CH3OH	95.69	78.16	94.87	81.26
C2-C6 ALCOHOLS	1.54	10.80	1.08	7.49
C2-C6 ALD.&ESTERS	.10	1.72	.00	.89
CH4	1.23	4.37	1.47	3.94
C2-C3 HYDROCARBONS	.31	1.84	.29	2.17
C4+ HYDROCARBONS	.82	3.10	1.08	2.86
APPROACH TO(3) WGS Equilibrium, C				
CARBON ACCOUNTABILITY, % (4)	82.6	109.3	122.0	69.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-59

DATE : 3/26/81

CATALYST NUMBER : 217-29-1
ATOMIC FORMULA : $CuCoK_{.33}$
CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation

REDUCTION: in Situ Reduction

BULK DENSITY(1): 1.6 gm/cc

REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.00	2.00	2.00
FEED CO2	11.00	11.00	11.00
AVE. TEMP., C	272.0	290.0	292.0
HOT SPOT, C	272.0	290.0	292.0
PRESSURE, psig	940.0	940.0	1470.0
VHSV, l/hr/kgm cat.	4490.0	7524.0	8930.0
HOURS on STREAM	1.8	3.6	4.8
RPM	1480.0	1490.0	1490.0
CONVERSION :			
CO to Prods., vol%	12.56	18.81	18.52
CO to CO2, vol%	7.54	9.69	8.38
CO, gm mol/hr/kgm cat.	9.59	22.78	25.52
STY of oxygenates(2) gm mol/hr/kgm cat.	1.90	4.40	4.90
STOICHIOM. H2/CO converted	.86	.92	1.07
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	2.72	1.82	3.78
C2-C6 ALCOHOLS	4.80	8.48	9.30
C2-C6 ALD.&ESTERS	23.68	18.79	14.67
CH4	29.92	35.91	40.39
C2-C3 HYDROCARBONS	21.12	21.36	19.03
C4+ HYDROCARBONS	17.76	13.64	12.93
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	114.6	120.2	125.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-60

CATALYST NUMBER : UCI L-1123 DATE : 3/27/81
ATOMIC FORMULA : Proprietary Catalyst

PREP METHOD: UCI prep. REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1), : 1.14 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2	3	4	5	6
TEST CONDITIONS :						
FEED H2/CO RATIO	2.04	2.04	2.04	2.04	2.04	2.04
FEED CO2	5.00	5.00	5.00	5.00	5.00	5.00
AVE. TEMP., C	306.0	349.0	352.0	349.0	351.0	350.0
HOT SPOT, C	307.0	352.0	353.0	349.0	351.0	351.0
PRESSURE, psig	1480.0	1480.0	1480.0	1470.0	1470.0	1470.0
VHSV, l/hr/kgm cat.	3100.0	4120.0	2960.0	2820.0	2770.0	1930.0
HOURS on STREAM	.4	2.1	3.3	4.8	6.1	6.8
RPM	.0	.0	.0	.0	.0	.0
CONVERSION :						
CO to Prods., vol%	22.42	20.91	21.55	12.70	12.14	14.39
CO to CO2, vol%	-.02	2.59	3.95	1.60	1.96	3.41
CO, gm mol/hr/kgm cat.	8.44	11.77	9.17	4.90	4.75	4.17
STY of oxygenates(2) gm mol/hr/kgm cat.	8.20	9.14	6.14	3.10	2.80	2.20
STOICHIOM. H2/CO converted	1.90	1.40	1.25	1.60	1.65	1.53
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :						
CH3OH	95.80	75.75	64.85	72.07	69.21	63.60
C2-C6 ALCOHOLS	1.30	9.67	12.07	7.55	7.66	8.91
C2-C6 ALD.&ESTERS	.00	1.91	2.25	1.01	.93	1.24
CH4	1.80	4.83	7.93	9.91	11.03	13.61
C2-C3 HYDROCARBONS	.30	2.70	5.80	5.52	6.15	7.55
C4+ HYDROCARBONS	.80	4.95	7.10	3.94	5.11	5.20
APPROACH TO(3) WGS Equilibrium, C						
CARBON ACCOUNTABILITY, % (4)	103.1	111.0	102.6	127.0	114.2	112.0

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-61

DATE : 3/30/81

CATALYST NUMBER : 217-29-3
ATOMIC FORMULA : $CuCoK_{.22}$
CATALYST SUPPORT :88.0% SiO_2

PREP METHOD: Evaporation Impregnation
REDUCTION: in Situ Reduction

BULK DENSITY(1): .38 gm/cc
REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.10	2.10
FEED CO2	11.00	11.00
AVE. TEMP., C	293.0	294.0
HOT SPOT, C	293.0	294.0
PRESSURE, psig	940.0	940.0
VHSV, 1/hr/kgm cat.	4915.0	4910.0
HOURS on STREAM	4.8	5.5
RPM	1500.0	1480.0
CONVERSION :		
CO to Prods., vol%	10.86	4.16
CO to CO2, vol%	.14	2.54
CO, gm mol/hr/kgm cat.	5.82	3.54
STY of oxygenates(2) gm mol/hr/kgm cat.	1.18	.38
STOICHIOM. H2/CO converted	2.33	3.16
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	1.52	1.77
C2-C6 ALCOHOLS	10.03	8.53
C2-C6 ALD.&ESTERS	9.02	6.76
CH4	23.10	26.06
C2-C3 HYDROCARBONS	26.85	29.44
C4+ HYDROCARBONS	29.58	29.44
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	104.8	231.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-63

CATALYST NUMBER : UCI L-1124 DATE : 4/6/81
ATOMIC FORMULA : Proprietary Catalyst

PREP METHOD: UCI preparation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.14 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	5.00	5.00
AVE. TEMP., C	359.0	360.0
HOT SPOT, C	359.0	360.0
PRESSURE, psig	1505.0	1500.0
VHSV, l/hr/kgm cat.	2480.0	2120.0
HOURS on STREAM	1.3	3.6
RPM	1500.0	1490.0
CONVERSION :		
CO to Prods., vol%	9.00	10.52
CO to CO2, vol%	.50	.88
CO, gm mol/hr/kgm cat.	2.95	3.00
STY of oxygenates(2) gm mol/hr/kgm cat.	2.30	2.20
STOICHIOM. H2/CO converted	2.15	1.85
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	70.33	68.26
C2-C6 ALCOHOLS	10.03	9.97
C2-C6 ALD.&ESTERS	4.01	4.12
CH4	4.44	5.74
C2-C3 HYDROCARBONS	2.22	3.25
C4+ HYDROCARBONS	8.98	8.67
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	122.0	106.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC.

SUMMARY FOR RUN # 213-64

CATALYST NUMBER : 217-22 (used) DATE : 4/8/81

ATOMIC FORMULA : $CuCoK_{.22}$

CATALYST SUPPORT : NONE

PREP METHOD: Coprecipitation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1): 1.52 gm/cc REACTOR TYPE: Plug Flow

TEST NUMBER	1	2
TEST CONDITIONS :		
FEED H2/CO RATIO	2.00	2.00
FEED CO2	11.00	11.00
AVE. TEMP., C	269.0	292.0
HOT SPOT, C	269.0	292.0
PRESSURE, psig	940.0	935.0
VHSV, l/hr/kgm cat.	4100.0	6840.0
HOURS on STREAM	1.5	3.0
RPM	.0	.0
CONVERSION :		
CO to Prods., vol%	7.51	10.45
CO to CO2, vol%	6.19	5.35
CO, gm mol/hr/kgm cat.	6.00	11.54
STY of oxygenates(2) gm mol/hr/kgm cat.	.95	2.50
STOICHIOM. H2/CO converted	.96	1.14
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :		
CH3OH	3.28	3.78
C2-C6 ALCOHOLS	8.21	9.37
C2-C6 ALD.&ESTERS	17.52	19.65
CH4	32.66	32.65
C2-C3 HYDROCARBONS	20.80	20.55
C4+ HYDROCARBONS	17.52	13.90
APPROACH TO(3) WGS Equilibrium, C		
CARBON ACCOUNTABILITY, % (4)	85.1	96.6

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

CHEM SYSTEMS INC

SUMMARY FOR RUN # 213-65

CATALYST NUMBER : 217-30 DATE : 4/9/81

ATOMIC FORMULA : $CuCoK_{.22}$

CATALYST SUPPORT :88.0% Na-Y Zeolite

PREP METHOD: Evaporation Impregnation REDUCTION: Reduced by 2% H2 in N2

BULK DENSITY(1) : .64 gm/cc REACTOR TYPE: Berty

TEST NUMBER	1	2	3
TEST CONDITIONS :			
FEED H2/CO RATIO	2.40	2.40	2.40
FEED CO2	11.00	11.00	11.00
AVE. TEMP., C	272.0	275.0	291.0
HOT SPOT, C	272.0	275.0	291.0
PRESSURE, psig	920.0	915.0	915.0
VHSV, l/hr/kgm cat.	3980.0	2310.0	2200.0
HOURS on STREAM	1.4	3.8	3.8
RPM	1490.0	1500.0	1500.0
CONVERSION :			
CO to Prods., vol%	6.52	11.74	18.66
CO to CO2, vol%	.48	1.06	1.74
CO, gm mol/hr/kgm cat.	3.01	3.20	4.85
STY of oxygenates(2) gm mol/hr/kgm cat.	.01	.01	.08
STOICHIOM. H2/CO converted	2.22	2.59	2.32
CARBON SELECTIVITY (Normalized Mol% on CO2-free Basis) :			
CH3OH	.43	.22	.33
C2-C6 ALCOHOLS	.11	.22	1.31
C2-C6 ALD.&ESTERS	.00	.11	.11
CH4	40.17	36.75	36.18
C2-C3 HYDROCARBONS	22.77	22.25	21.64
C4+ HYDROCARBONS	36.42	40.35	41.32
APPROACH TO(3) WGS Equilibrium, C			
CARBON ACCOUNTABILITY, % (4)	85.2	97.3	105.2

(1) Fresh, non-reduced catalyst.
(2) Space Time Yield (STY) = VHSV/22.4 * %CO in feed/100 * %CO conv./100 * %Sel to Oxygenates/100.
(3) Defined as T = T eq - T hs
where T eq = water gas shift equilibrium temp calculated for reactor eff. composition.
T hs = hot spot temperature.
(4) Defined as Carbon observed in Products to Feed Carbon Converted.

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