

Table 1. List of Co-based FT Catalysts Formulated

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.001	20%	1% Re	1% La ₂ O ₃ , 0.13% K	γ-alumina	U.S. Pat. 4,880,763	P
Co.002	20%	0.43% Ru	1% La ₂ O ₃	γ-alumina	U.S. Pat. 4,413,064	P
Co.003	20%	0.5% Ru	1% La ₂ O ₃	γ-alumina	U.S. Pat. 4,413,064	P
Co.004	20%	0.43% Ru	1% La ₂ O ₃	γ-alumina	Reproduce Co.002	P
Co.005	20%	0	0	γ-alumina	Base Catalyst	P
Co.005A	20%	0.4% Ru	0	γ-alumina	Ru added to calcined Co.005 by IW impreg.	P
Co.006	12%	0.75% Re	0	Titania	U.S. Pat. 4,794,009	P
Co.007	20%	0	0	Titania	Base Catalyst	P
Co.008	20%	0	0	Silica	UK Pat. Appl. GB 2 125 062 A (Kneaded with excess liquid)	P
Co.009	20%	0.5% Ru	0	γ-alumina	Ru-Promoted Catalyst (use Ru Chloride, single-step aqueous IW)	P
Co.010	20%	0	0	γ-alumina	Base Catalyst (non-calcined)	P
Co.010A	20%	0.4% Ru	0	γ-alumina	Ru added to dried Co.010 by IW impreg.	P
Co.011	20%	0	0	Silica	UK Pat. Appl. GB 2 125 062 A (Kneaded)	P
Co.012	20%	0	0	Silica	Base Catalyst (Inc. Wetness)	P
Co.013	20%	0	0	Titania	Base Catalyst like Co.007, but all aqueous	P
Co.014	12%	0.5% Ru	0	Titania	Ru-Promoted Catalyst (aqueous IW co- impregnation)	P
Co.015	20%	0.43% Ru	1% La ₂ O ₃	γ-Alumina	Similar to Co.002, but all aqueous	P
Co.016	20%	0.43% Ru	1% La ₂ O ₃	γ-Alumina	Similar to Co.015, but calcined after Co impregnation	P

Table 1. List of Co-based FT Catalysts Formulated (Contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.017	20%	0.5% Ru	1% La ₂ O ₃	γ-Alumina	Similar to Co.003, but all aqueous	P
Co.018	20%	0.5% Ru	0	γ-Alumina	Ru-Promoted Catalyst (single-step, aqueous IW)	P
Co.019	20%	0.5% Ru	0	Silica	Ru-Promoted Catalyst (single-step, aqueous IW)	P
Co.020	0	0.5% Ru	0	γ-Alumina	Ru Base Catalyst	P
Co.020A	20%	0.4% Ru	0	γ-Alumina	Co added to dried Co.020 by IW impreg.	P
Co.020B	20%	0.4% Ru	0	γ-Alumina	Co added to reduced Co.020 by IW impreg.	P
Co.020C	20%	0.4% Ru	0	γ-Alumina	Co added to calcined Co.020 by IW impreg.	P
Co.021	20%	0	0.7% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (single-step)	P
Co.022	20%	0	0.7% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (multiple-steps)	P
Co.023	20%	0	1.4% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (multiple-steps)	P
Co.024	20%	0	8.5% Zr	Silica	Eur. Pat. Appl. 0 167 215 A2 (non-aqueous Zr pre-impregnation)	P
Co.025	20%	0	8.5% Zr	Silica	Similar to Co.024 but aqueous Zr pre-impregnation	P
Co.026	20%	0	0	Silica (Davison Grade 59)	Similar to Co.012 but different grade silica	P
Co.027	20%	0.5% Ru	0	Silica (Davison Grade 59)	Similar to Co.019 but different grade silica	P
Co.028	20%	0.5% Ru	0.5% K	γ-alumina	Ru- and K-Promoted Catalyst (single-step IW)	P
Co.029	30%	0.5% Ru	0.5% K	γ-alumina	Similar to Co.028 but 30% Co	P

Table 1. List of Co-based FT Catalysts Formulated (Contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.030	20%	0	0.1% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.031	20%	0	1.4% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.032	20%	0	8.5% Zr	γ -alumina	Zr-Promoted Catalyst (aqueous IW co-impregnation)	P
Co.033	20%	0	8.5% Zr	γ -alumina	multiple-steps, aqueous IW, Co pre-impregnation	P
Co.034	20%	0	8.5% Zr	γ -alumina	multiple-steps, aqueous IW, Zr pre-impregnation	P
Co.035	20%	0	8.5% Zr	Silica	Zr-Promoted Catalyst (single-step aqueous, kneaded)	P
Co.036	20%	0	8.5% Zr	Silica	multiple-steps, aq. Co pre-impreg. by kneading, aqueous IW Zr impreg.	P
Co.037	12%	0	0	Titania	Similar to Co.013, but TiO ₂ mainly anatase	P
Co.038	12%	0.5% Ru	0	Titania	Similar to Co.014, but TiO ₂ mainly anatase	P
Co.039	12%	0	0	Titania	Similar to Co.007, but only 12% Co	P
Co.040	12%	0	0	Titania	Similar to Co.013, but only 12% Co	P
Co.041	20%	0.5% Ru	8.5% Zr	Silica	Similar to Co.025, but Ru-promoted	P
Co.042	0	0	8.5% Zr	Silica	Blank Zr-promoted SiO ₂	P
Co.043	20%	0.5% Ru	8.5% Zr 0.5% K	Silica	Similar to Co.041, but K-promoted	P
Co.044	20%	0	15% Zr	Silica	Similar to Co.025, but 15% Zr	P
Co.045	20%	0	4% Zr	Silica	Similar to Co.025, but 4% Zr	P
Co.046	12%	0.75% Re	4% SiO ₂	Titania	Similar to Co.006, but SiO ₂ -promoted	-

Table 1. List of Co-based FT Catalysts Formulated (Contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.047	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.028, but 0.3% K	P
Co.048	20%	0.5% Ru	8.5% Zr 0.3% K	Silica	Similar to Co.043, but 0.3% K	P
Co.049	20%	0.5% Ru	0.1% K	γ -alumina	Similar to Co.047, but 0.1% K	P
Co.050	20%	0.5% Ru	8.5% Zr 0.1% K	Silica	Similar to Co.048, but 0.1% K	P
Co.051	0	0.5% Ru	0	Titania (R)		P
Co.052	0	0.5% Ru	0	Titania (A)		P
Co.053	20%	0.5% Ru	0	γ -alumina	Similar to Co.018 (New Batch)	P
Co.054	20%	0	8.5% Zr 0.3% K	Silica	Similar to Co.043, but without Ru	P
Co.055	20%	1% Re	1% La ₂ O ₃	γ -alumina	Similar to Co.001, but without K	P
Co.056	20%	0	8.5% La ₂ O ₃	Silica	Similar to Co.025, but La instead of Zr	P
Co.057	20%	1% Re	1% La ₂ O ₃	Silica	Similar to Co.055, but with SiO ₂ support	P
Co.058	20%	0	1% La ₂ O ₃	γ -alumina	Similar to Co.055, but without Re (one-step impreg.)	P
Co.059	20%	0	1% La ₂ O ₃	γ -alumina	Similar to Co.015, but without Re (two-step impreg.)	P
Co.060	30%	0	0	γ -alumina	Similar to Co.005, but with 30% Co	P
Co.061	30%	0.5% Ru	0	γ -alumina	Similar to Co.053, but with 30% Co	P
Co.062	30%	0.5% Ru	1.5% K	γ -alumina	Similar to Co.029, but with 1.5% K	P
Co.063	20%	0	8.5% La	γ -alumina	Two-steps, aqueous IW, La pre-impregnation	P
CAL.01 (97E-13E)	20%	0.5% Ru	0	γ -alumina	Similar to Co.018 (Calsicat Prep.)	P
CAL.02 (97E-16B)	20%	0.5% Ru	0	γ -alumina	Similar to CAL.01 (New Batch)	P
CAL.03 (97E-13F)	20%	0.5% Ru	0	γ -alumina	2-step impreg., Similar to CAL.02	P

Table 1. List of Co-based FT Catalysts Formulated (Contd.)

CAT. NO.	wt% Co	wt% M.	wt% Prom.	Support	Basis	Prepared
CAL.04 (97E-50C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Stand. Calc. in Air	P
CAL.05 (97E-50D)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Stand. Calc. in N ₂	P
CAL.06 (97E-51A)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Red. and Pas. in Air	P
CAL.07 (97E-51B)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Red. and Protected in Paraffin (51.3% Cat. Conc.)	P
CAL.08 (97E-51C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Calc., Red. and Protected in Paraffin (54.4% Cat. Conc.)	P
CAL.09 (97E-69C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05, Reduced and Protected in Soya (51.7% Cat. Conc.)	P
CAL.10 (97E-79A)	20%	0.5% Ru	0.3% K	γ -alumina (Condea)	Similar to CAL.05, but on Condea Al ₂ O ₃	P

Table 2. List of Water-Gas Shift Catalysts and F-T Catalysts with WGS Function

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
WGS.01	0	5.0% Cu	0	γ -alumina	single-step, aqu. IW	P
WGS.02	0	5.0% Cu	10% Zn	γ -alumina	single-step, aqu. IW	P
WGS.03	0	5.0% Cu	4.0% Cr	γ -alumina	single-step, aqu. IW	P
WGS.04	0	0	4.0% Cr	γ -alumina	single-step, aqu. IW	P
WGS.05	0	0	4.0% Mn	γ -alumina	single-step, aqu. IW	P
WGS.06	0	5.0% Cu	4.0% Mn	γ -alumina	single-step, aqu. IW	P
WGS.07	0	4.0% Fe	0	γ -alumina	single-step, aqu. IW	P
WGS.08	0	4.0% Fe	4.0% Cr	γ -alumina	single-step, aqu. IW	P
WGS.09	0	5.0% Cu	4.0% Cr	γ -alumina	Similar to WGS.03	P
CoW.01	20%	5.0% Cu	10% Zn	γ -alumina	multiple-steps, aqu. IW, Cu,Zn pre-impr.	P
CoW.02	20%	5.0% Cu	4.0% Cr	γ -alumina	multiple-steps, aqu. IW, Cu,Cr pre-impr.	P
CoW.03	10%	5.0% Cu	4.0% Cr	γ -alumina	similar to CoW.02 (10% Co only)	P
CoW.04	10%	10% Cu	8.0% Cr	γ -alumina	similar to CoW.03; 10% Cu and 8% Cr	P
CoW.05	20%	5.0% Cu	4.0% Cr	γ -alumina	similar to CoW.02 with support calcined at 750°C	P
CoW.06	20%	5.0% Cu	4.0% Cr	Silica	multiple-steps, aqu. IW, Cu,Cr pre-impr.	P
CoW.07	20%	5.0% Cu	4.0% Cr	Silica	similar to CoW.06, but with support calcined at 750°C	P
CoW.08	30%	5.0% Cu	4.0% Cr	γ -alumina	Similar to CoW.05, but with 30% Co	P
CoW.09	20%	10.0% Cu	8.0% Cr	Silica	similar to CoW.06, but with 10% Cu and 8% Cr	P
CoW.10	10% Co, 10% Fe	0.5% Ru	0	γ -alumina	Single Step, IW	P
CoW.11	10% Co, 10% Fe	0.5% Ru	0.5% K	γ -alumina	Single Step, IW	P
CoW.12	10% Co, 10% Fe	0.5% Ru	0	Silica	Single Step, IW	P

Table 3. Summary of Physical Properties

CATALYST	Composition	BET Surface Area (m ² /g)	Pore Volume (cc/g)	Average Pore Dia. (Å)	Average Part. Size (µm)
Vista-B Al ₂ O ₃	(0-400 mesh)	299	1.69	269	24
Vista-B Al ₂ O ₃	Calcined 500°C	240	0.49	82	
Vista-B Al ₂ O ₃	Calcined 600°C	206	0.49	95	
Vista-B Al ₂ O ₃	Calcined 600°C	174	0.47	109	
Condea Al ₂ O ₃	(as received)	219	0.53	97	77
Davison SiO ₂	(0-400 mesh)	219	0.51	89	121
Degussa P25 TiO ₂	(as received)	47	0.40	335	6
Degussa P25 TiO ₂	Dried 60°C, Calc. 350°C/16hrs	46	0.48	419	51
Degussa P25 TiO ₂	Dried 60°C, Calc. 650°C/16hrs	12	0.17	573	212
Co.001	20Co/1Re/ 1La ₂ O ₃ /0.13K/A	191	0.31	66	42 40
Co.002	20Co/0.43Ru/ 1La ₂ O ₃ /A	149	0.33	89	74
Co.003	20Co/0.5Ru/ 1La ₂ O ₃ /A	122	0.26	87	77
Co.004	20Co/0.43Ru/ 1La ₂ O ₃ /A				78
Co.005	20Co/A	173	0.34	81	65 86
Co.006	12Co/0.75Re/T	16	-	-	121
Co.007	20Co/T	11	0.10	372	
Co.008	20Co/S	181	1.06	234	
Co.009	20Co/0.5/A				
Co.010	20Co/A				
Co.011	20Co/S	211	1.07	203	107
Co.012	20Co/S	211	-	-	105
Co.013	20Co/T				
Co.014	12Co/0.5Ru/T	15	0.12	328	111

Table 3. Summary of Physical Properties (contd.)

CATALYST	Composition	BET Surface Area (m ² /g)	Pore Volume (cc/g)	Average Pore Dia. (Å)	Average Part. Size (µm)
Co.015	20Co/0.43Ru/ 1La ₂ O ₃ /A	141	-	-	67
Co.016	20Co/0.43Ru/ 1La ₂ O ₃ /A	116	-	-	79
Co.017	20Co/0.5Ru/ 1La ₂ O ₃ /A	123	-	-	73
Co.018	20Co/0.5Ru/A	158	-	-	69
Co.019	20Co/0.5Ru/S				110
Co.021	20Co/0.7Zr/S	213	1.12	210	74
Co.023	20Co/1.4Zr/S	213	-	-	
Co.024	20Co/8.5Zr/S	215	1.08	202	
Co.025	20Co/8.5Zr/S	208	0.97	187	87
Co.026	20Co/S(59)	184	-	-	
Co.027	20Co/S(59)	189	-	-	
Co.028	20Co/0.5Ru/0.5K/A	161	0.33	82	80
Co.029	30Co/0.5Ru/0.5K/A	140	-	-	76
Co.031	20Co/1.4Zr/S				75
Co.032	20Co/8.5Zr/A	155	0.30	77	
Co.034	20Co/8.5Zr/A	150	0.31	83	
Co.035	20Co/8.5Zr/S	207	1.21	233	89
Co.036	20Co/8.5Zr/S	209	-	-	
Co.037	12Co/T(A)	38	-	-	
Co.039	12Co/T(R)	13	-	-	
Co.040	12Co/T				130
Co.041	20Co/0.5Ru/8.5Zr/S	214	-	-	-
Co.044	20Co/15Zr/S				92
Co.047	20Co/0.5Ru/0.3K/A	162	0.31-	78	83
Co.048	20Co/0.5Ru/0.3K/ 8.5Zr/S				82
Co.049	20Co/0.5Ru/0.3K/A				81

Table 3. Summary of Physical Properties (contd.)

CATALYST	Composition	BET Surface Area (m ² /g)	Pore Volume (cc/g)	Average Pore Dia. (Å)	Average Part. Size (μm)
Co.053	20Co/0.5Ru/A				75
Co.054	20Co/0.3K/8.5Zr/S				101
Co.055	20Co/1Re/ 1La ₂ O ₃ /A				86
Co.056	20Co/8.5La ₂ O ₃ /S				100
CAL.01	20Co/0.5Ru/A	178	0.34	76	
CAL.02	20Co/0.5Ru/A	158	-	-	74
CAL.03	20Co/0.5Ru/A	158	-	-	
CAL.04	20Co/0.5Ru/0.3K/A	151			72
CAL.05	20Co/0.5Ru/0.3K/A	163			73
CAL.06	20Co/0.5Ru/0.3K/A	162			72
CAL.07	20Co/0.5Ru/0.3K/A	-			
CAL.08	20Co/0.5Ru/0.3K/A	-			63
CAL.09	20Co/0.5Ru/0.3K/A				63
CAL.10	20Co/0.5Ru/0.3K/A	142	-	-	83

Table 4. H₂ Chemisorption and TPR Results

Catalyst	H ₂ Chemisorption ^a				H ₂ TPR	
	Total (μ mol H ₂ /g cat)	Irrevers. (μ mol H ₂ /g cat)	Average d_p^b (nm)	% Disp.	%Co Red. ^c (TPR calc. Cat.)	% Red. ^d (stand. red.)
Co.001	174 \pm 5	157 \pm 5		10.2		
Co.002	155	130		9.1		
Co.003	165	140		9.6		
Co.004 ^f (1)	205	185	7	12.1	91	
(2)	132	116	11	6.6	55	
(3)	144	123	10	7.2	46	
(4)	136	122	10	6.8	41	
Co.005	48	42	20	2.8	89	58
Co.005a	129	110	11	7.6	92	84
Co.006	44	32	19	4	80	
Co.007	33	23	36	2.0	78	78
Co.008						
Co.009	133	109	13	7.8	98	
Co.010						
Co.010a	124	100	12.5	7.3	91	89
Co.011	82	70	15.6	4.8	75	75
Co.012	89	74	15	5.2	80	80
Co.013	21	17	79	1.2	97	
Co.014	38	30	21	3.7	79	
Co.015	146	124	11.7	8.6	94	94
Co.016	163	146	10.5	9.6	96	96
Co.017	202	183	8.5	11.9	97	97
Co.018	185	165	9.2	11	97	94

Table 4. H₂ Chemisorption^a and TPR Results (contd.)

Catalyst	H ₂ Chemisorption ^a				TPR	
	Total (μ mol H ₂ /g cat)	Irrev. (μ mol H ₂ /g cat)	Average d_p^b (nm)	% Disp.	%Co Red: ^c (TPR calc. Cat.)	% Red: ^d (stand. red.)
Co.018-Cl					95	
Co.019	112	92		6.6		
Co.020						
Co.020a	153	126	10	9.1	88	
Co.020b	134	113	11	7.9	86	
Co.020c	115	100	13	6.8	88	
Co.021	74	50		4.3		
Co.022	141	122		8.3	80	
Co.023	158	136		9.3	81	
Co.024	87	72		5.1	91	
Co.025	93	77		5.5	75	
Co.026						
Co.027						
Co.028	170	148		10		
Co.029	175	155		7		
Co.030						
Co.031	71	51	20	4.2	82	
Co.032	55	39	26	3.2	85	
Co.033	43	32	31	2.5	79	
Co.034	114	91	14	6.7	96	
Co.035	125	115	11	7.2	82	
Co.036	122	98		7.2		

Table 4. H₂ Chemisorption^a and TPR Results (contd.)

Catalyst	H ₂ Chemisorption ^a				TPR	
	Total (μ mol H ₂ /g cat)	Irrev. (μ mol H ₂ /g cat)	Average d_p^b (nm)	% Disp.	%Co Red. ^c (TPR calc. Cat.)	% Red. ^d (stand. red.)
Co.037	21	3	48	2	99	
Co.038	45	35	21	4.3	91	
Co.039	19	16	40	1.8	72	
Co.040	14	11	53	1.4		
Co.041	70	55		4		
Co.043	137	109		8	86	
Co.053 ^b	(1) 168 (2) 101 (3) 138	139 76 117	8 14 10	8.4 5.2 6.9	60 82 47	
Co.054					57	
Co.055 ^h	(1) 165 (2) 179 (3) 103 (4) 192	139 163 84 165	8.5 8 14 7	8.3 9.0 5.2 9.6	78 50 76 -	
Co.056					58	
CAL.01	-	-	58 ^e	4.4 ^e	54	
CAL.02	-	-	63 ^e	5.1 ^e	55	
CAL.03	-	-	57 ^e	4.2 ^e	85	
CAL.04			55 ^e	3.5 ^e		
CAL.05			56 ^e	4.4 ^e		
CAL.06			57 ^e	4.2 ^e		
CAL.10			72 ^e	3.7 ^e		

(a) static H₂ chemisorption at 100°C(b) Est. assuming $H_{tot}/Co_s = 1$, $5.46 \times 10^{-20} \text{ m}^2/Co_s$, and $d_p = 5/S_{Co}/\rho$
S_{Co} is based on amt. Co reducible during standard reduction

(c) % Co reducible from TPR of calcined catalysts up to 900°C

(d) % Co reduced after standard reduction procedure

(e) Based on CO chemisorption

(f) (1)=uncalcined; (2)=calcined in air and reduced in H₂; (3)=calcined in He; (4)calcined in nitrogen

(g) (1) and (2)=uncalcined

(h) (1) and (3)=calcined in air; (2)=calcined in nitrogen; (4)=uncalcined

(i) Catalyst Co.018-Cl is chlorinated.

Table 5. Summary of fixed bed reaction results

Catalyst	Run	Prep	CO Conv (%)	Rate g CH ₂ /g cat/hr	R-C6+ g CH ₂ /g cat/hr	R (CO) mol/mol Co/s	wt% CH ₄	alpha	C3-C5 Ole/Par	CO ₂ (%) (CO)	g/g cat/hr	E act kcal/mol	Comment
Co.001	4	(1)	2.6	0.116	0.056	6.8E-04	19.6	0.76	8.61	0.4	0.061		NSH**
Co.002	4	(2)	6.7	0.258	0.082	1.5E-03	26.1	0.64	1.97	0.1	0.012		NS
Co.003	1	(3)	5.5	0.185	0.044	1.1E-03	30.8	0.57	4.22			28.9	old startup
Co.004	1	(2) s	4.3	0.291	0.086	1.7E-03	30.4	0.62	2.77	0.1	0.025	25.9	NSH
"	2	u	11.2	0.517	0.155	3.0E-03	28.9	0.61	1.02	0.1	0.038		NSH
"	2h	u	47.6	0.548	0.211	3.2E-03	21.9	0.64	0.40	2.3	0.090		NSH, high conv. study
"	2a	f	3.8	0.177	0.063	1.0E-03	25.5	0.65	3.02	0.1	0.024		NSH, calc. after run 2, T surge
"	3	u	6.7	0.499	0.153	2.9E-03	27.8	0.61	1.45	0.1	0.036		NSH
"	3h	u	27.0	0.506	0.164	3.0E-03	27.3	0.62	0.46	0.8	0.048		NSH, high conv. study
"	4	u	1.8	0.427	0.241	2.5E-03	24.0	0.79	2.40	0.1	0.078		NSH, 10 atm
"	5	f	4.5	0.288	0.150	1.7E-03	19.4	0.75	7.84	0.1	0.03		NSH
"	6	n	6.9	0.466	0.151	2.7E-03	27.8	0.61	1.60	0.2	0.044		NSH
"	7	ROR	3.9	0.225	0.072	1.3E-03	28.8	0.61	3.01	0.2	0.042		NSH
"	8	He	5.8	0.399	0.144	2.3E-03	27.2	0.66	2.13	0.1	0.028		NSH
Co.005	2	(1)	3.3	0.087	0.037	5.1E-04	21.4	0.66	3.40	0.1	0.005		NS
"	2a		2.5	0.066	0.021	3.9E-04	25.9	0.59	4.92	0.1	0.004		CO:H ₂ :Ar = [2:2
"	2b		2.4	0.064	0.021	3.7E-04	26.3	0.60	6.22	0.1	0.006		+ H ₂ O (eq. 7.5% CO conv.)
"	3		3.3	0.077	0.024	4.5E-04	28.4	0.62	2.29	0.1	0.013		NSH
"	4		4.0	0.069	0.021	4.0E-04	30.0	0.62	2.16	0.2	0.009	25.1	NSH
"	5		3.9	0.171	0.084	1.0E-03	26.8	0.76	2.59	0.1	0.018		NSH, 10 atm
"	6		2.1	0.129	0.044	7.6E-04	25.7	0.64	5.53	0.1	0.017		NSH
"	7		6.7	0.084	0.040	4.9E-04	18.8	0.70	1.95	0.1	0.003		S2
Co.005a	1	(4a)	3.2	0.227	0.067	1.3E-03	30.0	0.60	3.05	0.1	0.034		NSH
Co.005b	1	(1)	2.4	0.040	0.024	2.3E-04	13.9	0.74	0.55	0.4	0.023		S2, 1/4WGS.03+3/4Co.005
Co.005c	1	(1)	5.7	0.071	0.031	4.1E-04	20.3	0.68	0.21	1.8	0.076		S2, 1/2WGS.03+1/2Co.005
Co.006	1	(5)	2.7	0.052	0.007	5.1E-04	45.0	0.49	1.90	0.1	0.006		NSH
Co.007	1	(5)	3.2	0.024	0.003	1.4E-04	49.8	0.50	0.72	0.2	0.004		NSH
Co.009	1	(1)	4.9	0.346	0.090	2.0E-03	31.1	0.57	1.69	0.1	0.020		NSH
"	2		4.9	0.338	0.091	2.0E-03	31.1	0.58	1.64	0.1	0.026		NSH
Co.010a	1	(4b) s	3.5	0.246	0.076	1.4E-03	29.5	0.62	2.58	0.2	0.040		NSH
"	2		4.1	0.262	0.080	1.5E-03	30.0	0.61	2.31	0.1	0.022		NSH
Co.011	2	(6b)	2.9	0.094	0.037	5.5E-04	22.4	0.61	4.83	0.3	0.030		NSH
Co.012	1	(1)	3.8	0.083	0.027	4.8E-04	26.3	0.64	4.40			22.5	slow CO startup (60 min)
"	2		4.4	0.085	0.030	5.0E-04	29.1	0.64	1.93	0.3	0.018		NSH
"	3		2.1	0.081	0.026	4.7E-04	28.6	0.66	3.57	0.4	0.049		NSH
"	4		2.5	0.105	0.035	6.2E-04	28.4	0.61	4.94	0.4	0.023		NSH
Co.014	1	(1)	1.5	0.028	0.009	2.8E-04	32.3	0.63	4.70	0.1	0.003		NSH
"	2		2.6	0.034	0.013	3.3E-04	27.7	0.69	10.8	0.1	0.011	26.0	NSH
Co.015	1	(4) s	6.8	0.211	0.063	1.2E-03	26.7	0.60	3.30	0.1	0.011		slow CO startup (120 min)
"	2	f	7.0	0.388	0.135	2.3E-03	26.4	0.64	1.39	0.1	0.011		NSH
"	3	u	6.7	0.375	0.123	2.2E-03	28.2	0.63	1.62	0.2	0.011		NSH
Co.016	1	(4a) s	5.2	0.161	0.035	9.4E-04	33.6	0.56	6.85				slow CO startup (30 min)
"	2	f	5.1	0.291	0.112	1.7E-03	25.1	0.68	2.48	0.1	0.01		NSH

Table 5. Summary of fixed bed reaction results (contd.)

Catalyst	Run	Prep	CO Conv (%)	Rate g CH ₂ /g cat/hr	R-C6+ g CH ₂ /g cat/hr	R (CO) mol/mol Co/s	wt% CH ₄	alpha	C3-C5 Ole/Par	CO ₂ (%) (CO)	g/g cat/hr	Fact kcal/mol	Comment
Co.017	2	(1) s	4.6	0.139	0.066	8.2E-04	22.0	0.69	3.72	0.1	0.012		NS
"	2a	s	3.7	0.111	0.043	6.5E-04	25.9	0.64	4.19	0.1	0.011		CO:H ₂ :Ar = 1:2:2
"	2b	s	3.4	0.102	0.039	6.0E-04	26.9	0.65	4.39	0.1	0.013		+ H ₂ O (eq. 7.5% CO conv.)
"	3	f	4.9	0.274	0.111	1.6E-03	23.0	0.67	2.41	0.2	0.030		NSH, calc. flow air
Co.018	2	s	3.4	0.170	0.068	1.0E-03	27.2	0.69	2.24	0.1	0.013		NS
"	2a	s	2.7	0.133	0.041	7.8E-04	33.2	0.64	2.52	0.1	0.011		CO:H ₂ :Ar = 1:2:2
"	2b	s	3.0	0.147	0.045	8.6E-04	33.6	0.63	2.41	0.1	0.015		+ H ₂ O (eq. 7.5% CO conv.)
"	3	s	4.1	0.290	0.086	1.7E-03	30.0	0.62	2.34	0.1	0.022		NSH
"	4	s	3.6	0.340	0.180	2.0E-03	25.4	0.80	1.92	0.1	0.041		NSH, 10 atm
"	5	f	7.5	0.470	0.136	2.8E-03	29.0	0.60	1.93	0.3	0.055		NSH
"	6	f	6.5	0.409	0.147	2.4E-03	24.6	0.64	2.42				NSH,S2"
Co.018Cl	1	(1)	4.5	0.320	0.075	1.9E-03	33.5	0.57	1.45	0.1	0.018		NSH
Co.019	1	(1)s	4.4	0.088	0.047	5.2E-04	15.2	0.74	7.61				NS
"	2	s	2.2	0.085	0.046	5.0E-04	18.9	0.73	8.59	0.3	0.040		NSH
"	3	f	3.4	0.142	0.071	8.3E-04	19.3	0.72	6.74	0.2	0.025		NSH
"	3h	f	16.7	0.172	0.091	1.0E-03	18.2	0.74	1.77	1.0	0.034		NSH, high conv. study
Co.020a	1	(4) s	4.6	0.343	0.085	2.0E-03	33.5	0.57	1.70	0.1	0.024		NSH
"	2		4.4	0.315	0.086	1.8E-03	31.2	0.59	1.96	0.1	0.028		NSH
Co.020b	1	(4b) s	4.4	0.311	0.084	1.8E-03	31.7	0.58	1.81	0.2	0.051		NSH
Co.020c	1	(4a) s	4.0	0.287	0.083	1.7E-03	30.4	0.60	2.38	0.1	0.017		NSH
Co.021	1	(6b)	3.4	0.109	0.032	6.4E-04	27.3	0.62	2.78	0.1	0.012	28.2	NSH
"	2		3.6	0.114	0.035	6.7E-04	28.0	0.56	2.69	0.1	0.012		NSH
Co.022	1	(6c)	3.8	0.121	0.037	7.1E-04	26.7	0.55	2.91	0.1	0.015	30.1	NSH
Co.023	1	(6c)	3.8	0.123	0.038	7.2E-04	28.3	0.56	3.18	0.2	0.023	29.5	NSH
Co.024	1	(7)	5.1	0.165	0.047	9.7E-04	32.8	0.62	2.08	0.5	0.055		NSH
"	2		5.7	0.182	0.060	1.1E-03	28.7	0.62	2.25	0.3	0.035		NSH
Co.025	1	(4)	5.0	0.160	0.062	9.4E-04	23.5	0.63	4.13	0.2	0.019	26.9	NSH
Co.026	1	(1)	4.4	0.129	0.043	5.0E-04	26.9	0.62	2.65	0.2	0.022		NSH
"	1h		22.9	0.170	0.072	6.6E-04	22.6	0.67	0.64	1.5	0.037		NSH, high conv. study
Co.027	1	(1)	4.2	0.169	0.068	6.6E-04	23.0	0.65	3.44	0.2	0.026		NSH
"	1h		17.8	0.180	0.085	7.0E-04	19.4	0.71	0.96	1.2	0.011		NSH, high conv. study
Co.028	1	(4)	3.8	0.146	0.076	5.7E-04	18.2	0.76	7.63	0.2	0.031		NSH
"	2		4.3	0.167	0.105	6.5E-04	14.7	0.80	13.2	0.2	0.030	28.4	NSH
"	3		4.5	0.206	0.126	8.0E-04	15.5	0.79	13.4	0.2	0.037		NSH, re-calc. in flow air
Co.029	1	(4)	2.8	0.173	0.105	6.7E-04	15.3	0.79	25.9	0.2	0.026		NSH
Co.031	1	(1)	1.9	0.060	0.022	3.5E-04	26.1	0.64	4.65	0.3	0.031		NSH
Co.032	1	(1)	3.3	0.183	0.079	1.1E-03	22.0	0.70	5.28	0.1	0.022		NSH
Co.033	1	(1)	1.3	0.073	0.027	4.3E-04	24.1	0.67	7.36	0.1	0.020		NSH
Co.034	1	(4)	5.0	0.275	0.107	1.6E-03	24.0	0.67	4.29	0.1	0.018		NSH
Co.035	2	(6)	4.6	0.147	0.068	8.6E-04	22.0	0.69	4.84	0.2	0.019		NSH
Co.036	2	(6c)	3.9	0.125	0.045	7.3E-04	28.9	0.67	4.20	0.1	0.013		NSH
Co.037	1	(4a)	2.7	0.053	0.011	5.2E-04	32.8	0.59	2.82				NSH
Co.038	1	(4a)	4.5	0.051	0.018	4.9E-04	25.1	0.68	4.63	0.3	0.013	24.2	NSH

Table 5. Summary of fixed bed reaction results (contd.)

Catalyst	Run	Prep	CO Conv (%)	Rate g CH ₂ /g cat/hr	R-C6+ g CH ₂ /g cat/hr	R (CO) mol/mol Co/s	wt% CH ₄	alpha	C3-C5 Ole/Par	CO ₂ (%) g/g (CO)	E _{act} kcal/mol	Comment	
Co.039	1	(5)	1.1	0.021	0.004	2.0E-04	57.2	0.64	0.84	0.2	0.010	25.6	NSH, cracking in the line
"	2		3.9	0.049	0.007	4.7E-04	42.4	0.48	0.95	0.2	0.009		NSH
Co.040	1	(4a)	1.9	0.037	0.004	3.7E-04	45.2	0.53	1.79	0.2	0.007		NSH
"	2		2.8	0.033	0.004	3.3E-04	44.6	0.46	1.12	0.2	0.007		NSH
Co.041	1	(4)	3.5	0.136	0.042	8.0E-04	40.7	0.69	1.47	0.6	0.079		NSH, cracking in the line
Co.043	1	(4a)	4.6	0.104	0.062	6.1E-04	15.3	0.78	12.1	0.6	0.048		NSH, 2.5 hr on-stream
"	2		3.7	0.078	0.045	4.6E-04	16.3	0.78	7.75	0.5	0.035	35.1	NSH
Co.044	1	(4)	3.1	0.179	0.081	1.0E-03	22.7	0.73	5.16	0.3	0.020		NSH
Co.045	1	(4)	2.6	0.161	0.076	9.4E-04	22.2	0.73	6.89	0.3	0.022		NSH
Co.047	1	(4)	6.4	0.263	0.128	1.5E-03	21.3	0.73	7.20	0.3	0.040	26.6	NSH
Co.048	1	(4)	3.5	0.162	0.094	9.5E-04	16.3	0.77	17.1	0.2	0.027	28.0	NSH
Co.049	1	(4)	7.1	0.366	0.153	2.1E-03	23.4	0.69	5.63	0.3	0.043		NSH
"	2		6.0	0.388	0.160	2.3E-03	23.3	0.68	5.93	0.3	0.056		NSH, re-calcined in flow air
"	3	f	6.7	0.410	0.158	2.4E-03	25.2	0.69	4.64	0.3	0.059		NSH
"	3h	f	44.9	0.457	0.178	2.7E-03	26.5	0.67	0.67	3.8	0.131		NSH,HCS
Co.053	1	(1)	7.0	0.408	0.127	2.4E-03	27.3	0.62	3.07	0.2	0.049		NSH
"	1h		28.5	0.417	0.145	2.4E-03	26.8	0.64	0.79	1.6	0.081		NSH, high conv. study
"	2	f	6.6	0.433	0.174	2.5E-03	23.4	0.63	2.35	0.2	0.052		NSH
"	3		7.8	0.453	0.143	2.7E-03	27.6	0.62	1.67	0.1	0.027		NSH
"	3h		31.5	0.457	0.164	2.7E-03	25.4	0.65	0.52	0.9	0.044		NSH, high conv. study
"	4	u	6.1	0.426	0.142	2.5E-03	28.3	0.65	1.41	0.1	0.030		NSH
"	5	ROR	5.6	0.360	0.118	2.1E-03	27.9	0.64	1.49	0.2	0.034		NSH
"	6	f	8.2	0.485	0.163	2.8E-03	28.9	0.64	1.25	0.1	0.030		NSH
Co.054	1	(1)	1.2	0.041	0.023	2.4E-04	17.8	0.79	16.3	0.2	0.014		NSH
Co.055	1	(1) f	9.1	0.490	0.159	2.9E-03	28.9	0.63	1.31	0.2	0.034		NSH
"	2	u	4.9	0.290	0.105	1.7E-03	25.7	0.65	1.49	0.2	0.022		NSH, T surge
"	3	u	11.0	0.611	0.193	3.6E-03	29.4	0.60	1.02	0.2	0.033		NSH
"	4	u	5.9	0.380	0.124	2.2E-03	28.3	0.60	1.94	0.2	0.047		NSH
"	5	u	6.6	0.409	0.135	2.4E-03	29.6	0.59	1.83	0.2	0.030		NSH
"	6	ROR	7.5	0.469	0.145	2.7E-03	30.9	0.63	1.21	0.2	0.023		NSH
"	7	n	7.5	0.466	0.119	2.7E-03	33.5	0.60	1.11	0.2	0.031		NSH
Co.056	1	(1)	2.4	0.137	0.054	8.0E-04	23.9	0.69	8.22	0.1	0.029		NSH
"	2	u	2.2	0.137	0.054	8.0E-04	23.4	0.68	9.44	0.1	0.033		NSH
Co.057	1	(1)	2.8	0.171	0.078	1.0E-03	23.4	0.73	4.65	0.1	0.029		NSH
Co.060	1	(2)	3.8	0.244	0.097	1.4E-03	25.0	0.69	3.82	0.1	0.023		NSH
AL.01	1	(1)	4.8	0.181	0.068	1.1E-03	24.4	0.66	5.86	0.3	0.036		NSH, temp. surge (startup)
"	2		7.4	0.491	0.142	2.9E-03	28.7	0.61	2.06	0.4	0.083		NSH
"	3		2.5	0.164	0.053	9.6E-04	25.6	0.63	4.97	0.2	0.052		NSH, HT, re-reduced
"	4		7.3	0.483	0.103	2.8E-03	35.8	0.57	1.21	0.2	0.098		NSH, HT, re-calcined
AL.02	1	(1)	6.1	0.379	0.121	2.2E-03	27.3	0.63	3.04	0.2	0.040		NSH
AL.03	1	(1)	7.3	0.459	0.133	2.7E-03	29.0	0.60	2.59	0.2	0.048		NSH
AL.04	1	(1)	4.1	0.234	0.123	1.4E-03	19.1	0.71	8.98	0.2	0.026		NSH
AL.05	1	(1)	4.7	0.274	0.134	1.6E-03	20.8	0.75	6.85	0.2	0.026		NSH

Table 5. Summary of fixed bed reaction results (contd.)

Catalyst	Run	Prep	CO Conv (%)	Rate g CH ₂ /g cat/hr	R:C6+ g CH ₂ /g cat/hr	R (CO) mol/mol Co/s	wt% CH ₄	alpha	C3-C5 Ole/Par	CO ₂ (%) (CO)	g/g cat/hr	E. act. kcal/mol	Comment
CAL.06	1	(1)	5.8	0.267	0.135	1.6E-03	20.7	0.74	5.50	0.2	0.021		NSH
CAL.10	1	(1)	3.5	0.196	0.097	1.1E-03	23.5	0.74	1.75	0.2	0.045		NSH
CoW.01	1	(4a)	1.2	0.016	0.003	9.5E-05	30.2	0.58	3.78	0.2	0.006		NSH, reduced at 230 °C
"	1		0.5	0.007	0.001	3.4E-05	42.1	0.51	0.95	0.1	0.003		NSH, re-reduced at 350 °C
"	2		0.2	0.006	0.000	3.4E-05	40.9	0.51	11.3	0.1	0.006		NSH, reduced at 350 °C
CoW.02	1	(4a)	0.3	0.009	0.002	5.4E-05	25.6	0.60	4.94	0.1	0.008		NSH, reduced at 230 °C
CoW.03	1	(4a)											NSH, negligible activity
CoW.04	1	(4a)											S2, negligible activity
CoW.05	1	(4c)	2.8	0.035	0.006	2.1E-04	33.1	0.55	0.66	0.2	0.008		S2, reduced at 350 °C
"	2	u	4.7	0.058	0.011	3.4E-04	34.8	0.50	0.85	0.2	0.009		S2
CoW.06	1	(4a)	3.3	0.041	0.012	2.4E-04	26.0	0.59	2.21	0.2	0.007		S2, reduced at 250 °C
"	2	u	2.6	0.032	0.004	1.9E-04	39.3	-0.46	0.99	0.3	0.012		S2
"	2		17.0	0.207	0.004	1.2E-03	68.7	0.32	0.37	1.7	0.07		S2, rxn. at 280 °C
UOP	1	(1)	7.8	0.298	0.104	1.7E-03	22.6	0.61	1.29	0.2	0.023		NSH

action conditions: 220° C , H₂: CO = 2 , 1 atm

! the catalysts are reduced and passivated before loading into reactor, then rereduced in-situ

! catalysts are calcined at UPARC (static) : except where specified in prep. column

: calcined at Pitt, static

calcined at Pitt, flow

uncalcined

Nitrogen calcined

!R : catalyst is reduced ,calcined and rereduced before it is loaded

some cases, "re-calcined" means calcination of the calcined catalyst from UPARC for a longer period

single step, aqueous incipient wetness

Two step impregnation: aqueous incipient wetness of Co + acetone/ethanol impregnation of Ru, La

three step, with calcination after each step, acetone incipient wetness

two step, aqueous incipient wetness, (a) intermediate calcination, (b) intermediate reduction, (c) intermediate calcination 750 °C

single step, acetone impregnation

single step, aqueous kneading, (a) = 150%, (b) = 110% of pore volume

) aqueous kneading for Co, calcined, then aqueous incipient wetness for Zr

Two step impregnation :organic incipient wetness + aqueous incipient wetness

New startup

New startup, heated inlet

was done in the second system

Davison Grade 59 Silica, if not specified, S refers Davison Drade 952 Silica

corrected overheated line on 3/6/1994

COMPARISON OF CONVERSION AND SELECTIVITY OF
METHANE REDUCTION CATALYSTS AT STARTUP CONDITIONS

Period No.		Temp.	Pres.	H ₂ /CO Ratio									
-----		-----	-----	-----									
1		240 C	450psi	2.0									
Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Catalyst Prom%	Composit. Metal%	Suppt
					%CH ₄	%C ₂	%C ₃₊	%CO ₂					
M-4 SBCR													
3	Co.002	15.2	29.4	1.42	17.3	2.3	79.4	1.01	0.73	0.82	1.0La	0.43Ru	Al
4	Co.024	15.4	25.5	1.21	8.6	2.0	89.0	0.43	0.79	0.84	8.5Zr	0.0	Si
5	CO.035	15.4	24.8	1.18	8.5	2.1	89.0	0.47	0.78	0.84	8.5Zr	0.0	Si
6	CO.028	15.4	21.2	1.00	6.1	1.6	91.3	1.01	0.81	0.83	0.5K	0.5Ru	Al
7	CO.043	15.4	13.0	0.61	3.7	1.8	93.4	1.06	0.79	0.85	8.5Zr	0.5Ru	Si
											0.5K		
8	CO.006	15.0	2.7	0.13	0.1	0.2	98.0	1.75	0.67	0.85	0.0	0.75Re	Ti
9	CO.048	15.4	19.1	0.90	9.9	1.6	87.4	1.10	0.77	0.88	8.5Zr	0.5Ru	Si
											0.3K		
10	CAL.02	15.9	34.5	1.58	12.9	2.0	83.9	1.23	0.75	0.81	0.0	0.5Ru	Al
11	CAL.03	15.6	29.7	1.39	13.5	2.1	83.4	1.08	0.74	0.86	0.0	0.5Ru	Al
12	CO.053	15.9	34.2	1.56	12.6	2.0	84.2	1.23	0.75	0.83	0.0	0.5Ru	Al
13	CO.054	15.7	10.4	0.48	4.7	1.8	92.3	1.17	0.78	0.86	8.5Zr	0.0	Si
											0.3K		
14	BlendA	20.0	29.3	1.41	10.1	1.6	86.3	2.02	0.77	0.86	5.0Cu	4.0Cr	Al
15	Co.034	13.0	27.5	1.54	10.4	1.6	87.2	0.80	0.78	0.84	8.5Zr	0.0	Al
16	CAL.04	16.1	26.3	1.34	7.1	1.3	90.3	1.38	0.80	0.85	0.3K	0.5Ru	Al
17	CAL.08	15.0	16.9	0.93	5.9	0.8	91.7	1.36	0.82	0.88	0.3K	0.5Ru	Al
18	CAL.07	15.0	20.6	1.03	7.7	1.2	90.0	1.09	0.81	0.88	0.3K	0.5Ru	Al
19	CAL.05	15.7	26.6	1.22	7.3	1.3	90.2	1.19	0.82	0.86	0.3K	0.5Ru	Al
20	CAL.06	15.0	5.6	0.26	3.1	2.1	92.0	2.86	0.80	0.90	0.3K	0.5Ru	Al
21	CO.004	15.9	39.3	1.80	15.2	2.3	81.2	1.38	0.74	0.80	1.0La	0.43Ru	Al
22	BlendB	30.5	35.6	1.64	12.7	1.6	79.4	6.29	0.75	0.81	5.0Cu	4.0Cr	Al
23	CAL.09	15.0	17.4	0.84	0.02	1.2	97.9	0.95	0.84	0.88	0.3K	0.5Ru	Al
24	Co.053	28.5	50.4	1.28	14.1	2.1	81.8	2.03	0.75	0.79	0.0	0.5Ru	Al
25	CO.056	15.0	11.4	0.55	7.8	3.6	87.2	1.43	0.67	0.87	8.5La	0.0	Si
26	CAL.10	15.6	21.9	1.01	5.4	1.5	91.9	1.25	0.79	0.85	0.3K	0.5Ru	Al
27	Co.050	14.6	20.4	1.01	6.8	1.9	90.2	1.04	0.78	0.87	8.5Zr	0.5Ru	Si
											0.1K		

Note: Catalysts for all runs except Run 8 screened thru 150 x 400 mesh.
Catalyst for Run 8 screened thru 100 x 400 mesh.
Blend A contains 15.0 gm of Cat. No. Co.005 plus 5.0 gm of Cat. No. WGS.03.

Cat. Nos. CAL.07 and CAL.08 were prereduced and wax coated.
H₂ to CO ratio for Runs 16 and 17 was 1.76/1.0.
Cat. No. CAL.06 was H₂ reduced and air stabilized.
Blend B contains 15.0 gm of Cat. No. Co.005 plus 15.0 gm of Cat. No. WGS.03.
Cat. No. CAL.09 was prereduced and coated with Soya.
Cat. No. CAL.10 was prepared on Condea Alumina.

Table 7

SUMMARY OF H3 SBCR RUN RESULTS

a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using H2 as an internal standard in the GC analysis of the offgas.

d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraf		Olefins C6-18, %	Comments
												%CH4	%C2	%C3+	%CO2			C3	C4		
30	CO.053	29.6	1	26	39	240	450	2.0	20	41.8	1.02	22.6	2.9	71.5	3.05	0.66	0.77	0.99	0.65	19.6	
30	CO.053	29.6	2	55	63	260	450	2.0	20	46.9	1.11	40.6	5.5	46.0	7.98	0.45	--	0.83	0.64		
30	CO.053	29.6	3	79	87	280	450	2.0	20	41.4	0.96	41.9	6.5	42.0	9.63	0.40	--	2.06	1.35		
30	CO.053	29.6	4	103	111	240	450	2.0	20	19.9	0.49	19.2	3.6	75.8	1.45	0.64	--	4.29	2.50	--	
30	CO.053	29.6	5	131	135	265	450	2.0	20	36.4	0.89	36.4	5.2	54.4	4.04	0.53	--	2.45	1.60	--	
30	CO.053	29.6	6	154	159	280	450	2.0	20	39.6	0.96	48.3	5.9	39.0	6.84	0.40	--	2.44	1.62	--	
30	CO.053	29.6	7	174	183	300	450	2.0	20	40.7	0.94	42.4	6.8	40.7	10.2	0.47	--	3.11	2.03	--	
30	CO.053	29.6	8	198	207	309	450	2.0	20	38.3	0.85	22.8	7.3	58.3	11.6	0.62	--	3.76	2.48	--	G.C. Calib
30	CO.053	29.6	9	220	231	310	450	2.0	20	37.5	0.87	55.5	7.2	25.5	11.8	0.13	--	3.93	2.67	--	
30	CO.053	29.6	10	242	254	320	450	2.0	20	40.8	0.90	61.7	7.4	14.5	16.4	0.00	--	3.62	2.63	--	
30	CO.053	29.6	11	270	279	320	450	1.0	20	30.8	0.92	42.9	6.0	26.9	24.2	0.30	--	5.68	4.28	--	

Table 8

SUMMARY OF M4 SBCR RUN RESULTS

a)Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b)Conversion is total CO conversion over the period (Z).

c)Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas.

d)Prod. rate: Rate for production of total hydrocarbons,C1+ (kg/kg cat.,hr).

e)Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraf		Olefins	Comments
												IC3H4	IC2	IC3+	IC02			C3	C4	C5-18,Z	
24	CO.053	28.5	1	23	39	240	450	2.0	20	50.4	1.28	14.1	2.1	81.8	2.03	0.75	0.79	1.14	0.68	--	G.C.Calib
24	CO.053	28.5	2	54	63	250	450	2.0	20	53.5	1.34	24.2	3.6	67.9	4.24	0.66	--	0.66	0.48	--	
24	CO.053	28.5	3	78	87	260	450	2.0	30	55.3	1.36	38.2	5.2	49.0	7.64	0.53	--	0.53	0.47	--	
24	CO.053	28.5	4	102	110	260	450	2.0	30	52.8	2.13	29.1	4.0	62.1	4.79	0.64	--	0.68	0.49	--	
24	CO.053	28.5	5	126	135	260	450	2.0	30	58.9	1.90	28.5	3.9	62.8	4.90	0.65	--	0.70	0.48	--	
24	CO.053	28.5	6	146	158	260	450	2.0	30	42.6	1.74	26.9	3.8	66.3	2.96	0.65	--	0.99	0.67	--	
24	CO.053	28.5	7	175	182	260	450	2.0	30	51.5	1.31	31.6	4.5	60.0	3.90	0.60	--	0.94	0.65	--	
24	CO.053	28.5	8	199	208	260	450	2.0	30	58.1	1.89	27.6	3.7	65.1	3.67	0.66	--	0.88	0.56	--	
24	CO.053	28.5	9	218	231	260	450	2.0	30	62.9	2.05	23.2	3.0	70.6	3.20	0.71	--	0.93	0.58	--	
24	CO.053	28.5	10	259	263	275	450	2.0	30	72.1	2.24	39.1	5.0	46.4	9.53	0.57	--	0.41	0.34	--	
24	CO.053	28.5	11	290	304	260	450	2.0	30	48.8	1.62	29.0	3.8	65.4	1.83	0.65	--	1.78	1.09	--	

Feed Gas Rates

Per No	N2 SLH	H2 SLH	CO SLH	Total SLH
1	563	225	112	900
2	563	225	112	900
3	563	225	112	900
4	360	360	180	900
5	288	288	144	720
6	540	360	180	1080
7	563	225	112	900
8	200	288	144	632
9	108	288	144	540
10	108	288	144	540
11	108	288	144	540

Table 9

SUMMARY OF M3 SBCR RUN RESULTS

a)Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b)Conversion is total CO conversion over the period (%).

c)Conversion and selectivities are calculated using H2 as an internal standard in the GC analysis of the offgas.

d)Prod. rate: Rate for production of total hydrocarbons,C1+ (kg/kg cat.,hr).

e)Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities %				Alpha GC	Alpha Liq	Olefin/Paraf C3	C4	Olefins C6-C18,%	Comments
33	Co.053	31.4	1	24	39	240	450	2.0	20	41.4	0.94	23.2	3.1	69.6	4.06	0.65	0.76	0.82	0.58	21.7	G.C.Calib
33	Co.053	31.4	2	54	63	240	300	2.0	20	35.2	0.47	29.9	3.9	59.6	6.57	0.55	--	0.89	0.70	--	
33	Co.053	31.4	3	78	87	240	300	2.0	20	38.7	0.38	31.1	3.9	57.5	7.48	0.54	--	0.97	0.71	--	
33	Co.053	31.4	4	102	111	250	300	2.0	20	39.6	0.38	43.1	4.6	41.1	11.3	0.38	--	0.99	0.77	--	
33	Co.053	31.4	5	126	135	260	300	2.0	20	37.7	0.37	42.1	4.6	42.4	10.9	0.42	--	1.76	1.21	--	
33	Co.053	31.4	6	150	159	260	450	2.0	20	45.0	0.44	43.2	4.8	40.9	11.1	0.44	--	1.35	0.95	--	
33	Co.053	31.4	7	174	183	260	450	2.0	20	45.7	0.73	46.4	4.6	40.2	8.77	0.43	--	1.06	0.77	--	
33	Co.053	31.4	8	198	207	260	450	2.0	20	49.2	0.98	44.4	4.3	43.5	7.84	0.51	--	0.87	0.65	--	
33	Co.053	31.4	9	222	230	240	450	2.0	20	16.1	0.38	33.7	4.8	59.2	2.24	0.35	--	3.14	1.91	--	

Feed Gas Rates

Per No	H2 SLH	H2 SLH	CO SLH	Total SLH
1	563	225	112	900
2	338	135	67	540
3	250	100	50	400
4	250	100	50	400
5	250	100	50	400
6	250	100	50	400
7	160	160	80	400
8	100	200	100	400
9	563	225	112	900

Table 10

SUMMARY OF M4 SBCR RUN RESULTS

- a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.
- b) Conversion is total CO conversion over the period (Z).
- c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas.
- d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat.,hr).
- e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt.,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraf C3	Olefins C4	Comments C5-18,Z
26	CAL.10	15.6	1	23	39	240	450	2.0	20	21.9	1.01	5.4	1.5	91.9	1.25	0.79	0.85	3.60	2.27	25.9
26	CAL.10	15.6	2	54	63	240	450	2.0	20	21.7	1.30	8.3	1.1	89.9	1.10	0.80	--	3.78	2.45	--
26	CAL.10	15.6	3	78	87	240	450	2.0	20	17.2	1.04	11.7	1.4	86.1	1.39	0.76	--	3.57	2.30	--
26	CAL.10	15.6	4	102	111	240	450	2.0	20	17.7	1.01	11.9	1.4	86.0	1.40	0.77	--	3.52	2.28	--
26	CAL.10	15.6	5	118	126	240	450	2.0	20	16.2	0.75	4.9	1.7	92.3	1.10	0.77	--	4.29	2.75	--

Feed Gas Rates

Per No	N2 SLH	H2 SLH	CO SLH	Total SLH
1	563	225	112	900
2	108	288	144	540
3	54	288	144	486
4	25	274	137	436
5	563	225	112	900

Table 11

DATE: 12/30/94

COMPARISON OF CONVERSION AND SELECTIVITY OF
CALCICAT PRODUCED CATALYSTS AT STARTUP CONDITIONS

Period No.	Temp.	Pres.	H ₂ /CO Ratio
1	240 C	450psi	2.0

a) Total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.

Flows: N₂-563 SLH, H₂-225 SLH, CO-112.5 SLH

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas.

d) Prod. rate: Rate for production of total hydrocarbons C₁+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Catalyst Prom%	Composit. Metal%	Suppt
					%CH ₄	%C ₂	%C ₃ +	%CO ₂					
M-4 SBGR													
10	CAL.02	15.9	34.5	1.58	12.9	2.0	83.9	1.23	0.75	0.81	0.0	0.5Ru	Al
11	CAL.03	15.6	29.7	1.39	13.5	2.1	83.4	1.08	0.74	0.86	0.0	0.5Ru	Al
16	CAL.04	16.1	26.3	1.34	7.1	1.3	90.3	1.38	0.80	0.85	0.3K	0.5Ru	Al
17	CAL.08	15.0	16.9	0.93	5.9	0.8	91.7	1.36	0.82	0.88	0.3K	0.5Ru	Al
18	CAL.07	15.0	20.6	1.03	7.7	1.2	90.0	1.09	0.81	0.88	0.3K	0.5Ru	Al
19	CAL.05	15.7	26.6	1.22	7.3	1.3	90.2	1.19	0.82	0.86	0.3K	0.5Ru	Al
20	CAL.06	15.0	5.6	0.26	3.1	2.1	92.0	2.86	0.80	0.90	0.3K	0.5Ru	Al
23	CAL.09	15.0	17.4	0.84	0.1	1.2	97.9	0.95	0.83	0.88	0.3K	0.5Ru	Al
26	CAL.10	15.6	21.9	1.01	5.4	1.5	91.9	1.25	0.79	0.85	0.3K	0.5Ru	Al

M-3 SBGR

12	CO.018	15.6	33.8	1.56	9.7	2.0	86.6	1.68	0.75	0.85	0.0	0.5Ru	Al
23	CO.047	15.8	28.2	1.29	7.7	1.5	89.3	1.47	0.79	0.84	0.3K	0.5Ru	Al

Note: Catalysts for all runs except Runs 17, 18, & 20 screened thru 150 x 400 mesh.

Catalyst CAL.04 was calcined in air; Catalyst CAL.05 processed in N₂.

Cat. No. CAL.06 was H₂ reduced and air stabilized before charging.

Cat. Nos. CAL.08 and CAL.07 were prereduced and wax coated. CAL.08 was calcined in N₂; CAL.07 was reduced in H₂ without prior calcination.

H₂ to CO ratio for Runs 16 and 17 was 1.76/1.

Cat. Nos. Co.018 & Co.047 were prepared by Pitt. Shown for comparison.

Cat. No. CAL.09 was prereduced and coated with Soya.

Cat. No. CAL.10 was prepared on Condea Alumina.

COMPARISON OF CONVERSION AND SELECTIVITY OF
METHANE REDUCTION CATALYSTS AT STARTUP CONDITIONS

Period No.	Temp.	Pres.	H2/CO Ratio										
-----	-----	-----	-----										
1	240 C	450psi	2.0										
Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Catalyst Prom%	Composit. Metal%	Suppt
-----	-----	-----	-----	-----	%CH4	%C2	%C3+	%CO2	-----	-----	-----	-----	-----
M-3 SBCR													
5	CO.003	15.1	31.7	1.53	16.7	2.4	79.8	1.16	0.71	--	1.0La	0.5Ru	Al
6	CO.011	15.3	14.3	0.67	7.6	1.6	89.4	1.42	0.78	0.83	0.0	0.0	Si
7	CO.012	15.8	13.9	0.63	6.1	1.5	90.6	1.74	0.80	0.89	0.0	0.0	Si
8	CO.015	15.0	28.3	1.37	12.7	2.0	84.1	1.24	0.76	0.80	1.0La	0.43Ru	Al
9	CO.011	15.0	18.5	0.89	8.8	1.7	88.8	0.77	0.78	0.83	0.0	0.0	Si
11	CO.017	15.0	27.2	1.32	11.2	1.8	85.9	1.14	0.77	0.80	1.0La	0.5Ru	Al
12	CO.018	15.6	33.8	1.56	9.7	2.0	86.6	1.68	0.75	0.85	0.0	0.5Ru	Al
13	CO.016	14.7	26.4	1.31	(1)	1.7	89.3	0.68	0.78	0.81	1.0La	0.43Ru	Al
14	CO.019	15.2	13.9	0.66	(2)	1.7	97.2	0.70	0.80	0.86	0.0	0.5Ru	Si
15	CO.005	14.7	27.1	1.34	7.9	1.6	89.7	0.82	0.79	0.82	0.0	0.0	Al
16	CO.002	15.4	30.1	1.42	12.5	2.5	83.9	1.09	0.75	0.80	1.0La	0.43Ru	Al
17	CO.025	15.6	26.6	1.24	10.7	2.1	86.4	0.82	0.76	0.82	8.5Zr	0.0	Si
18	CO.004	15.0	33.9	1.64	15.3	2.4	80.9	1.37	0.74	0.79	1.0La	0.43Ru	Al
19	CO.021	15.6	23.2	1.08	9.4	2.0	88.0	0.73	0.77	0.82	0.7Zr	0.0	Si
20	CO.041	15.8	25.3	1.16	11.0	2.1	86.0	0.88	0.76	0.84	8.5Zr	0.5Ru	Si
21	CO.014	15.1	8.5	0.40	8.3	3.5	85.8	2.43	0.74	0.83	0.0	0.5Ru	Ti
22	CO.040	14.5	1.8	0.09	0.0	4.0	94.1	1.89	0.71	0.82	0.0	0.0	Ti
23	CO.047	15.8	28.2	1.29	7.7	1.5	89.3	1.47	0.79	0.84	0.3K	0.5Ru	Al
24	CO.049	15.6	30.6	1.41	10.9	1.8	85.7	1.66	0.76	0.82	0.1K	0.5Ru	Al
25	CO.047	15.6	28.1	1.30	8.8	1.6	88.1	1.50	0.78	0.85	0.3K	0.5Ru	Al
26	CO.031	15.9	30.9	1.41	12.1	1.9	84.9	1.12	0.75	0.83	1.4Zr	0.0	Al
27	CO.029	15.9	28.3	1.27	8.3	1.6	87.9	2.21	0.77	0.84	0.5K	0.5Ru	Al
28	COW.01	15.0	1.1	0.05	0.0	12.	83.9	4.23	0.58	--	5.0Cu	10.0Zn	Al
29	CO.053	25.2	42.0	1.19	15.8	2.3	79.5	2.42	0.73	--	0.0	0.5Ru	Al
30	CO.053	29.6	41.8	1.02	22.6	2.9	71.5	3.05	0.66	0.77	0.0	0.5Ru	Al
31	CO.055	15.0	30.0	1.46	23.7	3.7	70.2	2.30	0.61	0.81	1.0La	1.0Re	Al
32	CO.044	16.4	20.9	0.93	6.7	1.9	90.8	0.56	0.77	0.83	15.0Zr	0.0	Si
33	CO.053	31.4	41.4	0.94	23.2	3.1	69.6	4.06	0.65	0.76	0.0	0.5Ru	Al
34	CO.060	15.6	31.4	1.46	14.0	2.3	82.2	1.48	0.75	0.79	0.0	0.0	Al

Note: Catalyst Run 9 screened thru 170 x 400 mesh.

Catalysts For Runs 11 through 28 (except Runs 21 and 22) screened thru 150x 400 mesh.

Catalysts for Runs 21 and 22 screened thru 100 x 400 mesh.

Catalysts Nos. Co.029 and Co.060 contained 30 wt% cobalt.

G.C. Problems

- (1) Weak TCD filaments in G.C. CH4 peaks smaller than expected.
- (2) Internal valve in G.C. leaked. CH4 peak undetected.

SBCR CATALYST EXTRACTIONS

Catalyst No. (Support)	Run No.	Charge		Recovered (Oxidized) wt, gm	Charge		Recovered		Reduction in Particle Size, %
		(H ₂ Reduced) wt, gm	Particle Size, mvd, microns		Particle Size at 10% microns	Particle Size at 10% microns	Particle Size at 10% microns		
Co.001 (Al)	1	14.5	42.02	12.63	42.02	24.25	41.06	23.62	2.3
Co.001 (Al)	2	16.5	42.02	15.18	42.02	24.25	40.09	22.86	4.6
Co.005 (Al)	3	19.5	85.66	18.41	85.66	30.46	64.53	31.27	24.7
Co.002 (Al)	4	20.1	73.61	20.4	73.61	32.86	71.19	33.50	3.3
Co.003 (Al)	5	15.1	76.81	14.54	76.81	34.40	72.57	34.25	5.5
Co.011 (Si)	6	15.3	107.09 (1)	16.03	107.09 (1)	53.19	94.02	40.44	12.2
Co.012 (Si)	7	15.8	105.22 (1)	14.73	105.22 (1)	51.33	101.37	44.44	3.7
Co.015 (Al)	8	15.0	75.63 (1)	15.52	75.63 (1)	33.15	74.68	32.68	1.3
Co.011 (Si)	9	15.0	79.88 (2)	15.92	79.88 (2)	48.31	72.44	36.31	9.3
Co.016 (Al)	10	15.5	64.60 (2)	15.72	64.60 (2)	32.16	64.38	32.78	0.3
Co.017 (Al)	11	15.0	73.14 (3)	15.09	73.14 (3)	36.29	69.95	35.62	4.4
Co.018 (Al)	12	15.6	62.89 (3)	16.97	62.89 (3)	32.56	68.16	34.74	---
Co.016 (Al)	13	14.7	67.69 (3)	13.30	67.69 (3)	35.05	64.79	34.20	4.3
Co.019 (Si)	14	15.2	92.63 (3)	15.00	92.63 (3)	42.73	84.39	36.52	8.9
Co.005 (Al)	15	14.7	80.62 (3)	15.30	80.62 (3)	45.07	71.90	36.79	10.8
Co.002 (Al)	16	15.4	73.61 (3)	14.98	73.61 (3)	32.86	67.62	32.67	8.1
Co.002 (Al)	1 (M4)	15.0	73.61 (3)	11.00	73.61 (3)	32.86	66.26	35.75	10.0
Co.025 (Si)	17	15.6	87.19 (3)	14.60	87.19 (3)	47.35	78.31	36.27	10.2
Co.004 (Al)	18	15.0	78.12 (3)	15.25	78.12 (3)	44.15	66.86	33.83	14.4
Co.021 (Si)	19	15.6	86.18 (3)	16.06	86.18 (3)	46.54	77.95	35.59	9.55
Co.041 (Si)	20	15.8	87.48 (3)	17.02	87.48 (3)	49.26	68.74	26.72	17.0
Co.021 (Si)	3 (M4)	15.2	73.61 (3)	15.1	73.61 (3)	24.46	71.38	32.33	3.03
Co.024 (Al)	4 (M4)	15.4	---	(4)	---	---	---	---	---
Co.035 (Si)	5 (M4)	15.4	89.14 (3)	14.08	89.14 (3)	49.29	74.76	31.67	19.2
Co.028 (Al)	6 (M4)	15.4	80.83 (3)	15.7	80.83 (3)	44.81	71.83	36.34	11.1

(1) Screened through 100x400 mesh screens.

(3) Screened through 150x400 mesh screens.

(2) Screened through 170x400 mesh screens.

(4) Did not filter, too waxy

Note: The charge weights are in the hydrogen-reduced state and the recovered weights are in the oxidized state. The particle size is reported as the mean volume diameter (mvd) as measured by a Microtrac particle size analyzer.

Table 13
(Continued)

SBCR CATALYST EXTRACTIONS

Catalyst No. (Support)	Run No.	Charge		Recovered (Oxidized) wt. gm	Charge		Recovered		Reduction in Particle Size, %
		(H ₂ Reduced) wt. gm	wt. gm		Particle Size at 10% microns	Particle Size mvd. microns	Particle Size at 10% microns	Particle Size mvd. microns	
Co. 014 (Ti)	21	15.1	111.70 (1)	15.1	111.70 (1)	32.65	106.66	33.49	4.51
Co. 040 (Ti)	22	14.5	(5)	8.5	(5)	(5)	130.40	51.40	--
Co. 047 (Al)	23	15.8	83.42 (3)	16.95	83.42 (3)	44.41	76.46	39.02	8.34
Co. 049 (Al)	24	15.6	81.3 (3)	16.54	81.3 (3)	42.39	70.11	35.87	13.8
Co. 047 (Al)	25	15.6	79.36 (3)	16.69	79.36 (3)	41.72	69.09	36.16	12.94
Co. 031 (Al)	26	15.9	75.48 (3)	15.37	75.48 (3)	38.34	68.42	35.39	9.35
Co. 029 (Al)	27	15.9	76.39 (3)	18.28	76.39 (3)	39.56	68.72	36.04	10.04
Co. 043 (Si)	7 (M4)	15.4	(5)	15.1	(5)	(5)	85.51	40.20	--
Co. 006 (Ti)	8 (M4)	15.0	121.38 (1)	9.09	121.38 (1)	52.80	99.31	38.62	18.2
Co. 048 (Si)	9 (M4)	15.4	82.40 (3)	15.85	82.40 (3)	40.94	70.69	25.53	14.2
CAL. 02 (Al)	10 (M4)	15.9	74.40 (3)	16.42	74.40 (3)	37.79	65.89	34.14	11.44
Co. 053 (Al)	12 (M4)	15.9	82.02 (3)	16.95	82.02 (3)	43.10	69.53	35.76	15.23
Co. 054 (Si)	13 (M4)	15.7	101.17 (3)	17.09	101.17 (3)	57.54	82.37	37.89	18.58
Blend A (Al)	14 (M4)	20.0	86.23 (3)	14.61	86.23 (3)	46.36	77.43	42.81	10.21
Co. 034 (Al)	15 (M4)	13.0	(5)	9.52	(5)	(5)	88.26	45.28	--
CAL. 04 (Al)	16 (M4)	16.1	71.54 (3)	21.78	71.54 (3)	36.28	66.50	32.82	7.05
CAL. 08 (Al)	17 (M4)	15.0 (6)	63.12	14.27	63.12	25.60	62.80	26.03	0.51
CAL. 07 (Al)	18 (M4)	14.5 (6)	--	13.37	--	--	67.02	28.12	--
CAL. 05 (Al)	19 (M4)	15.7	72.75	5.62	72.75	36.90	71.62	36.55	1.55
CAL. 06 (Al)	20 (M4)	15.0	72.62	(7)	72.62	37.33	--	--	--
Co. 053 (Al)	29 (M3)	25.2	75.63	25.8	75.63	40.80	71.09	38.20	6.00
Co. 004 (Al)	21 (M4)	15.9	81.38	15.04	81.38	41.82	72.88	37.61	10.44

-
- (1) Screened through 100x400 mesh screens.
 - (3) Screened through 150x400 mesh screens.
 - (5) Insufficient feed sample.
 - (6) Wax coated.
 - (7) Lost catalyst.

Table 13
(Continued)

SBCR CATALYST EXTRACTIONS

Catalyst No. (Support)	Run No.	Charge		Recovered (Oxidized) wt, gm	Charge		Recovered		Reduction in Particle Size, %
		(H ₂ Reduced) wt, gm	wt, gm		Particle Size at 10% microns	Particle Size mvd, microns	Particle Size at 10% microns	Particle Size mvd, microns	
Blend B (Al)	22 (M4)	30.5		31.75	77.85	43.10	73.74	38.80	5.28
CAL.09 (Al)	23 (M4)	30.0 (6)		14.34	63.12	25.60	62.10	26.32	1.62
Co.053-3 (Al)	24 (M4)	28.5		27.85	75.63	40.80	70.69	35.03	6.53
Co.055 (Al)	31 (M3)	15.0		14.67	85.58	46.27	74.56	39.00	12.88
Co.056 (Si)	25 (M4)	15.0		14.93	99.93	54.62	88.48	43.26	11.46
Co.044 (Si)	32 (M3)	16.4		17.01	92.15	49.30	84.92	40.21	7.85
CAL.10 (Al)	26 (M4)	15.6		14.63	83.05	47.11	81.12	45.87	2.32
Co.053-4 (Al)	33 (M4)	31.4		31.9	84.09	44.40	73.50	37.10	12.6
Co.050 (Al)	27 (M4)	14.6		10.62	(5)	(5)	91.37	44.07	--
Co.060 (Al)	34 (M3)	15.6		15.8	87.45	47.08	80.89	43.42	7.50

(5) Insufficient feed sample.