

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%	0.00	0.00	γ -alumina	Base Catalyst	P
Co.005A	20%	0.4% Ru	0.00	γ -alumina	Ru added to calcined Co.005 by IW impreg.	P
Co.006	12%	0.75% Re	0.00	Titania	U.S. Pat. 4,794,009	P
Co.007	20%	0.00	0.00	Titania	Base Catalyst	P
Co.008	20%	0.00	0.00	Silica	UK Pat. Appl. GB 2 125 062 A (Kneaded with excess liquid)	P
Co.009	20%	0.5% Ru	0.00	γ -alumina	Ru-Promoted Catalyst (use Ru Chloride, single-step aqueous IW)	P
Co.010	20%	0.00	0.00	γ -alumina	Base Catalyst (non-calcined)	P
Co.010A	20%	0.4% Ru	0.00	γ -alumina	Ru added to dried Co.010 by IW impreg.	P
Co.011	20%	0.00	0.00	Silica	UK Pat. Appl. GB 2 125 062 A (Kneaded)	P
Co.012	20%	0.00	0.00	Silica	Base Catalyst (Inc. Wetness)	P
Co.013	20%	0.00	0.00	Titania	Base Catalyst like Co.007, but all aqueous	P
Co.014	12%	0.5% Ru	0.00	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

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

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.016	20%	0.43% Ru	1% La ₂ O ₃	γ -Alumina	Similar to Co.015, but calcined after Co impregnation	P
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	0.00	γ -Alumina	Ru-Promoted Catalyst (single-step, aqueous IW)	P
Co.019	20%	0.5% Ru	0.00	Silica	Ru-Promoted Catalyst (single-step, aqueous IW)	P
Co.020	0.00	0.5% Ru	0.00	γ -Alumina	Ru Base Catalyst	P
Co.020A	20%	0.4% Ru	0.00	γ -Alumina	Co added to dried Co.020 by IW impreg.	P
Co.020B	20%	0.4% Ru	0.00	γ -Alumina	Co added to reduced Co.020 by IW impreg.	P
Co.020C	20%	0.4% Ru	0.00	γ -Alumina	Co added to calcined Co.020 by IW impreg.	P
Co.021	20%	0.00	0.7% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (single-step, aqueous kneaded)	P
Co.022	20%	0.00	0.7% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (aqueous, multiple-steps, kneaded Co pre-impregnation, IW Zr)	P
Co.023	20%	0.00	1.4% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (aqueous, multiple-steps, kneaded Co pre-impregnation, IW Zr)	P
Co.024	20%	0.00	8.5% Zr	Silica	Eur. Pat. Appl. 0 167 215 A2 (non-aqueous, IW, multiple-steps, Zr pre-impregnation)	P
Co.025	20%	0.00	8.5% Zr	Silica	Similar to Co.024 but aqueous Zr pre-impregnation	P

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

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.026	20%	0.00	0.00	Silica (Davison Grade 59)	Similar to Co.012 but different grade silica	P
Co.027	20%	0.5% Ru	0.00	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
Co.030	20%	0.00	0.1% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.031	20%	0.00	1.4% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.032	20%	0.00	8.5% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.033	20%	0.00	8.5% Zr	γ -alumina	Multiple-steps, aqueous IW, Co pre-impregnation	P
Co.034	20%	0.00	8.5% Zr	γ -alumina	Multiple-steps, aqueous IW, Zr pre-impregnation	P
Co.035	20%	0.00	8.5% Zr	Silica	Zr-Promoted Catalyst (single-step aqueous, kneaded)	P
Co.036	20%	0.00	8.5% Zr	Silica	Multiple-steps, aq. Co pre-impreg. by kneading, aqueous IW Zr impreg.	P
Co.037	12%	0.00	0.00	Titania	Similar to Co.013, but TiO ₂ mainly anatase	P
Co.038	12%	0.5% Ru	0.00	Titania	Similar to Co.014, but TiO ₂ mainly anatase	P
Co.039	12%	0.00	0.00	Titania	Similar to Co.007, but only 12% Co	P
Co.040	12%	0.00	0.00	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

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

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.042	0.00	0.00	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%	0.00	15% Zr	Silica	Similar to Co.025, but 15% Zr	P
Co.045	20%	0.00	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	-
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	0.00	0.5% Ru	0.00	Titania (R)		P
Co.052	0.00	0.5% Ru	0.00	Titania (A)		P
Co.053	20%	0.5% Ru	0.00	γ -alumina	Similar to Co.018 (New Batch)	P
Co.054	20%	0.00	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%	0.00	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%	0.00	1% La ₂ O ₃	γ -alumina	Similar to Co.055, but without Re (one-step impreg.)	P
Co.059	20%	0.00	1% La ₂ O ₃	γ -alumina	Similar to Co.015, but without Re (two-step impreg.)	P
Co.060	30%	0.00	0.00	γ -alumina	Similar to Co.005, but with 30% Co	P
Co.061	30%	0.5% Ru	0.00	γ -alumina	Similar to Co.053, but with 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.062	30%	0.5% Ru	1.5% K	γ -alumina	Similar to Co.029, but with 1.5% K	P
Co.063	20%	0.00	8.5% La	γ -alumina	Multiple-steps, aqueous IW. La pre-impregnation	P
Co.064	20%	0.5% Ru	8.5% Zr	γ -alumina	Multiple-steps, aqueous IW. Zr pre-impregnation	P
Co.065	20%	0.5% Ru	8.5% Zr 0.3% K	γ -alumina	Multiple-steps, aqueous IW. Zr pre-impregnation	P
Co.066	15%	0.5% Ru, 5.0% Fe	0.00	γ -alumina	Ru- and Fe-Promoted Catalyst (single-step, aqueous IW)	P
Co.067	20%	2.0% Pd	0.00	γ -alumina	Pd-Promoted Catalyst (single-step, aqueous IW)	P
Co.068	20%	1.0% Pd	0.00	γ -alumina	Similar to Co.067, but with 1% Pd	P
Co.069	20%	2.0% Ru	0.00	γ -alumina	Similar to Co.053, but with 2% Ru	P
Co.070	13%	0	0.00	γ -alumina	Similar to Co.005, but with 13% Co	P
CAL.01 (97E-13E)	20%	0.5% Ru	0.00	γ -alumina	Similar to Co.018 (Calsicat Prep.)	P
CAL.02 (97E-16B)	20%	0.5% Ru	0.00	γ -alumina	Similar to CAL.01 (New Batch)	P
CAL.03 (97E-13F)	20%	0.5% Ru	0.00	γ -alumina	Multiple-step impreg., Similar to CAL.02	P
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

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

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
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_2O_3	P
CAL.11 (29F-07B)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05	P
CAL.12 (29F-05D)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05	P
CAL.13 (29F-07E)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05	P
CAL.15 (29F-38B)	20%	0.00	0.00	γ -alumina	Similar to Co.005, Reduced and Protected in Soya Wax	P
CAL.16 (29F-3D)	20%	0.00	0.00	γ -alumina	Similar to Co.005, Reduced and Protected in Soya Wax	P
CAL.17 (29F-39E)	20%	0.00	0.00	γ -alumina	Similar to Co.005, Reduced and Protected in Soya Wax	P
CAL.18 (29F-40C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.13	P
CAL.19 (29F-39A)	20%	0.00	0.00	γ -alumina	Similar to CAL.15, 16 and 17, Reduced at EI under standard conditions	P
CAL.20 (29F-39A,B,C)	20%	0.00	0.00	γ -alumina	Similar to CAL.19, Reduced at EI in large batch	P
CAL.24	20%	0.00	0.00	γ -alumina	CAL.20 Re-reduced twice at EI using standard conditions	P
CAL.25	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.018, but reduced and passivated in Synfluid	P
Fe.01	0%	30%Fe	1.5%Cu	Silica		P

Table 2. Reducibility Data of Promoted and Unpromoted Catalysts Obtained by TPR

Catalyst	Time of Reduction at 350°C (hours)	% Co Reduced at 350°C (Time = 0)	Total % Co Reduction (after n hours)
Co.005	4	27.7	69.3
	10	28.2	73.2
	16	27.9	75.1
Co.053	2	26.3	96.6
CAL.13	2	-	97.3

Table 3

SUMMARY OF ADDITIONAL M3 AND M4 SBCR RUN RESULTS

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

Flows: N2-563 SLH, H2-225 SLH, CO-112 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	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Comments
												ICH4	IC2	IC3+	IC02			
3060	CAL.15	15	1	6	13	220	450	2.0	20	2.0	0.09	-	-	100	-	0.84	-	Flaked in Soya
3061	CAL.17	15	1	6	13	220	450	2.0	20	1.2	0.06	-	-	100	-	0.80	-	Flaked in Soya
3062	CAL.19	15	1	6	14	220	450	2.0	20	13.6	0.66	3.2	-	96.0	0.81	0.88	-	
4042	CAL.16	15	1	6	13	220	450	2.0	20	<1.0	0.04	-	-	100	-	-	-	Flaked in Soya
4043	CAL.18	15	1	6	13	220	450	2.0	20	8.4	0.41	-	-	98.9	1.13	0.89	-	Flaked in Soya
4045	CAL.20	15	1	6	14	220	450	2.0	20	3.4	0.17	-	-	100	-	0.86	-	
4047	CAL.24	16	1	6	13	220	450	2.0	20	4.9	0.22	-	-	100	-	0.87	-	
4048	CAL.25	15	1	23	38	220	450	2.0	20	9.5	0.46	-	-	99.5	0.47	0.89	-	