APPENDIX A

Co CATALYST FORMULATIONS

Catalyst Prep #	Co.066	Date Tech	May-15-95	Amount	200.0 g

Compound	Co	Ru	Fe	Al2O3
(%wt)	15	0.5	5	

Support	y-Alumina VISTA B	Amount	159.00 g
Particle Size	400 - 0 mesh	Treatment	500°C / 10 hrs
Cobalt	Cobalt Nitrate	Amount	147.97 g
Metal	Ruthenium Nitrosylnitrate	Amount	3.73 g
Promotor	Iron (III) Nitrate	Amount	72.31 g
Promotor		Amount	
Promotor		Amount	

PROCEDURE

Preparation X Incipient Wetness Wet Impregnation
Ion Exchange Other

Notes: Incipient wetness: aqueous solution of Co, Fe, Ru
Dry catalyst precursor in an oven 115°C / 5 hrs with stirring

Calcination Temperature 300°C Time 10 hrs

Notes: After drying, 60 g of catalyst are NOT to be calcined!!

Co.066:

15 wt% Co
5.0 wt% Fe
0.5 wt% Ru
γ-alumina

Preparation Procedure:

Calcine the γ-alumina at 500°C for 10 hrs. Use Vista B alumina. Presieve to >38 microns (400-0 mesh).

Impregnate the support with an aqueous solution of Co nitrate [$Co(NO_3)_2 \cdot 6H_2O$], Fe (III) nitrate and Ru nitrosil nitrate using an appropriate quantity to get incipient wetness (ca. 1.2 ml/g) with the desired loading of Co, Fe and Ru.

Dry the catalyst precursor in an oven for 5 hrs at 115°C with moderate stirring.

The dried catalyst is then calcined in air by raising its temperature at a heating rate of ca. 1°C/min to 300°C and holding for 10 hrs.

Reduction Procedure before Reaction:

Reduce the catalyst in a pure hydrogen flow of 3000 cc/g/hr by heating at 1°C/min to 350°C and holding for 10 hrs.

Catalyst Prep #	Co.067	Date Tech	May-15-95	Amount	200.0 g

Compound	Co	Pd	Al2O3
(%wt)	20	2	

Support	y-Alumina VISTA B	Amount	156.00 g
Particle Size	400 - 0 mesh	Treatment	500° C / 10 hrs
Cobalt	Cobalt Nitrate	Amount	197.29 g
Metal	Palladium (II) Nitrate	Amount	10.01 g
Promotor		Amount	
Promotor		Amount	
Promotor		Amount	

PROCEDURE

Preparation	X	Incipient Wetness	Wet Impregnation
		Ion Exchange	Other

Notes: Incipient wetness: aqueous solution of Co, Pd
Dry catalyst precursor in an oven 115°C / 5 hrs with stirring

Calcination: Temperature 300°C Time 10 hrs

Notes: After drying, 60 g of catalyst are NOT to be calcined!!

Co.067:

20 wt% Co
2.0 wt% Pd
γ-alumina

Preparation Procedure:

Calcine the γ-alumina at 500°C for 10 hrs. Use Vista B alumina. Presieve to >38 microns (400-0 mesh).

Impregnate the support with an aqueous solution of Co nitrate [$Co(NO_3)_2 \cdot 6H_2O$] and Pd (II) nitrate using an appropriate quantity to get incipient wetness (ca. 1.2 ml/g) with the desired loading of Co and Pd.

Dry the catalyst precursor in an oven for 5 hrs at 115°C with moderate stirring.

The dried catalyst is then calcined in air by raising its temperature at a heating rate of ca. 1°C/min to 300°C and holding for 10 hrs.

Reduction Procedure before Reaction:

Reduce the catalyst in a pure hydrogen flow of 3000 cc/g/hr by heating at 1°C/min to 350°C and holding for 10 hrs.

Catalyst Prep #	Co.068	Date Tech	May-24-95	Amount	200.0 g

Compound	Co	Pd				Al2O3
(%wt)	20	1				

Support	y-Alumina VISTA B	Amount	158.00 g
Particle Size	400 - 0 mesh	Treatment	500°C / 10 hrs
Cobalt	Cobalt Nitrate	Amount	197.29 g
Metal	Palladium (II) Nitrate	Amount	5.01 g
Promotor		Amount	
Promotor		Amount	
Promotor		Amount	

PROCEDURE

Preparation	X	Incipient Wetness	Wet Impregnation
		Ion Exchange	Other

Notes: Incipient wetness: aqueous solution of Co, Pd
Dry catalyst precursor in an oven 115°C / 5 hrs with stirring

Calcination: Temperature 300°C Time 10 hrs

Notes: After drying, 60 g of catalyst are NOT to be calcined!!

Co.068:

20 wt% Co
1.0 wt% Pd
γ-alumina

Preparation Procedure:

Calcine the γ-alumina at 500°C for 10 hrs. Use Vista B alumina.. Presieve to >38 microns (400-0 mesh).

Impregnate the support with an aqueous solution of Co nitrate [$Co(NO_3)_2 \cdot 6H_2O$] and Pd (II) nitrate using an appropriate quantity to get incipient wetness (ca. 1.2 ml/g) with the desired loading of Co and Pd.

Dry the catalyst precursor in an oven for 5 hrs at 115°C with moderate stirring.

The dried catalyst is then calcined in air by raising its temperature at a heating rate of ca. 1°C/min to 300°C and holding for 10 hrs.

Reduction Procedure before Reaction:

Reduce the catalyst in a pure hydrogen flow of 3000 cc/g/hr by heating at 1°C/min to 350°C and holding for 10 hrs.

Catalyst Prep #	Co.069	Date Tech	May-24-95	Amount	200.0 g
Compound		Co	Ru		Al2O3
(%wt)		20	2		

Support	γ-Alumina VISTA B	Amount	156.00 g
Particle Size	400 - 0 mesh	Treatment	500°C / 10 hrs
Cobalt	Cobalt Nitrate	Amount	197.29 g
Metal	Ruthenium Nitrosylnitrate	Amount	14.91 g
Promotor		Amount	
Promotor		Amount	
Promotor		Amount	

PROCEDURE

Preparation	X	Incipient Wetness	Wet Impregnation
		Ion Exchange	Other

Notes: Incipient wetness: aqueous solution of Co, Fe, Ru
Dry catalyst precursor in an oven 115°C / 5 hrs with stirring

Calcination: Temperature 300°C Time 10 hrs

Notes: After drying, 60 g of catalyst are NOT to be calcined!!

Co.069:

20 wt% Co
2.0 wt% Ru
γ-alumina

Preparation Procedure:

Calcine the γ-alumina at 500°C for 10 hrs. Use Vista B alumina. Presieve to >38 microns (400-0 mesh).

Impregnate the support with an aqueous solution of Co nitrate [$Co(NO_3)_2 \cdot 6H_2O$] and Ru nitrosil nitrate using an appropriate quantity to get incipient wetness (ca. 1.2 ml/g) with the desired loading of Co and Ru.

Dry the catalyst precursor in an oven for 5 hrs at 115°C with moderate stirring.

The dried catalyst is then calcined in air by raising its temperature at a heating rate of ca. 1°C/min to 300°C and holding for 10 hrs.

Reduction Procedure before Reaction:

Reduce the catalyst in a pure hydrogen flow of 3000 cc/g/hr by heating at 1°C/min to 350°C and holding for 10 hrs.

Catalyst Prep #	Co.070	Date Tech	Jun-08-95	Amount	200.0 g

Compound	Co	Al2O3
(%wt)	13	

Support	γ-Alumina VISTA B	Amount	174.00 g
Particle Size	400 - 0 mesh	Treatment	500°C / 10 hrs
Cobalt	Cobalt Nitrate	Amount	128.24 g
Metal		Amount	
Promotor		Amount	
Promotor		Amount	
Promotor		Amount	

PROCEDURE

Preparation: X Incipient Wetness; Wet Impregnation; Ion Exchange; Other

Notes: Incipient wetness: aqueous solution of Co, 60% of loading in 1st step
Dry catalyst precursor in an oven 115°C / 12 hrs with stirring
Incipient wetness: aqueous solution of Co, 40% of loading in 2nd step
Dry catalyst precursor in an oven 115°C / 12 hrs with stirring

Calcination: Temperature 300°C Time 2 hrs

Notes: After drying, 60 g of catalyst are NOT to be calcined!!

Co.070:

13 wt% Co
γ-alumina

Non-promoted catalyst similar to Co.005, with 13% Co.

Preparation Procedure:

Calcine the γ-alumina at 500°C for 10 hrs. Use Vista B alumina. Presieve to >38 microns (400-0 mesh).

Impregnate the support in 2 steps with an aqueous solution of Co nitrate [$Co(NO_3)_2 \cdot 6H_2O$], using an appropriate quantity to get incipient wetness (ca. 1.2 ml/g) with 60% of the desired loading of Co in the first step.

Dry in air at 115°C for 12 hours and calcine in air at 300°C for 2 hours (heating rate of ca. 1°C/min to 300°C).

In the second step, impregnate the remaining 40% of the Co. Repeat the drying and calcination procedures.

Reduction Procedure before Reaction:

Reduce the catalyst in a pure hydrogen flow of 3000 cc/g/hr by heating at 1°C/min to 350°C and holding for 10 hrs.

Catalyst Prep #	CoW.13	Date Tech	Jun-08-95	Amount	200.0 g

Compound	Co	Ru	Fe	Al2O3
(%wt)	10	0.5	10	

Support	γ-Alumina VISTA B	Amount	159.00 g
Particle Size	400 - 0 mesh	Treatment	500°C / 10 hrs
Cobalt	Cobalt Nitrate	Amount	98.64 g
Metal	Ruthenium Nitrosylnitrate	Amount	3.73 g
Promotor	Iron (III) Nitrate	Amount	144.63 g
Promotor		Amount	
Promotor		Amount	

PROCEDURE

Preparation	X	Incipient Wetness	Wet Impregnation
		Ion Exchange	Other

Notes: Incipient wetness: aqueous solution of Co, Fe, Ru
Dry catalyst precursor in an oven 115°C / 5 hrs with stirring

Calcination: Temperature 300°C Time 10 hrs

Notes: After drying, 60 g of catalyst are NOT to be calcined!!

CoW.13 **10 wt% Fe**
10 wt% Co
0.5 wt% Ru
γ-alumina

Ru promoted cobalt/iron impregnated on calcined γ-alumina similar to CoW.10 (2nd batch).

Preparation Procedure

Calcine γ-alumina at 500°C for 10 hrs. Use Vista B alumina. Presieve to >38 microns (400-0 mesh).

Impregnate the support with an aqueous solution of Fe nitrate [$Fe(NO_3)_3.9H_2O$], Co nitrate [$Co(NO_3)_2.6H_2O$] and Ru nitrosylnitrate [$Ru(NO)(NO_3)_3.2H_2O$] using appropriate quantities to get incipient wetness (ca. 1.2 ml/g) with the desired loading of Fe, Co, and Ru.

Dry the catalyst precursor in an oven for 5 hrs at 115°C with moderate stirring.

Calcine the dried catalyst in air by raising its temperature at a heating rate of ca. 1°C/min to 300°C and holding for 10 hrs.

Reduction Procedure before Reaction:

Reduce the catalyst in pure hydrogen flow of 3000cc/g/hr by heating at 1°C/min to 350°C and holding for 10 hrs.

Catalyst Prep #	Fe.01	Date Tech	May-05-95	Amount	200.0 g

Compound	Fe	Cu	SiO2
(%wt)	30	1.5	

Support	Silica Davison Grade 952	Amount	137.00 g
Particle Size	400 - 0 mesh	Treatment	500°C / 10 hrs
Cobalt	Iron (III) Nitrate	Amount	433.88 g
Metal	Copper (II) Nitrate	Amount	11.40 g
Promotor		Amount	
Promotor		Amount	
Promoter		Amount	

PROCEDURE

Preparation	X	Incipient Wetness	Wet Impregnation
		Ion Exchange	Other

Notes: Incipient wetness: aqueous solution of Fe + Cu
Dry catalyst precursor in an oven 110°C / 16 hrs

Calcination — Temperature: 500°C — Time: 24 hrs

Notes:

Fe.01 **30 wt% Fe**
1.5 wt% Cu
Silica

Preparation Procedure of Fe-Cu/Silica

Calcine silica at 500°C for 10 hrs. Use Davisson Grade 952 silica. Presieve to > 38 microns (400-0 mesh).

Impregnate the support with an aqueous solution of $Fe(NO_3)_3.9H_2O$ and $Cu(NO_3)_2.3H_2O$ using appropriate quantities to yield 30 wt% Fe and 1.5% Cu by weight and to get incipient wetness (ca. 1.2 ml/g).

Dry the catalyst precursor in an oven for 16 hours at 110°C.

The dried catalyst is then calcined in air by raising its temperature at a heating rate of ca. 1°C/min to 500°C and holding for 24 hours.

Reduction Procedure before Reaction:

A mixture of H_2O and H_2 is used for reduction to Fe_3O_4. Raise the temperature of the bed 1oC/min to 400°C with the feed being $H_2O/H_2 > 0.09$ and maintain these conditions for 48 hrs