Table II-2

Feedstocks Properties-Oil

	Kern	Hondo	Boscan	Hv Arabian	Maya	W. Texas	Lloyd-minster	Cold Lake	Cold Lake Resid	Athabasca GCOS[a] Bitumen	GCOS Coker Gas Oil	FCC Bottoms	Coal Tar
API	14.0	9.8	10.0	10.9	22.3	8.05	9.44	15.4	6.9				
Carbon					84.6	86.1	85.0	78.6		84.18	84.65	89.93	90.02
Hydrogen					11.5	10.4	10.7	9.3	10.2	10.31	10.95	7.35	4.63
Oxygen								5.9		0.78	0.64	0.99	2.53
Nitrogen	0.7	0.8	0.6	0.3	1.21	0.44	0.34	0.6	0.5	0.40	0.40	0.44	---
Sulfur	1.2	5.9	5.3	4.4	3.09	3.33	4.35	5.5	5.2	4.33	3.34	1.09	---
H/C	1.58	1.54	1.57	1.50	1.63	1.47	1.49	1.42		1.47	1.55	.98	---
Nickel	60	109	89	27				93	330				
Vanadium	30	284	940	89				235					
Asphaltenes	2.1	12.8	11.9	7.2	15.6	11.3	11.60	23.48		15.4	0.5		
C5-650F	18	4	14	2									
650-975F	45	44	28	41									
975+F	37	52	58	57									

[a]GCOS = Great Canadian Oil Sands

Table II-3
Feedstock Properties - Coal

	Cx Ranch Wyoming subbit.	Forrestburg subbit. C Coal	Alberta hv subbit. Coal	Wyodak subbit.	River King Illinois hv bituminous	McElroy W. Virginia hv bituminous	Burning Star Illinois hv bituminous	hvA bituminous	Lignite
H/C	0.87	0.72	0.76	0.89	0.83	0.83	0.83	0.87	1.19
Nitrogen	1.1	1.65	1.5	0.8	1.1	1.2	1.3	1.63	0.74
Oxygen	18.3	20.41	17.8	13.9	14.0	5.8	10.4	7.79	32.04
Sulfur	0.5	0.53	0.7	2.9	4.3	5.5	3.5	1.33	0.53
Ash	5.7	9.50	8.0	19.9	17.9	13.2	11.1		
Reflectance	0.4	0.42			0.5	0.8	0.5		
Vitrinite		92.2							
Liptinite		2.6							
Inertinite		3.1							
Mineral Matter		2.1							
Iron (ppm)		2379							
Nickel (ppm)		18							
Vanadium (ppm)		—							

Table II-4

Coprocessing Yields for Two Slurrying Media Using Illinois #6 Coal (Yan & Espenscheid, 1983)

	With FCC Bottoms	Coal Tar[a]
Coal Conversion (wt%)	92.8	51.4
Product Yields (wt%)		
Benzene Soluble	34.4	3.1
Benzene Insoluble	52.2	43.8
Gas	3.3	1.3
Water	2.9	3.2
Unreacted Coal	7.2	48.6

[a] According to our definition, this is not considered coprocessing since coal and a coal-derived material are used.

Table II-5

Effect of Pressure on Coprocessing Yields Using FCC Bottoms as the Host and Illinois #6 Coal (Yan & Espenscheid, 1983)

Pressure (MPa)	4.3	1.5	Atmospheric
Coal conversion (wt%)	92.8	86.6	83.7
Product Yield (wt%)			
Liquid Product C4-975F	86.6	74.9	74.0
Gas	3.3	5.2	6.5

Table II-6

CANMET Hydrocracking Yields Using a Coal Based Additive (Schindler et al., 1985)

	Laguna (Venezuela)	Cold Lake (Canada)	Lt. Arabian (Saudi Arabia)
Naphtha, C4-400F	30.7	27.0	28.4
Middle Distillate, 400-650F	36.8	33.8	34.8
Heavy Oil, 650-975F	29.6	36.1	32.8
Residual, 975+F	7.4	5.7	9.2
Desulfurization, wt%	60	56	45
Pitch Conversion, wt%	89	88	87
Asphaltene Conversion, wt%	84	72	51
Hydrogen Consumption, SCFB	1,380	1,200	1,230

Table II-7

CANMET Coprocessing Yields Compared with Direct Coal Liquefaction and CANMET Hydrocracking (Kelly, 1984)

	Direct Liquefaction	Coprocessing	Hydrocracking
Coal in Feed, (wt%)	33	30	(5%)
Host	Anthracene	Cold Lake	Cold Lake
C1-C4	1.3	5.4	3.8
Total Oil	16.5	75.9	81.9
Residue	13.2	29.6	22.5
Coal Conversion (wt%)	85.6	83.9	--
Pitch Conversion (wt%)	57.5	66.5	72.2
Hydrogen Consumption (wt%)	2.7	4.0	3.3
Hydrogen Utilization Efficiency	6.0	15.5	22.2

Table II-8

Effect of Coal Type and
Host Type on Coprocessing Yields (Shinn, 1984)

Coal Type	Illinois #6 (hv bit)	Illinois #6 (hv bit)	Cx Ranch Wyoming (subbit)	McElroy W. Va. (hv bit)
Solvent Type	Kern	Boscan	Kern	Kern
Coal Conversion (wt%)	87	89	70	88
Resid Conversion (wt%)	62	76	67	66
Hydrogen Consumption, SCF/Bbl	1350	1700	1350	1100
Demetalization (wt%)	95	97	91	87
Desulfurization	94	89	94	90

Table II-9

Two-Stage Coprocessing Yields Using Alberta Subbituminous Coal and Cold Lake Bitumen (MacArthur, 1985)

Oil/Coal/Recycle Weight Ration	1.7/1.0/0	1/1/0.7
Product Yields, with		
C1-C4	2.7	3.8
Naphtha, C4-390F	16.4	15.7
Middle Distillate, 390-650F	27.2	25.8
Heavy Oil, 650-975F	28.5	27.5
Residual Oil, 975+F	13.1	11.8
Coal Conversion	92	91
975+F Conversion	80	80
Desulfurization	77	87
Demetalation	94	96
Hydrogen Efficiency	21	16

Table II-10

H-Oil and Catalytic Two-Stage Liquefaction Yields
(MacArthur, 1985)

	H-Oil (using Cold Lake residuum)	Two-Stage Liquefaction (using Alberta subbituminous)
C1-C4	3.0	6.1
Liquid Oil, C4-975F	82.3	70.6
Coal Conversion	--	91
975F+ Conversion	85	89
Desulfurization	84	60
Demetallation	93	--
Hydrogen Efficiency	44	9

Table II-11

Hydrogen-Type Content of Various Petroleum Host Solvents
(Curtis et al., 1984)

	Maya	West Texas	Lloydminster	Kuwait
%cyclic α	7.2	6.1	8.5	7.3
%alkyl α	5.5	4.9	6.5	6.6
%cyclic β	16	17	18	17
%alkyl β	44	46	38	45
Coal Conversion (wt%)				
Inert Atmosphere	59.9	60.4	55.7	54.0
Hydrogen + Catalyst	67.3	73.7	72.1	64.0

Table II-12

Comparison of Coprocessing and Direct Coal Liquefaction Yields
With Illinois #6 Bituminous Coal (Rhodes, 1985)

	Direct Coal Liquefaction	Coprocessing (using Cold Lake Bitumen)
Coal Conversion (wt%)	94.1	95.4
Pyridine Soluble	89.2	91.9
Soluble-Coal Fraction, (wt%)		
Oils	15.6	40.7
Asphaltenes	63.2	43.0

Figure II-2

Effect of Solvent Type on Coprocessing
Using Alberta hv C Bituminous Coal
(Moschopedis 1982)

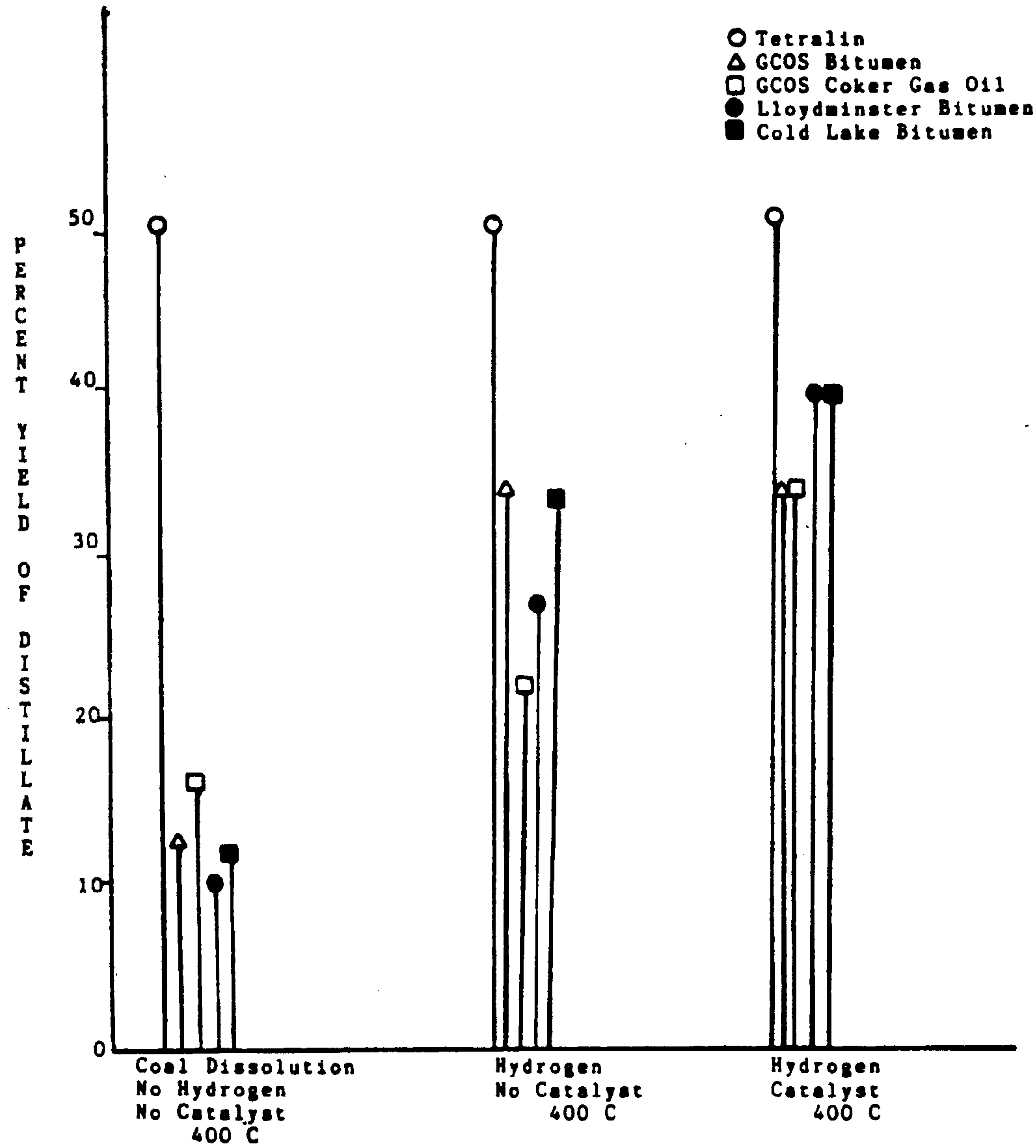
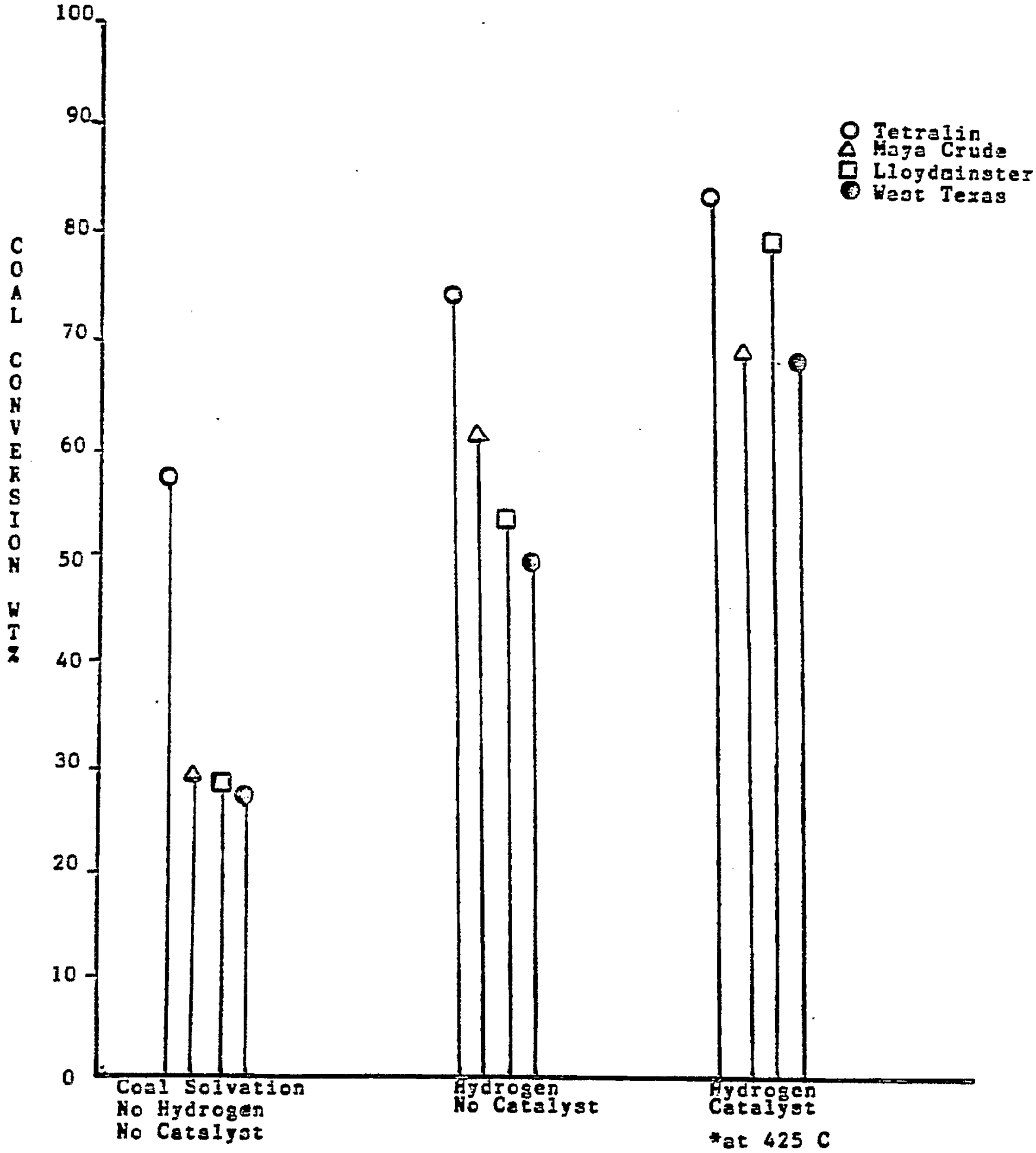


Figure II-3

Coal Conversion vs. Solvent Type and Temperature
Illinois #6 hv Bituminous Coal
Temperature = 400 C (673K)
Curtis, Guin, et al. (1984)



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