

TABLE 18. - Continued.

(f) Data from ref. 31

Property	Predicted range not yet verified by test of composition system	Range from tests		
Composition, vol %:				
H ₂	14 - 17	11.17-23.5		
CO	9 - 22	6.58-30.95		
CO ₂	5 - 11	6.91-19.26		
H ₂ S				
NH ₃				
CH ₄	3	1.49-3.66		
Other hydrocarbons				
N ₂	48 - 52	34.96-56.7		
COS				
Specific gravity				
Average molecular weight				
Heating value, Btu/ft ³ :				
Gross				
Net	100 - 135	90-197		
Gross with CO ₂ , H ₂ S, and NH ₃ removed				
Net with CO ₂ , H ₂ S, and NH ₃ removed				
Sulfur, ppm				
Alkali metals and sulfur, ppm				
Water, vol. %	9	0		
Solids, ppm				
Solids: particle size, μm				
Flammability limit ratio				

TABLE 18. - Concluded.

(g) Producer gas; data from course notes on "Synthetic Fuels from Coal," Center for Professional Advancement, July 22-24, 1974, p. 50

Property	Typical			
Composition, vol %:				
H ₂	10 - 14			
CO	26 - 32			
CO ₂	2 - 5			
H ₂ S				
NH ₃				
CH ₄	2 - 3			
Other hydrocarbons	0.1 - 4.0			
N ₂	50 - 53			
COS				
Specific gravity				
Average molecular weight				
Heating value, Btu/ft ³ :				
Gross	158 - 170			
Net	150 - 160			
Gross with CO ₂ , H ₂ S, and NH ₃ removed				
Net with CO ₂ , H ₂ S, and NH ₃ removed				
Sulfur, ppm				
Alkali metals and sulfur, ppm				
Water, vol. %				
Solids, ppm				
Solids: particle size, μm				
Flammability limit ratio				
Oxygen	0.1 - 0.3			

TABLE 19. - SUMMARY OF LIQUID FUEL PROPERTIES

Boiling range, °F	Gravity		Elemental composition, wt %			Viscosity, cP		Heat of combustion, Btu/lb	Reference
	API	Specific	H	N	S	at 100° F	at 210° F		
H-Coal process									
180 - >944	27.6	—	7.4	0.81	0.47	—	—	—	1
≥620	1.9	—	8.1	.77	.15	178	7.2	17 420	(a)
≥358	2.0	—	8.0	.80	.23	272	8.8	17 415	(a)
282 - 570 (90%)	19.0	—	10.34	.22	.16	2.47	.99	18 415	(a)
-50 - 350	44.9	—	12.9	.047	.26	—	—	—	2
217 - 500	25.9	—	11.2	.0044	.17	—	—	—	2
434 - 767	7.9	—	10.4	.0083	.17	—	—	—	2
400	-7.5	—	7.38	1.3	.48	—	(465 cP)	16 700	(b)
466 - >876	-16.5	—	8.35	1.11	1.43	—	—	—	3
493 - >910	-17.7	—	6.98	1.30	.66	—	—	—	3
144 - 609	19.8	—	—	.44	.21	2.4	—	—	4
144 - 397	32.3	—	—	.42	.13	1.08	—	—	4
397 - 687	13.0	—	—	.448	.29	3.87	—	—	4
138 - 795	17.0	—	—	.683	.27	6.1	—	—	4
138 - 387	37.4	—	—	.212	.06	.96	—	—	4
387 - 795	6.6	—	—	.871	.35	14.9	—	—	4
180 - 975	6.4	—	8.19	.61	.22	155	—	—	(c)
180 - 445	38.6	—	12.41	.19	.24	—	—	—	4
372 - 680	14.0	—	9.73	.42	.18	4.45	2.7	—	4
639 - 975	-2.3	—	7.58	1.01	.22	—	36	—	4
482 - >983	—	—	7.94	.77	.42	—	318.3	17 411	5
<950	—	—	8.85	.39	.19	—	—	—	5
≥950	—	—	8.28	1.30	.95	—	—	—	5
180 - 375	—	—	13.6	.1	.1	—	—	—	5
375 - 650	—	—	11.0	.1	.1	—	—	—	5
650 - 975	—	—	10.2	.1	.3	—	—	—	5
180 - 975	—	—	11.9	.1	.1	—	—	—	5
C ₄ + Liquids	15.0	—	9.48	.68	.19	—	—	—	7
C ₄ + Liquids	4.4	—	8.43	1.05	.43	—	—	—	7
C ₄ + Liquids	28.8	—	10.34	.64	.16	—	—	—	7
271 - 885	—	—	10.14	.36	.11	—	—	—	32
70 - 942	—	—	9.80	.38	.13	—	—	—	32
26 - 748	—	—	11.78	.20	.25	—	—	—	32
20 - 548	—	—	11.99	.20	.26	—	—	—	32
315 - 651	—	—	9.43	.42	.12	—	—	—	32
61 - 582	—	—	11.85	.13	.09	—	—	—	32
71 - 808	—	—	11.27	.44	.24	—	—	—	32
275 - 890	—	—	8.64	.41	—	—	—	—	32

^aLetter from G. R. Fox of General Electric Research and Development Center to Lloyd L. Shure of NASA Lewis Research Center, Feb. 18, 1977.

^bMemo for record, John S. Clark of NASA Lewis Research Center, July 19, 1977.

^cMeeting handout on H-Coal products for gas-turbine combined cycles. Paul W. Kydd of General Electric Co., Schenectady, N.Y., Jan. 9, 1976.

TABLE 19. - Continued.

Boiling range, °F	Gravity		Elemental composition, wt %			Viscosity, cP		Heat of combustion, Btu/lb	Reference
	API	Specific	H	N	S	at 100° F	at 210° F		
Synthoil process									
241 - >>530	-----	-----	7.72	1.190	1.021	-----	-----	-----	9
395 - >945	-5.7	1.125	-----	-----	-----	-----	43.65	-----	3
407 - >951	-3.5	1.1055	7.38	1.46	.55	-----	34.25	-----	↓
445 - >970	-4.3	1.1124	7.42	1.31	.56	-----	56.20	-----	↓
463 - 950	9.5	1.0035	9.77	.377	.02	-----	-----	-----	↓
329 - >795	-.6	1.061	-----	.756	.42	450	-----	-----	10
329 - 405	19.7	.936	-----	.423	.20	2.27	-----	-----	↓
405 - 685	11.4	.950	-----	.724	.30	2.56	-----	-----	↓
685 - 988	-3.9	1.109	-----	1.187	.44	-----	-----	-----	↓
(Full range)	-----	-----	7.72	1.205	1.057	-----	-----	-----	11
300 - >699	5.9	-----	-----	.79	.22	673	-----	-----	12
>695	-4.3	-----	-----	1.22	.31	-----	339.1	-----	↓
309 - 650	15.9	-----	-----	.32	.14	7.23	1.85	-----	↓
650 - 698	9.3	-----	-----	.47	.12	15.9	3.91	-----	↓
341 - >690	-2.9	1.10	7.97	.97	.43	2509	28.6	16 891	5
<405 - -780	4.0	-----	-----	.51	.21	143.5	-----	17 243	13
SRC process									
Solid: m. p. 312	-----	-----	6.56	1.87	1.07	-----	-----	15 719	15
Solid: m. p. 367	-----	-----	6.12	1.89	.88	-----	-----	15 733	↓
Solid: m. p. 327	-----	-----	5.62	1.91	1.10	-----	-----	15 957	↓
Solid: m. p. 354	-----	-----	5.45	1.95	1.09	-----	-----	15 673	↓
Solid: 900+	-18.3	-----	-----	2.0	.8	-----	-----	16 000	16, 17
400 - 900	5.0	-----	-----	7.9	.9	7.3	-----	17 300	16, 17
100 - 400	39.0	-----	11.5	.4	.2	-----	-----	19 048	16, 17
400 - >1020	-5.5	-----	6.97	1.23	.72	1900	20.45	-----	3
385 - >875	2.5	-----	-----	-----	-----	-----	-----	-----	3
433 - >1000	9.6	-----	9.76	.548	.02	-----	32.69	-----	3
181 - 561	22.6	.9182	9.98	.23	.40	1.441	.647	17 226	5
326 - 677	4.69	1.029	7.56	.59	.32	5.88	1.464	16 715	5
383 - 482	12.3	.984	8.6	.6	.2	2.75	-----	-----	(d)
155 - 402	20.0	.934	10.1	.6	.3	.794	-----	-----	(d)
83 - 563	35.6	.847	11.33	.30	.60	-----	-----	18 148	32
321 - 844	5.64	1.0318	7.65	.59	.41	5.56	1.45	16 426	↓
306 - 902	5.48	1.0333	7.43	.62	.37	3.79	1.48	16 921	↓
326 - 1067	5.48	1.0333	8.78	.50	.35	10.44	2.25	-----	↓
324 - 872	3.3	-----	7.43	.62	.37	5.79	1.48	16 921	↓

^dLetter from Robert G. Sperbac of Pittsburgh & Midway Coal Mining Co. to Thaine W. Reynolds of NASA Lewis Research Center, May 16, 1975.

TABLE 19. - Continued.

Boiling range, °F	Gravity		Elemental composition, wt %			Viscosity, cP		Heat of combustion, Btu/lb	Reference
	API	Specific	H	N	S	at 100° F	at 210° F		
SRC process (Concluded)									
175 - 857	13.0	—	8.88	0.44	0.06	3.43	1.10	17 728	30
180 - 818	14.5	—	10.32	.11	.01	2.20	.93	18 572	30
172 - 814	23.4	—	10.99	.02	.01	2.00	.90	18 903	30
COED process									
97 - 835	23.1	—	11.5	0.125	0.013	—	—	—	18
97 - >367	44.5	—	13.0	.056	.0049	—	—	—	↓
364 - >671	20.7	—	11.2	.16	.0055	—	—	—	↓
217 - >835	12.0	—	10.7	.09	.0090	—	—	—	↓
212 - >900	21.8	—	—	.226	.08	5.1	—	—	19
123 - 499	40.4	—	—	.190	.05	.89	—	—	↓
236 - 706	18.9	—	—	.248	.04	4.51	—	—	↓
>716	10.1	—	—	.294	.01	—	—	—	↓
280 - 950	20	—	11.0	.2	.1	8	—	—	6
190 - 746	22	—	10.9	.3	.1	5	—	—	↓
354 - >760	18.4	—	—	—	.16	8.1	—	—	↓
436 - 613	22.5	—	—	—	.004	3.9	—	—	↓
557 - >870	11.2	—	—	—	.07	—	—	—	↓
176 - 545	41.9	—	—	.193	<.01	.94	—	18 356	13
<300 - 849	22.5	—	—	.143	.05	6.82	—	18 020	13
198 - 950	19.0	—	11.97	.25	.18	—	—	—	20
148 - 844	22.3	—	12.13	.0388	.0271	—	—	—	20
Gulf Catalytic process									
—	7.0	—	8.84	0.51	0.07	—	—	—	21
—	10.4	—	9.44	.50	—	—	—	—	↓
266 - 688	14.0	—	9.54	.31	.04	—	—	—	↓
>130	—	—	8.97	.40	.04	—	—	—	↓
>130	—	—	8.18	.62	.17	—	—	—	↓
Excess Donor Solvent process									
158 - 392	31.1	0.87	10.90	0.21	0.47	—	—	18 300	23
158 - 392	45.4	.80	12.90	.06	.005	—	—	19 300	↓
392 - 1000	-.5	1.08	7.70	.66	.41	—	—	17 100	↓
392 - 1000	8.6	1.01	8.60	.24	.04	—	—	16 100	↓

TABLE 19. - Concluded.

Boiling range, °F	Gravity		Elemental composition, wt %			Viscosity, cP		Heat of combustion, Btu/lb	Reference
	API	Specific	H	N	S	at 100° F	at 210° F		
ZnCl ₂ hydrocracking process									
180 - 887	—	—	8.85	0.0023	0	—	—	—	24 ↓
180 - 392	—	—	8.33	.0018	.02	—	—	—	
392 - 617	—	—	9.65	.0025	.02	—	—	—	
617 - 887	—	—	8.98	.0060	.03	—	—	—	
C ₅ - >887	—	—	8.48	.0020	.02	—	—	—	
C ₅ - >887	—	—	8.65	.0023	0	—	—	—	
C ₅ - >887	—	—	8.58	.0194	.01	—	—	—	
Co-Steam process									
—	—	—	7.1	1.1	0.13	—	—	17 056	25
—	—	—	6.8	1.1	.10	—	—	16 886	25
—	—	—	6.6	1.1	.12	—	—	16 906	25
Flash Pyrolysis process									
406 - >620	—	—	6.15	1.13	0.56	—	—	—	26
411 - >745	—	—	6.18	1.43	.54	—	—	—	26
Sea Coal process									
-30v - 875	18.4	—	—	0.403	0.02	9.78	—	17 782	13

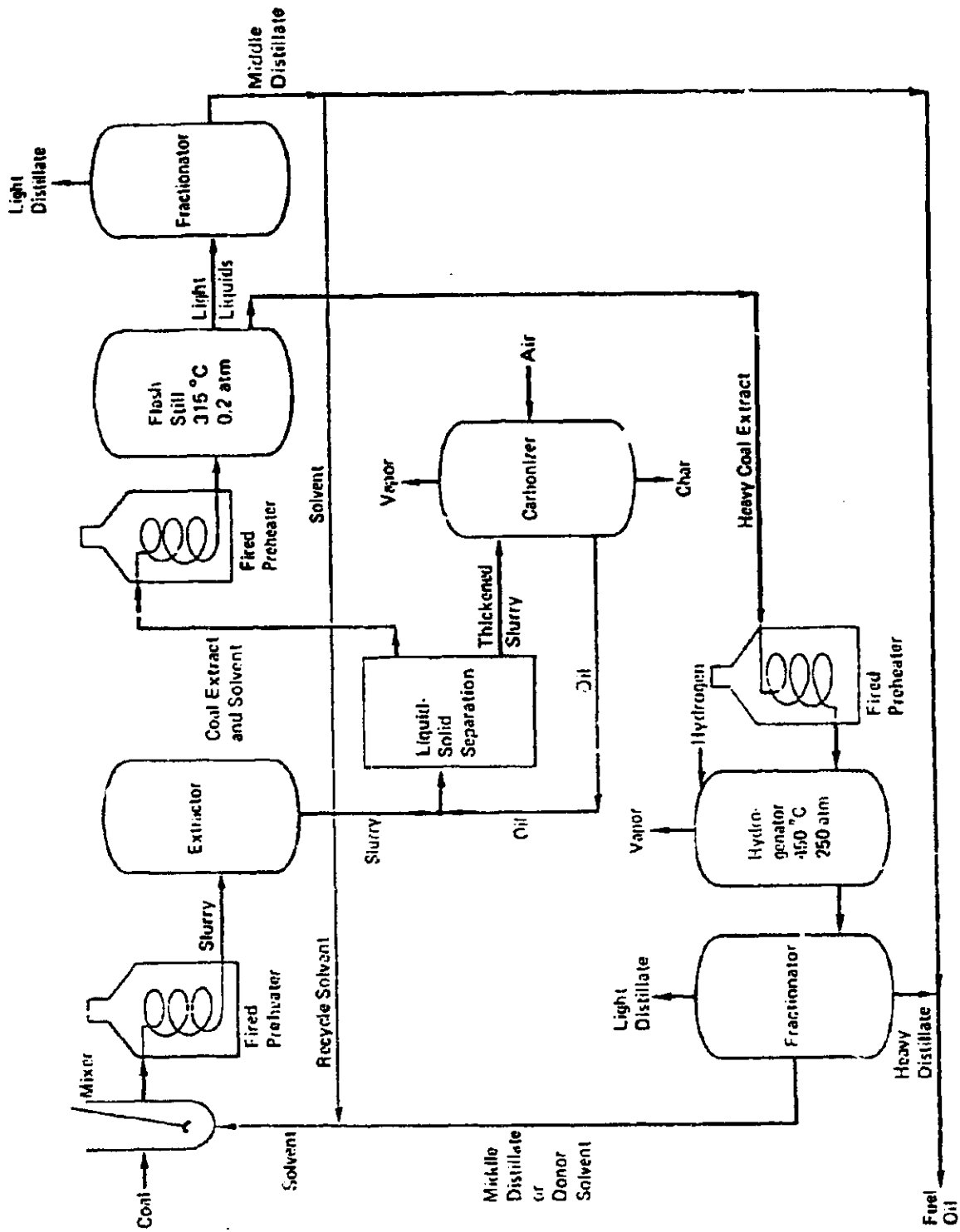


Figure 1. - Schematic of Consol Synthetic Fuel (CSF) process.

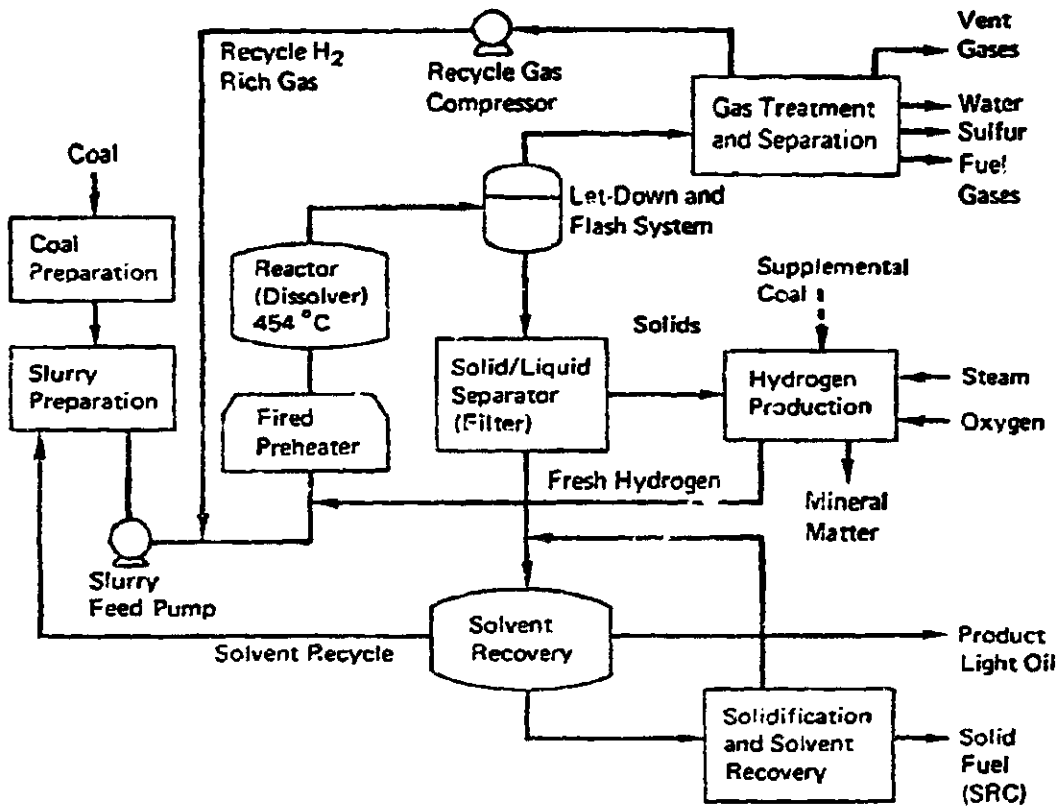


Figure 2. - Schematic of Solvent-Refined Coal (SRC) process.

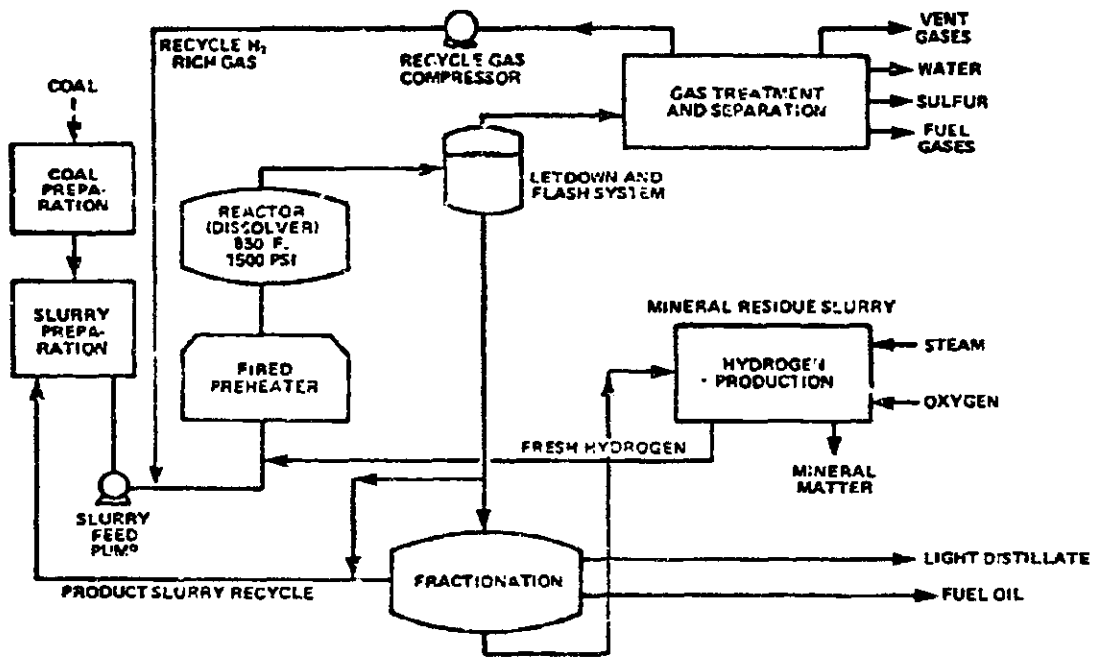


Figure 3. - Schematic of modified SRC process for distillate product

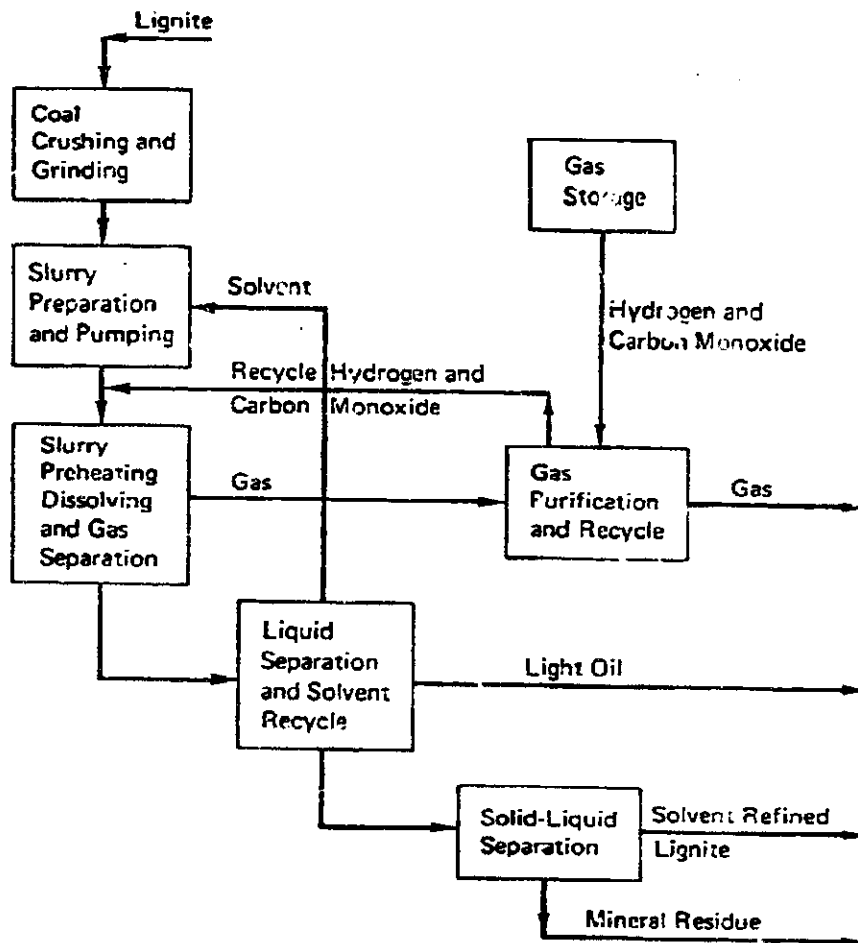


Figure 4. - Schematic of Solvent-Refined Lignite (SRL) process.

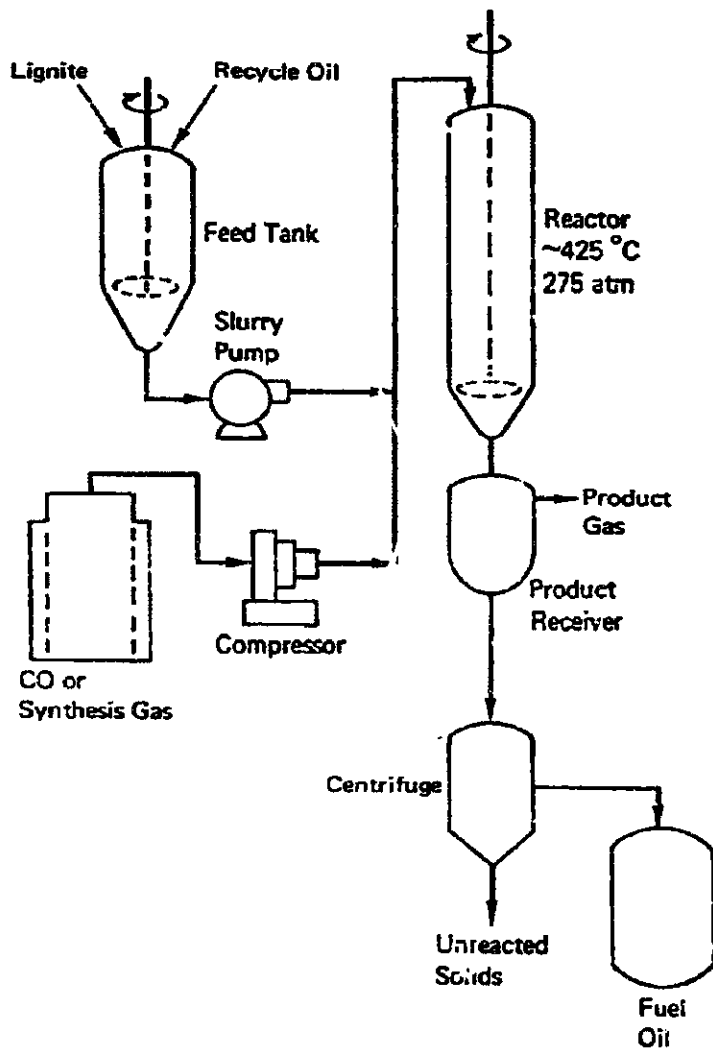


Figure 5. - Schematic of Co-Stream process.

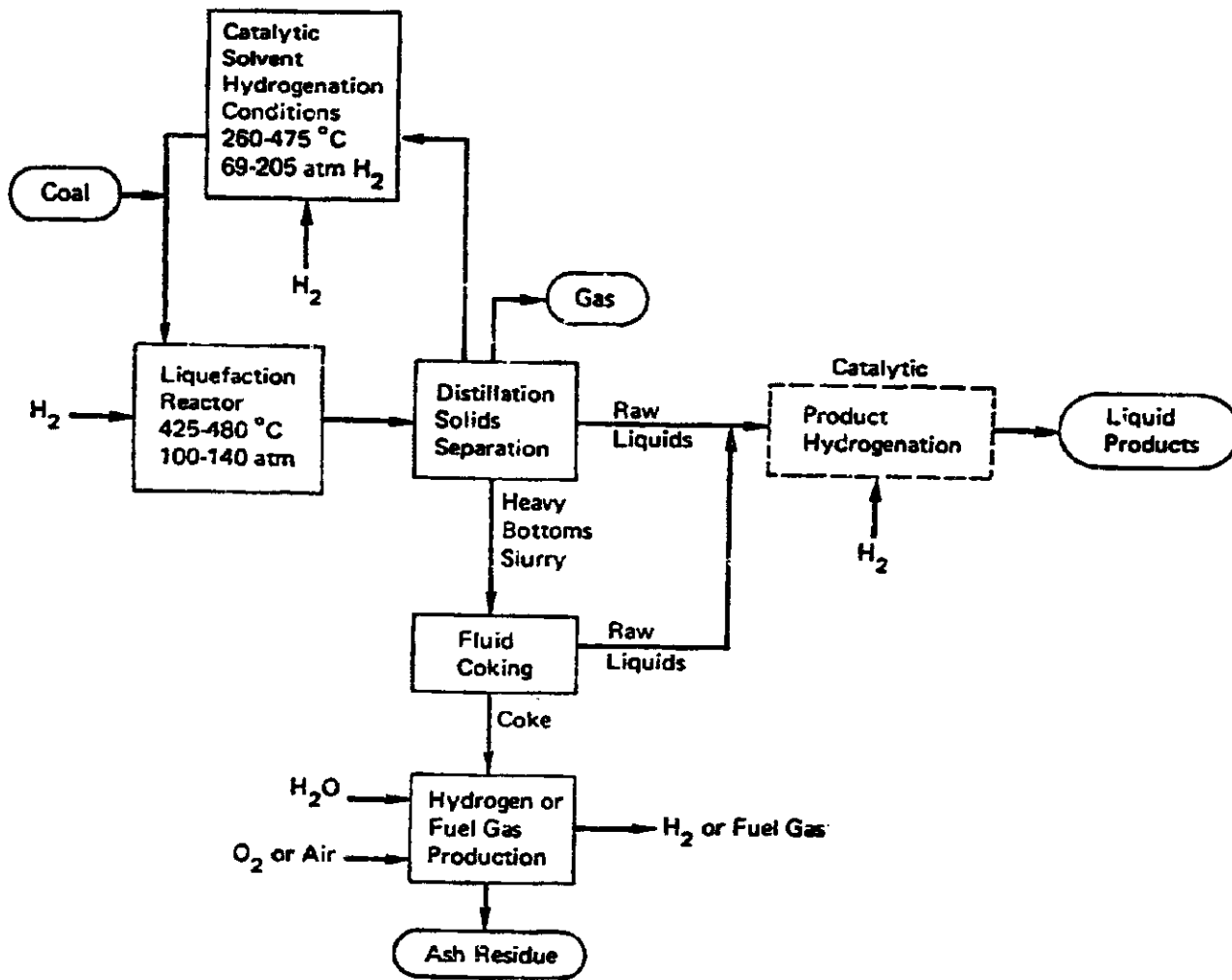


Figure 6. - Schematic of Exxon Donor Solvent (EDS) process.

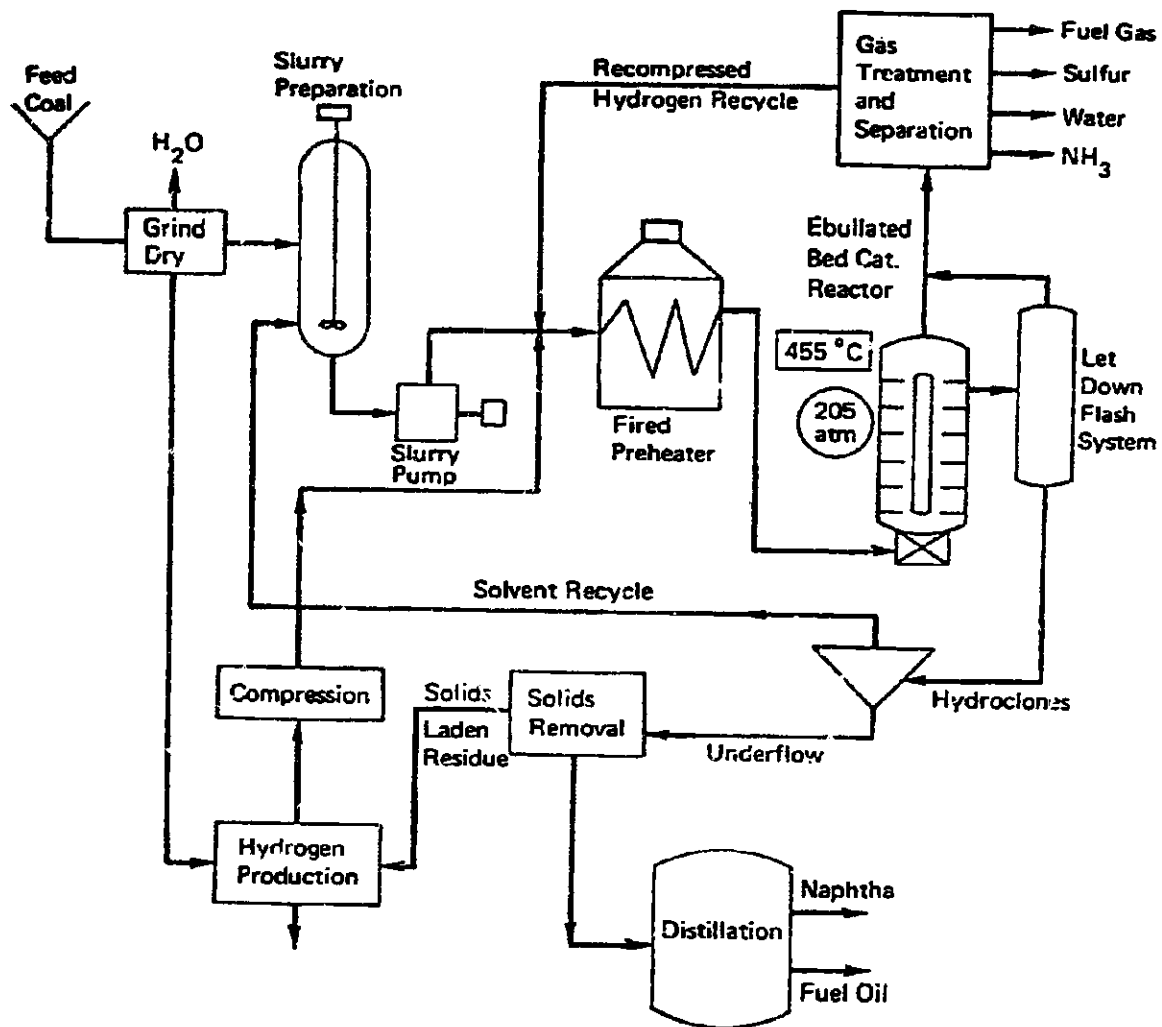


Figure 7. - Schematic of H-Coal process operated in syncrude mode.

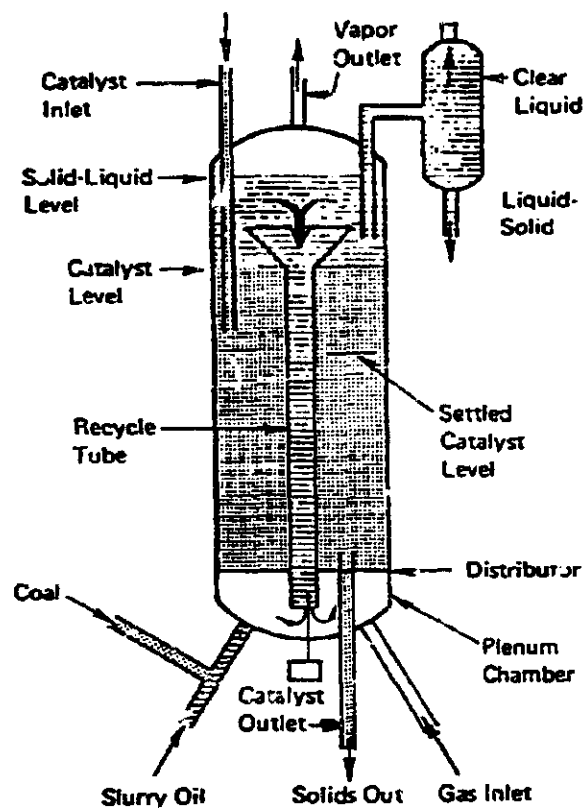


Figure 8. - Ebullating-bed reactor.

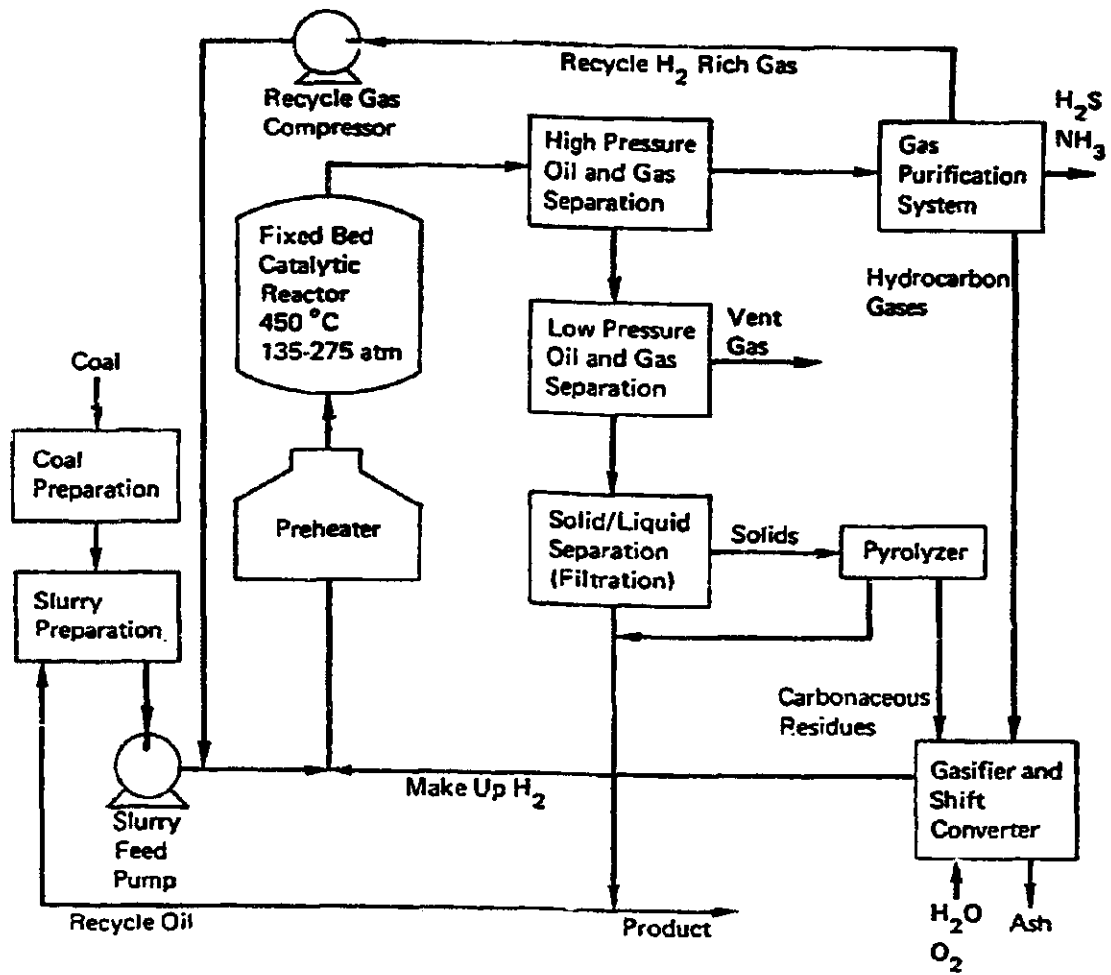


Figure 9. - Schematic of Synthoil process.

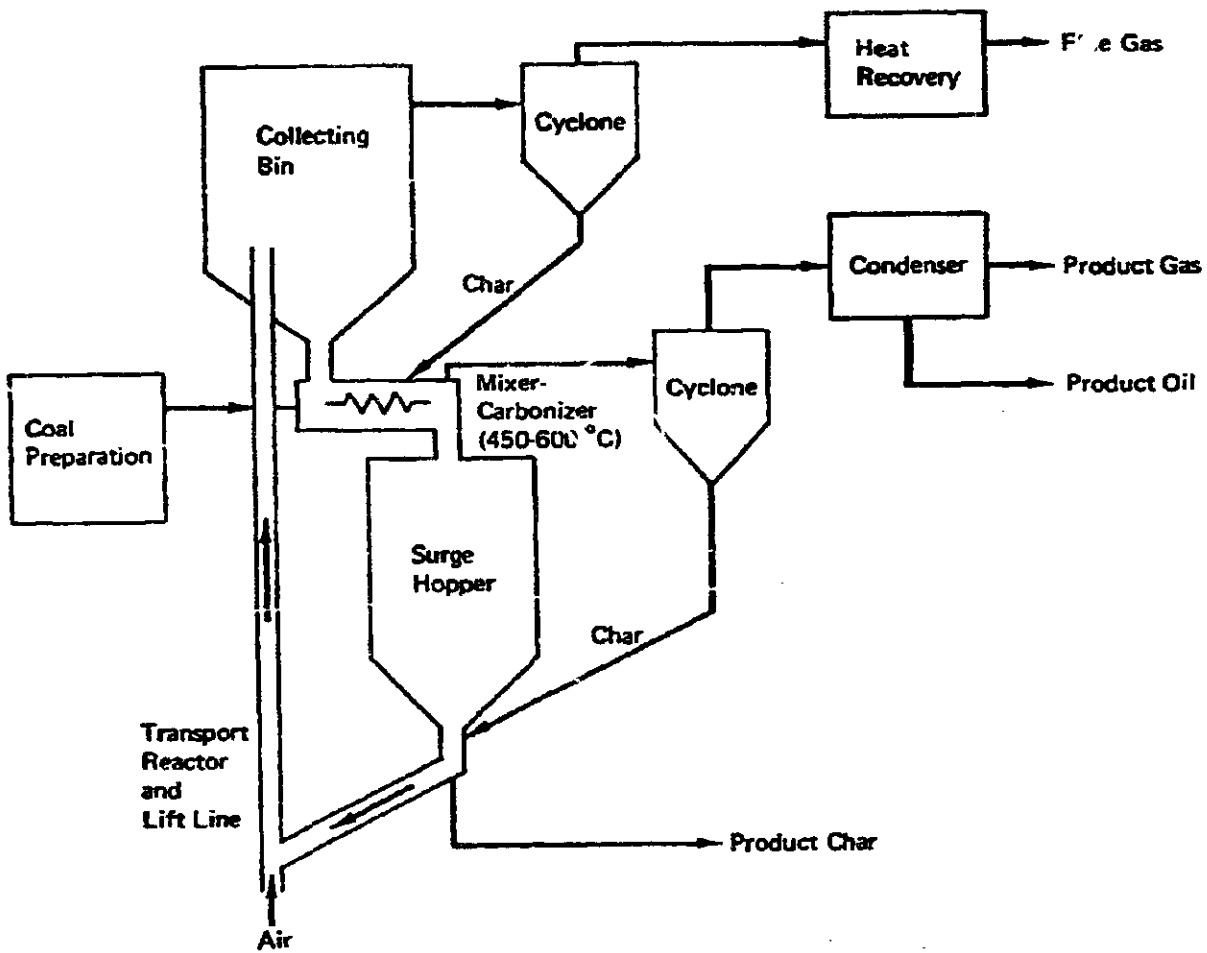


Figure 10. - Schematic of Lurgi-Ruhr gas process.

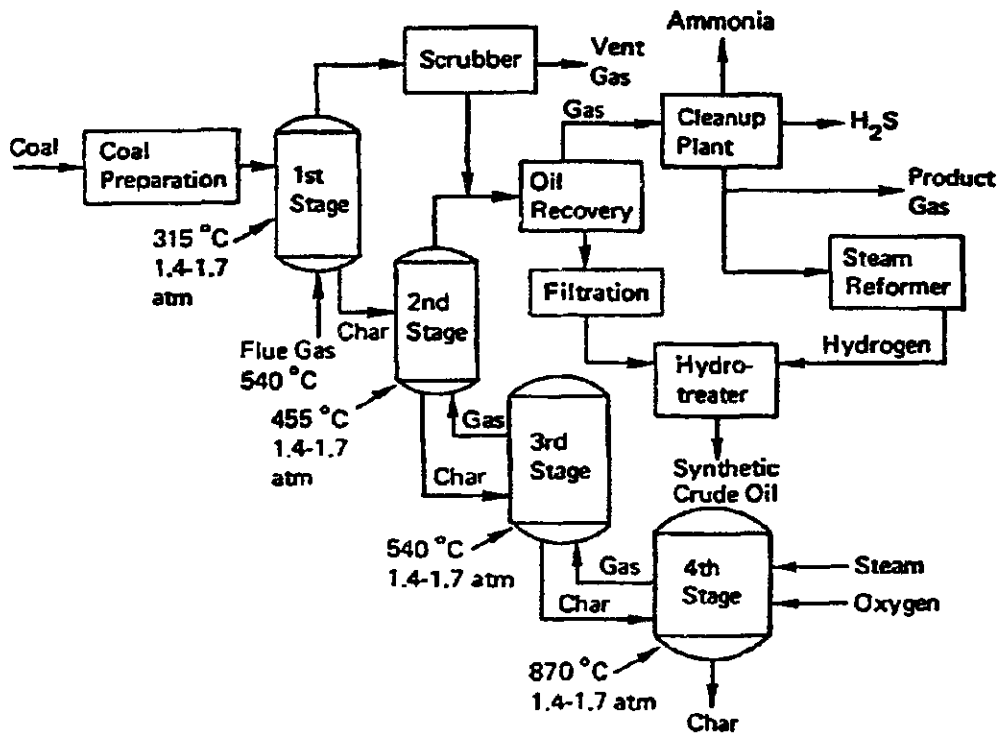


Figure 11. - Schematic of COED (FMC) process.

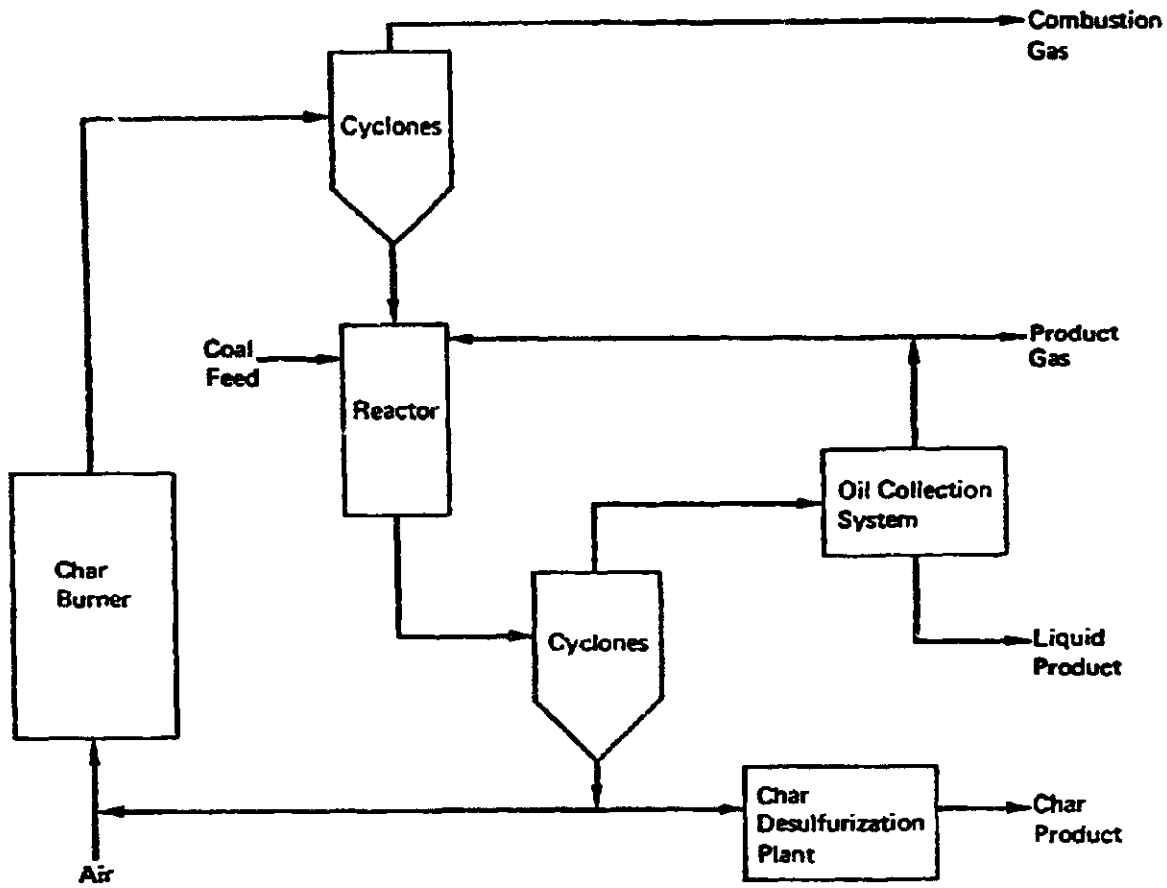


Figure 12. - Schematic of Occidental coal pyrolysis process.

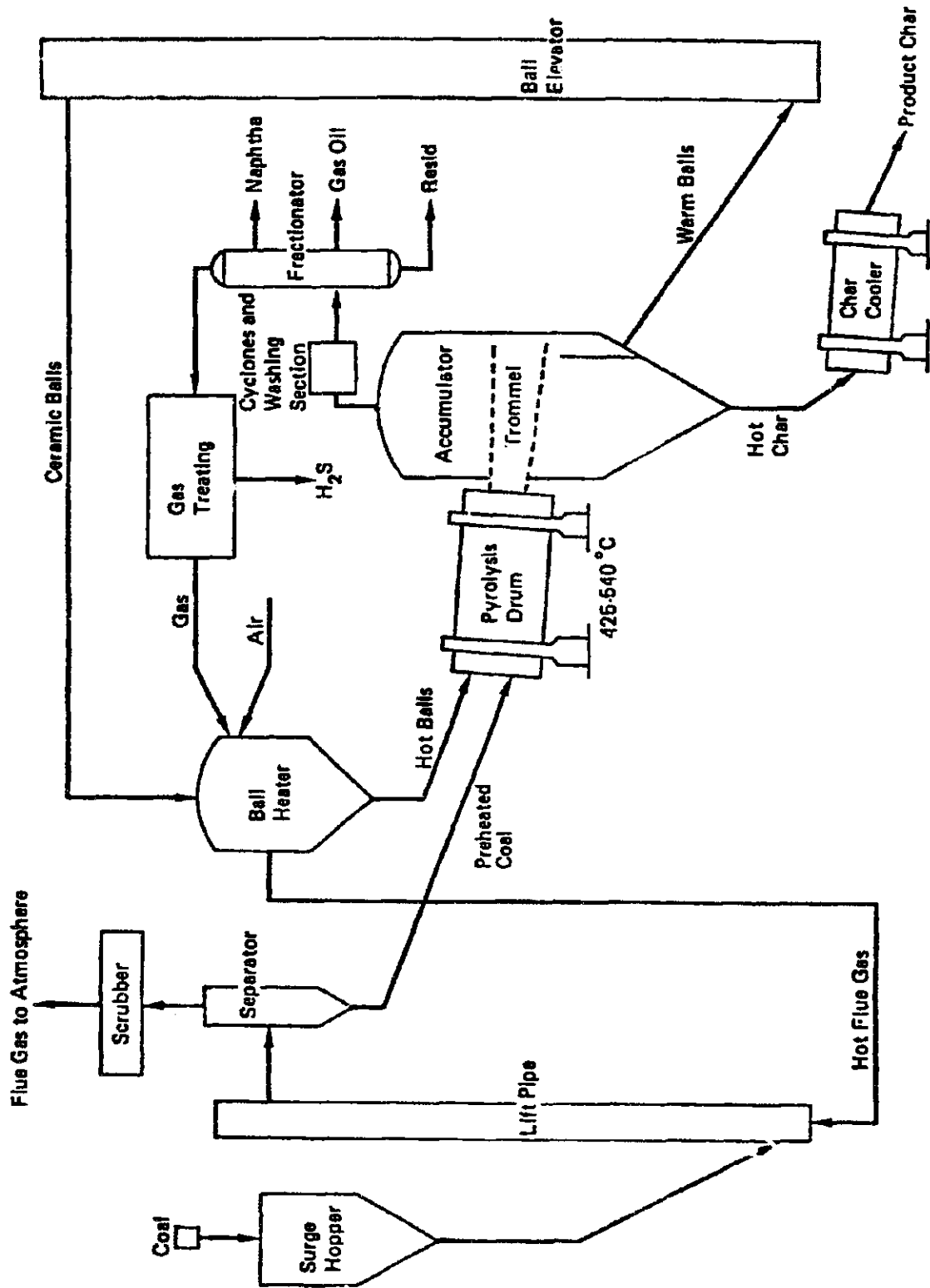


Figure 13. - Schematic of Toscoal process.

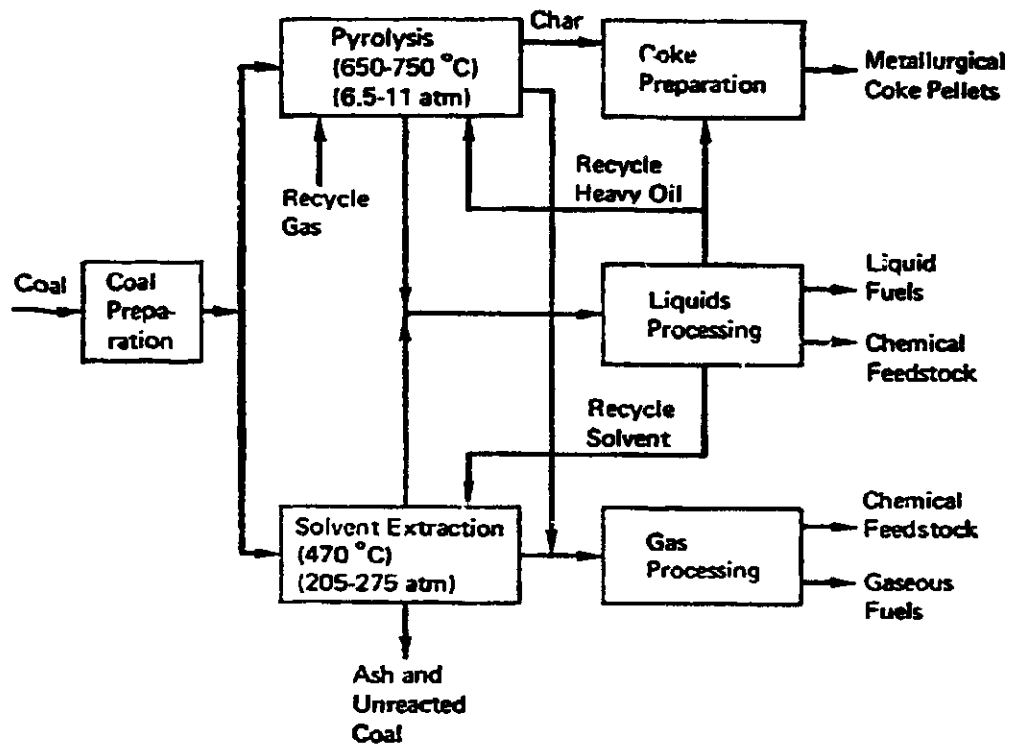


Figure 14. - Schematic of U.S. Steel Clean-Coke process.

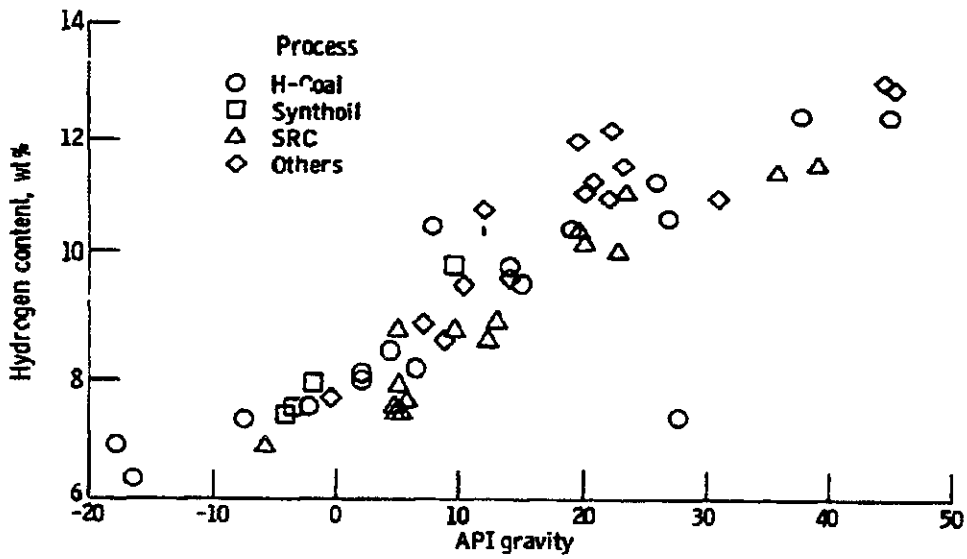


Figure 15. - Variation of hydrogen content of coal-derived fuels with API gravity.

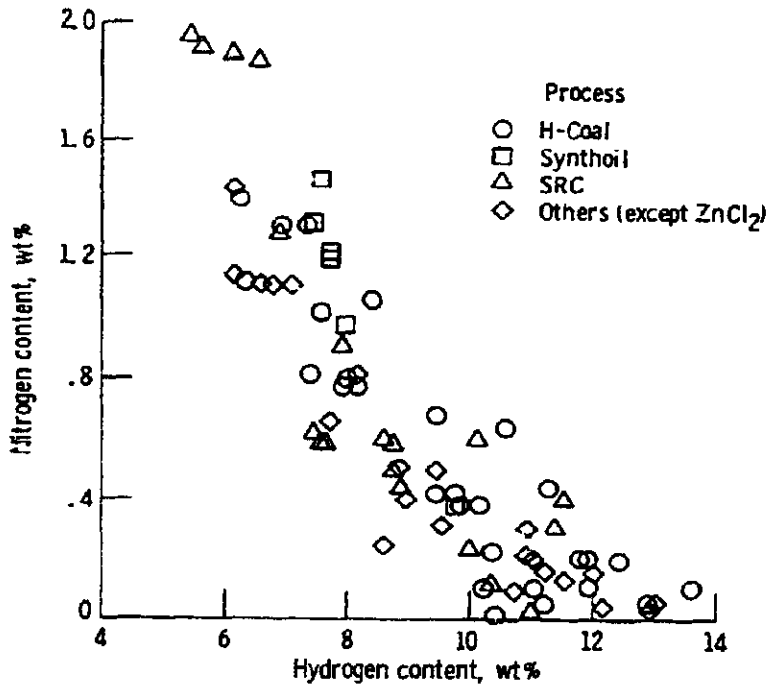


Figure 16. - Relation of fuel-bound nitrogen and hydrogen levels in coal-derived fuels.

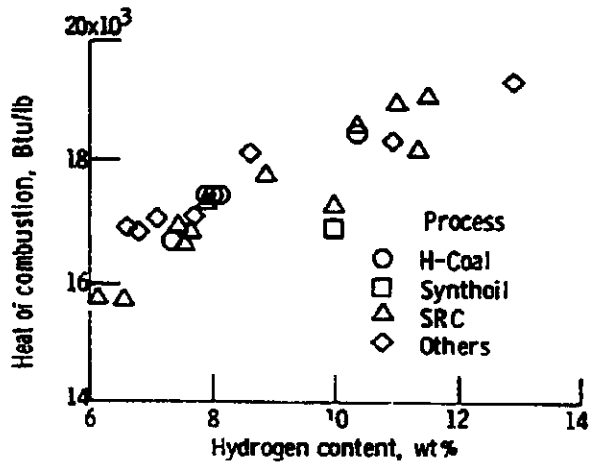


Figure 17. - Variation of heat of combustion of coal-derived fuels with hydrogen content.

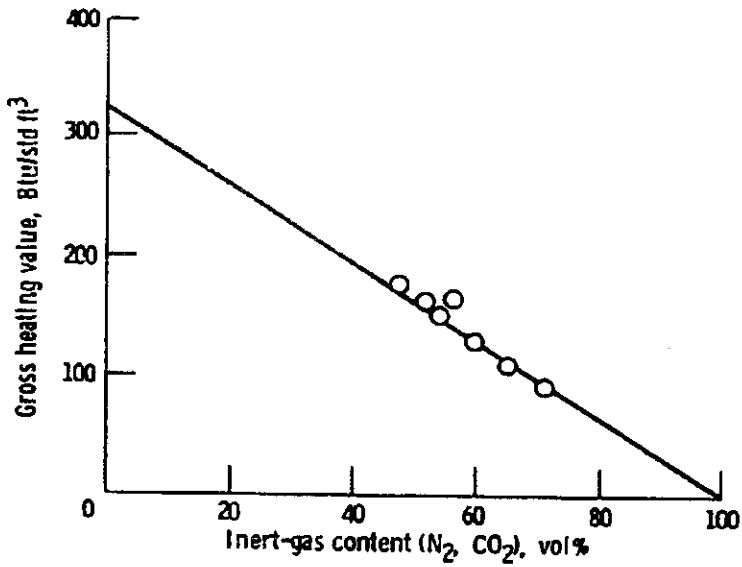


Figure 18. - Variation of gross heating value of low-Btu gases with inert-gas content.