SECTION 17

POTENTIAL IMPROVEMENTS

The conceptual POGO commercial plant design involves the interrelationship of several processes. The expectation was that the combination of processes selected would result in economies that could not be achieved individually as "stand alone" plants. The analysis presented in Section 14, Economics, indicates POGO to be potentially economically attractive. Some added concepts that are considered candidates for further improvements, technically and from the standpoint of economics, will be discusses in this section.

17.1 COAL FEED SIZE

The 70% minus 200 mesh coal size, as feed to the pyrolyzer, was selected as the most likely to result in immediate flashing of volatiles with some assurance of recovery in the high energy cyclone systems. The piloting of a slightly coarser grind would be advisable in the interest of easier solids recovery with acceptable pyrolysis results.

17.2 SRC CONVERSION

Recent studies indicate that certain coal ash constituents such as iron, are beneficial for improved hydroliquefaction yields. Work presently underway may identify the quantity and type of constituents required for improved catalysis.

17.3 SRC DISSOLVER DESIGN

Further experimental studies of required dissolver residence time may lead to a reduction of commercial dissolver size. The dynamics of the reactions in the slurry preheater furnace and in the dissolver vessel merit a thorough study. A possible result is the replacement of the dissolver by a large pipe connecting the furnace to the high pressure separator.

Another improvement would result from use of a solvent-to-coal ratio as low as 1.5 instead of the more conservative value of 3.0 used in this design. Pilot plant experience indicates that the lower ratio can be used. The predicted economic impacts are reductions of 3 to 5% in fixed capital investments, and required product selling prices

17.4 PROCESS DESIGN DATA

The process design is based on the data presently available. It is highly desirable to develop further supporting data by more extensive pilot plant investigations into the slurry recycle mode of SRC operation at varying pressures, dissolver retention times and temperatures, slurry-to-coal ratios, and other pertinent variables.

17.5 EQUIPMENT DEVELOPMENT

Certain items of mechanical equipment were included in this design that require further development. The design economics are intended to show the incentive for this development. Successful application of these items will advance the commercialization of coal conversion.

Representative desirable developments include:

- Medium- and high-pressure centrifugal coal slurry pumps.
- Medium- and high-pressure dry coal feeders.
- Improvements in the field of gas/solids separation, especially at high pressures and temperatures.
- Methods of operational control of two-stage entrained gasifiers to maintain steady state operation, considering the interaction of coal, char, oxygen, and steam feed variations.

17.6 FLASH PYROLYSIS

Development of yield data from pilot plant operations is needed. Improvement of yields and optimum pyrolyzer operation could result from a better selection of pyrolysis temperature.

17.7 THERMAL CRACKING AND COKING

These processes are based upon results derived from stocks of petroleum origin. Pilot runs are required on coal derived feeds to verify or establish accurate yields for these operations.

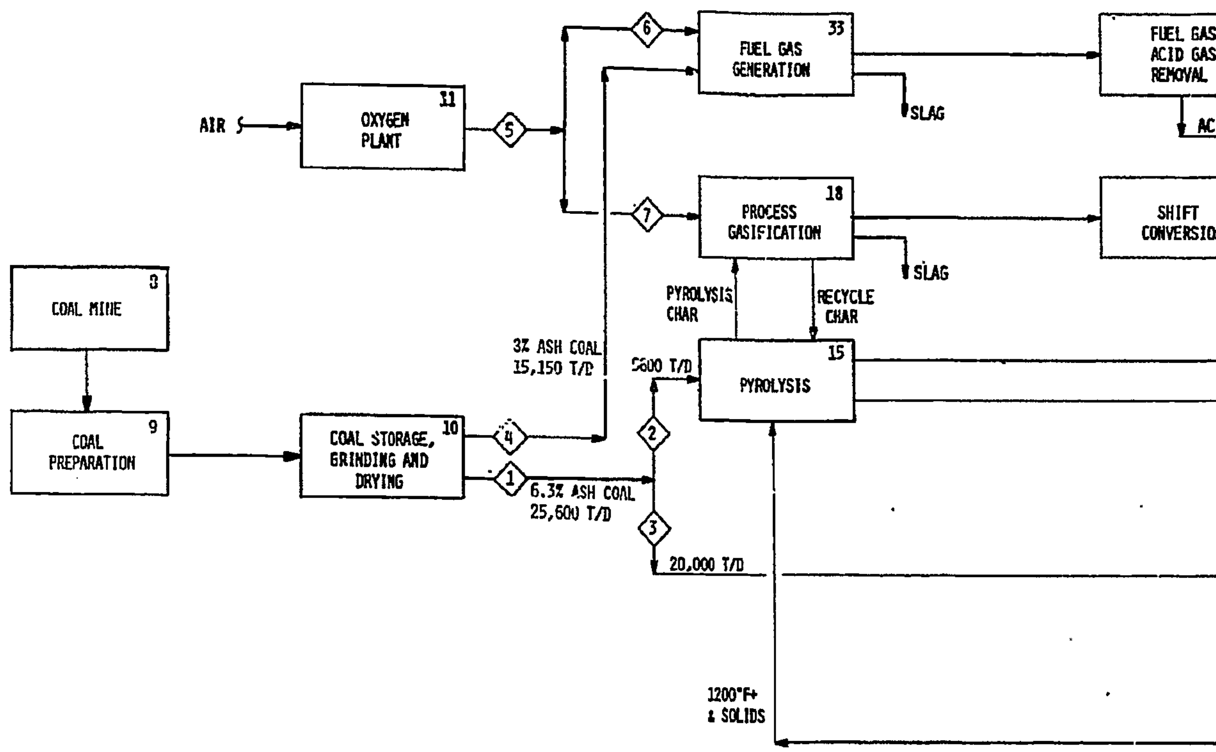
17.8 POWER GENERATION EQUIPMENT

Gas turbines at the present time are still undergoing vigorous development, but in the near future, units having inlet gas temperatures approaching 2,400°F with exhaust temperatures approximating 1,100°F do not seem unreasonable. The present state of the art for gas turbines are firing temperatures of 2,000°F with exhaust temperatures approaching 1,000°F. The higher gas turbine firing temperatures would increase unit capability as well as turbine efficiencies.

Present exhaust temperatures, approximating 1,000°F, limit steam temperatures to approximately 875°F to 900°F when used in an unfired steam bottoming cycle. Higher gas turbine exhaust temperatures, which are commensurate with improved gas turbine efficiency, would permit use of more sophisticated higher temperature unfired steam bottoming cycles. Steam temperatures approaching 1,000°F also increase bottom cycle efficiency; 1,000°F steam temperatures are considered common for steam power plants. This expected higher operating temperature with improved gas turbine efficiency would greatly improve combined cycle efficiency as presented for the POGO project, which uses present state of art hardware.

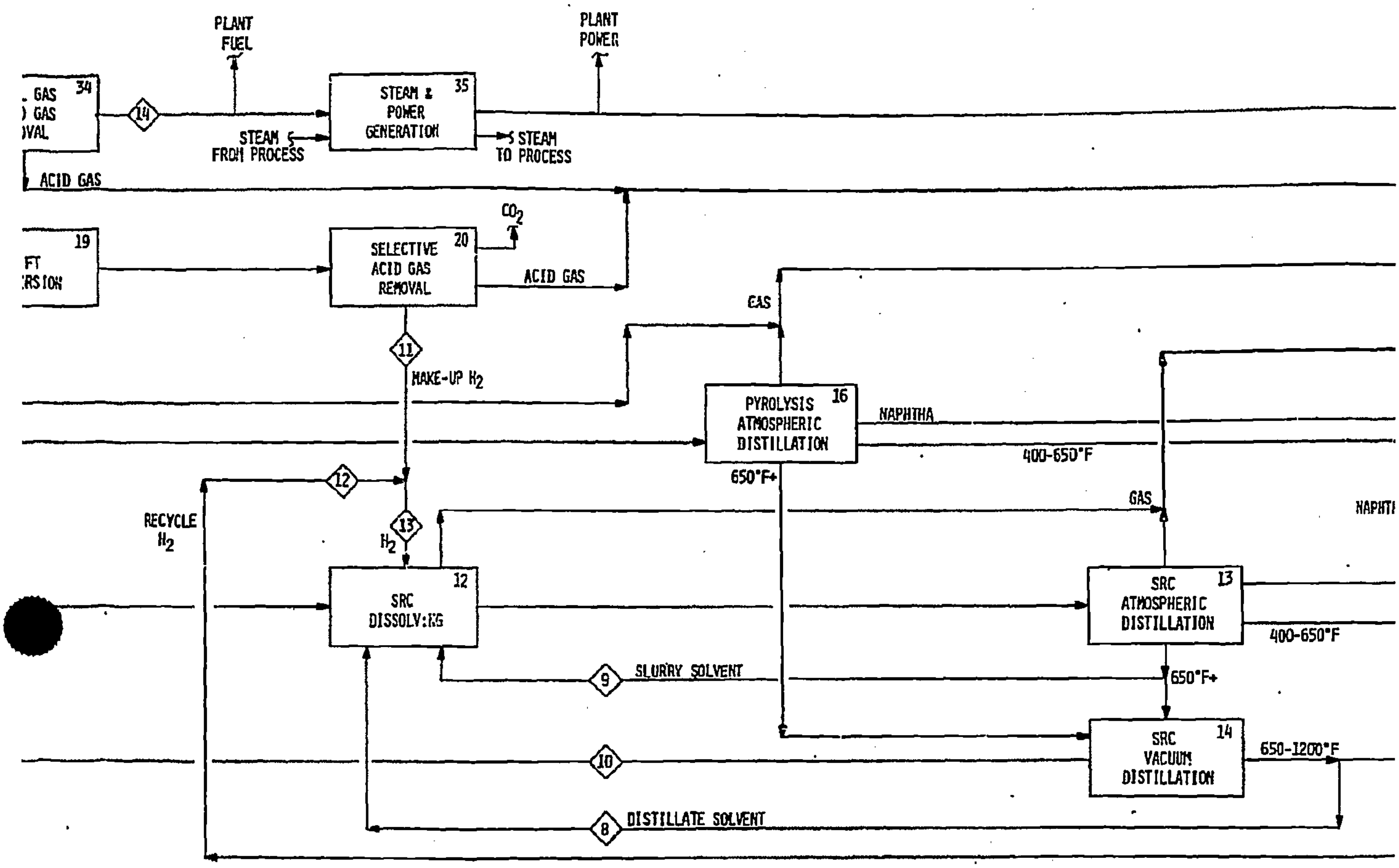
Overall combined cycle efficiencies, at present, are about 38%. With the higher turbine firing temperatures, an improvement in cycle efficiency on the order of 5% is reasonable.

Should larger quantities of 50-psig steam be required for process, a low pressure boiler section would be added to the waste heat recovery steam generator without affecting production of the high pressure boiler section. This 50 psig low pressure boiler section could be operated in parallel with a main steam turbine extraction and deaeration loop, which would make the supply of this steam more economical than depending solely on main steam turbine extraction, as shown for POGO because of the small quantities involved.



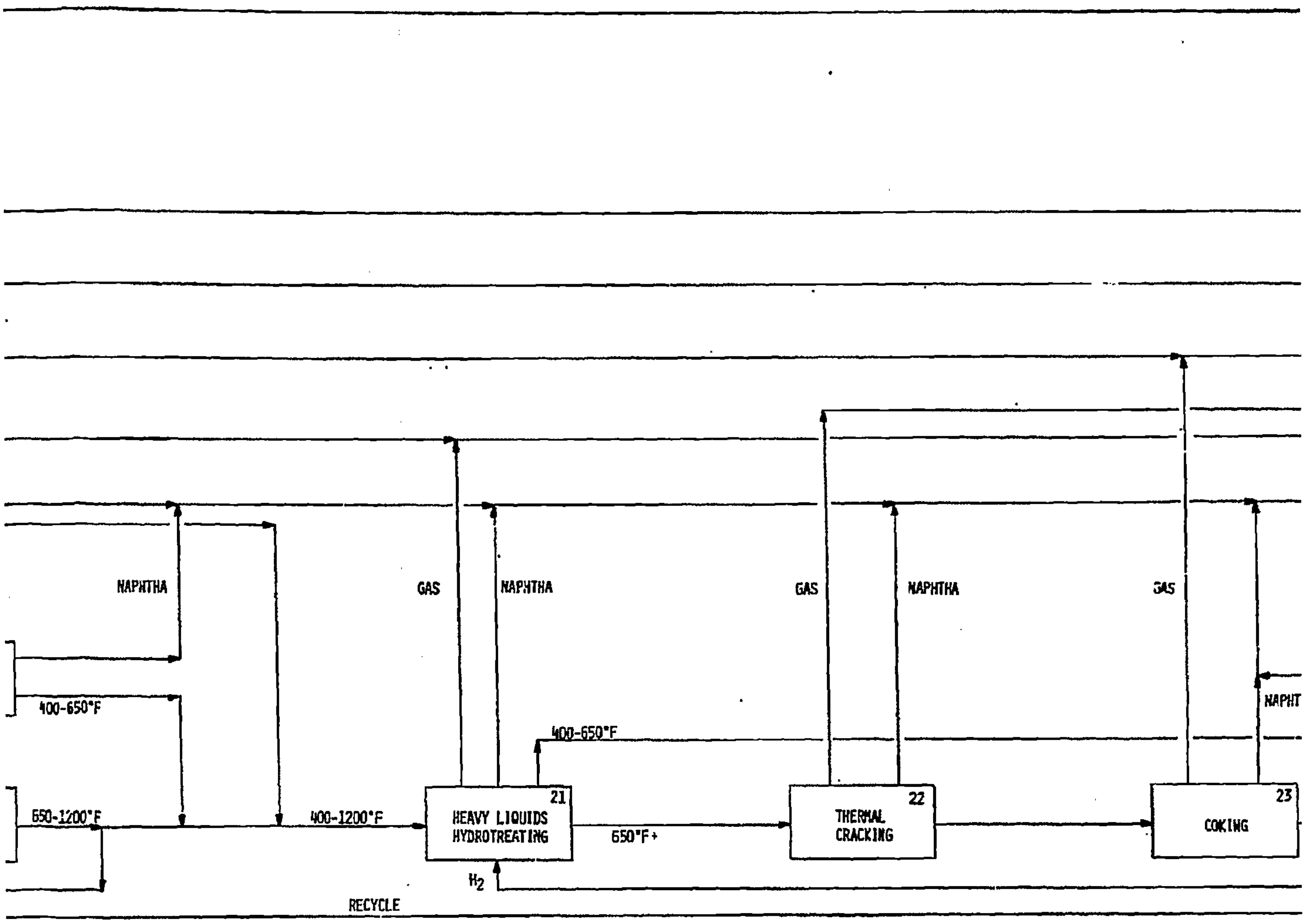
AIR
OXYGEN PLANT 11
5
6
7
FUEL GAS GENERATION 33
SLAG
FUEL GAS ACID GAS REMOVAL
AC
PROCESS GASIFICATION 18
SLAG
SHIFT CONVERSIO
COAL MINE 8
COAL PREPARATION 9
COAL STORAGE, GRINDING AND DRYING 10
4
3% ASH COAL 15,150 T/D
PYROLYSIS CHAR
RECYCLE CHAR
5600 T/D
PYROLYSIS 15
2
1
6.3% ASH COAL 25,600 T/D
3
20,000 T/D
1200°F+ & SOLIDS

A



DESCRIPTION / COMPONENT	① COAL TO PROCESS	② COAL TO PYROLYSIS	③ COAL TO SRC	④ COAL TO FUEL GAS	⑤ TOTAL OXYGEN	⑥ O_2 TO UNIT 34	⑦ O_2 TO PROCESS	⑧ DISTILLATE SOLVENT	⑨ SLURRY SOLVENT	VAC
O_2	-	-	-	-	17,998.99	11,155	6,843.99	-	-	
H_2	-	-	-	-	-	-	-	-	-	
N_2	-	-	-	-	321.98	199.7	122.28	-	-	
CO	-	-	-	-	-	-	-	-	-	
CO_2	-	-	-	-	-	-	-	-	-	
NH_3	-	-	-	-	-	-	-	-	-	
H_2S	-	-	-	-	-	-	-	-	-	
H_2O	691	151	540	408.8	-	-	-	-	-	
CH_4	-	-	-	-	-	-	-	-	-	
C_2H_4	-	-	-	-	-	-	-	-	-	
C_2H_6	-	-	-	-	-	-	-	-	-	
C_3H_6	-	-	-	-	-	-	-	-	-	
C_3H_8	-	-	-	-	-	-	-	-	-	
C_4H_8	-	-	-	-	-	-	-	-	-	
C_4H_{10}	-	-	-	-	-	-	-	-	-	
IBP-400	-	-	-	-	-	-	-	-	-	
400-650	-	-	-	-	-	-	-	400	737	
650-950	-	-	-	-	-	-	-	9,249	15,453	
950-1200	-	-	-	-	-	-	-	9,980	16,947	
1200+	-	-	-	-	-	-	-	371	3,592	
Residue	-	-	-	-	-	-	-	-	1,631	
Ash	1,613	353	1,260	1,212	-	-	-	-	1,640	
Coal (MAF)	23,296	5,096	18,200	13,529.2	-	-	-	-	-	
Coke	-	-	-	-	-	-	-	-	-	
Sulfur	-	-	-	-	-	-	-	-	-	
TOTAL T/D	25,600	5,600	20,000	15,150	18,320.97	11,354.7	6,966.27	20,000	40,000	
MMSCFD	-	-	-	-	435.5	269.9	165.6	-	-	
BPD	-	-	-	-	-	-	-	-	-	
Heating Value MMBTU/D	700.659	155.019	553.610	411.78	-	-	-	-	-	

B



8 TILLATE LVENT	9 SLURRY SOLVENT	10 SRC VACUUM BTMS..	11 MAKE UP H_2	12 RECYCLE H_2	13 TOTAL H_2	14 TOTAL FUEL GAS	15 NH_3	16 SULFUR	17 SNG	18 C_3 LPG	19 C_4LPG	20 GASOLINE	21 FUEL OIL	22 COKE
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	1,307.49	290.51	1,606	1,376.96	-	-	25.55	-	-	-	-	-
-	-	-	240.71	41.6	282.31	435.55	-	-	91.75	-	-	-	-	-
-	-	-	849.34	106.5	955.84	21,259.67	-	-	-	-	-	-	-	-
-	-	-	35.02	-	35.02	711.09	-	-	270.28	-	-	-	-	-
-	-	-	-	-	-	-	205.68	-	-	-	-	-	-	-
-	-	-	3.29	-	3.29	.01	-	-	-	-	-	-	-	1.6
-	-	-	2.61	-	2.61	61.07	-	-	0.16	-	-	-	-	-
-	-	-	124.66	19.3	143.96	145.89	-	-	1,506.50	-	-	-	-	-
-	-	-	-	-	-	-	-	-	81.75	0.41	-	-	-	-
-	-	-	-	-	-	-	-	-	861.65	32.95	2.1	-	-	-
-	-	-	-	-	-	-	-	-	6.18	62.43	55.8	34.0	-	-
-	-	-	-	-	-	-	-	-	60.90	1,162.29	15.18	9.2	-	-
-	-	-	-	-	-	-	-	-	-	2.11	739.65	777.8	-	-
-	-	-	-	-	-	-	-	-	-	43.78	7.1	4,652.53	361	-
-	-	-	-	-	-	-	-	-	-	-	-	-	3,367	-
400	737	7.53	-	-	-	-	-	-	-	-	-	-	230	-
9,249	15,453	165.45	-	-	-	-	-	-	-	-	-	-	-	-
9,980	16,947	105.21	-	-	-	-	-	-	-	-	-	-	-	-
371	3,592	2,628.48	-	-	-	-	-	-	-	-	-	-	-	-
-	1,631	1,306.60	-	-	-	-	-	-	-	-	-	-	-	-
-	1,640	1,265.37	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,601
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	769.9	-	-				
20,000	40,900	5,470.64	2,563.12	465.91	3,029.03	23,990.24	205.68	769.9	2,904.12	1,303.97	819.83	5,473.53	3,958	1,602.6
-	-	-	532.9	117.3	650.2	1,132.53	-	-	113.16	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	14,760	8,164	42,630	26,050	-
-	-	-	-	-	-	360.00	3.98	6.75	120.86	56.4	35.0	221.87	166.72	45.26