FE-2240-32
Distribution Category UC-90c

Series No. II: G-4

Vertical Lift Dryer
Pilot Plant Design

Final Report

A L Wilson and R H Stewart

C F BRAUN & CO
Alhambra, CA 91802

Date Published - April 1978

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY
AND
GAS RESEARCH INSTITUTE

Under Contract No. EX-76-C-01-2240

The material presented in this report does not contain nor disclose anything of a patentable nature.

ABSTRACT

While carrying out our responsibility as evaluation contractor for certain high Btu coal gasification processes, C F Braun & Co became aware that certain items of equipment were lacking in the sense that they were unavailable or unproven in the severe environment of demonstration size coal gasification plants. A vertical lift dryer is unproven in this service. Yet it would provide considerable economic advantage for drying pulverized coal at high pressure prior to injecting the coal into a gasifier.

Braun recommended that a small scale vertical lift dryer be tested to obtain design and scale-up data. The Joint DOE-GRI Operating Committee authorized Braun to design a pilot plant size vertical lift dryer. The dryer was to be installed at the BI-GAS pilot plant and integrated into its operations.

This report gives the details for the design and testing of a vertical lift dryer. Final closure engineering and construction will be done later.

TABLE OF CONTENTS

BASIS

C F Braun & Co has served under this contract to technically evaluate certain high Btu coal gasification pilot plants sponsored by the joint DOE-GRI Coal Gasification Program. The processes included (1) HYGAS Steam-oxygen, (2) CO_2 Acceptor, (3) BI-GAS, (4) Synthane, and (5) HYGAS Steam-Iron.

BACKGROUND While serving as evaluation contractor, Braun prepared commercial concept designs for the five high Btu coal gasification processes. It became evident that certain equipment would be needed in the commercial plants which were not available, not developed, or unproven. The capacities, temperatures, pressures, and erosive conditions encountered in the gasification processes exceeded the capability of certain existing equipment.

One of the equipment concepts that is not proven is a vertical lift dryer.(1) In this report we present the design of a pilot plant size vertical lift dryer. This design package was made specifically for the BI-GAS pilot plant, however with modification it can be adapted to other gasification pilot plants.

DISCUSSION

Coal must be reduced in size before being gasified. The size reduction operation may be carried out either by dry grinding or wet milling. Each method of size reduction has certain advantages. The final choice of which method to use for a given plant design will depend upon technical and economic considerations.

The ground coal must be introduced into a high pressure gasifier or pretreater vessel. One method of injecting coal is to pump a slurry into the gasifier at high pressure using reciprocating pumps. The slurry is composed of a mixture of ground coal and either water or oil.

The liquid must be vaporized in order to dry the coal before gasification commences. Before a process can be economically viable for a demonstration size plant, a cost effective method for drying the coal must be found.

The vertical lift coal dryer offers such a cost effective method. It utilizes the hot raw gas from the gasifier to lift and dry the coal slurry. Thus most of the necessary quenching of the raw gas prior to gas cleanup is accomplished without additional equipment or expenditure of energy.

The commercial concept design of a vertical lift dryer is shown in Figure 1. The BI-GAS process is used in this example. The coal slurry is pumped at high pressure into the slurry injection nozzle. Hot raw gas from the gasifier enters the annular space around the slurry injection nozzle. Flowing concurrently up the dryer, hot gas and coal slurry mix intimately. The water is evaporated by the hot gas. By the time the stream reaches the cyclone separator, the coal is dry. The coal is separated from the gasifier raw gas, and flows down the dip pipe into the gasifier. The raw gas flows to the raw gas quench section for further processing.

The pilot plant design of the vertical lift dryer will use a separate stream of hot gas to dry the coal. Either nitrogen or recycle gas can be used in the BI-GAS pilot plant. A separate gas stream is used so that the drying of coal can be done independently, and not have to depend upon having the gasifier in operation. This arrangement of using a separate hot gas stream to dry the coal is made only for the purpose of obtaining operating and design data. A demonstration plant is still expected to use hot gas from the gasifier to dry the coal.

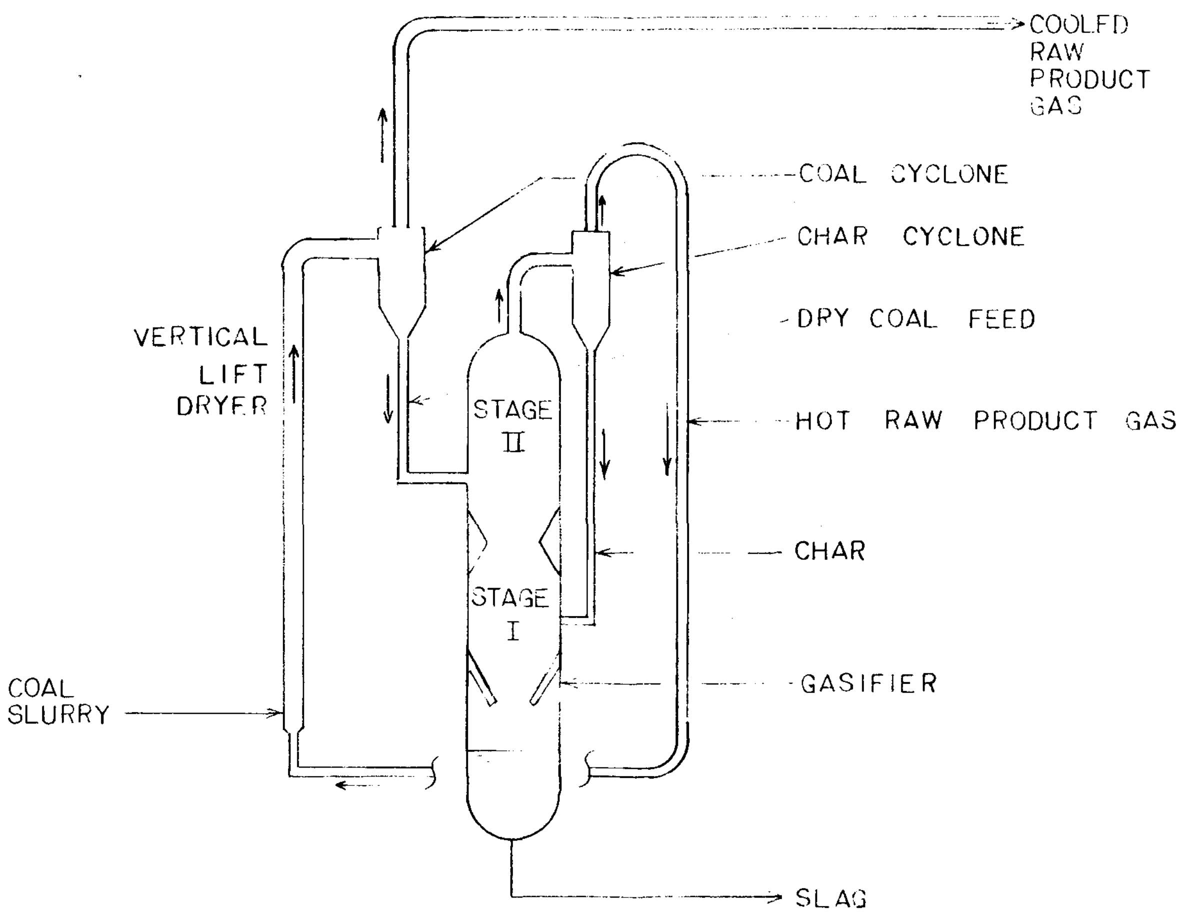


FIGURE I. COMMERCIAL CONCEPT ARRANGEMENT
BI-GAS PROCESS USING
VERTICAL LIFT DRYER

COAL DRYING

The arrangement for the vertical lift dryer for the BI-GAS pilot plant is shown on the two piping and instrumentation diagrams. Drawing number 4568-1006-KD-1, Page 7, shows the vertical lift dryer installed parallel to the existing down-flow dryer. A slurry of coal and water flows through the Slurry Preheater, E-201. In the exit line, two block valves will direct the slurry either through the existing spray dryer, X-202, or through the vertical lift dryer. When the vertical lift dryer is being used, the coal slurry is sprayed into an upward flowing stream of hot gas and is lifted to the top of the gasifier structure at elevation 160 feet. A sketch of the slurry nozzle section is presented on Page 8.

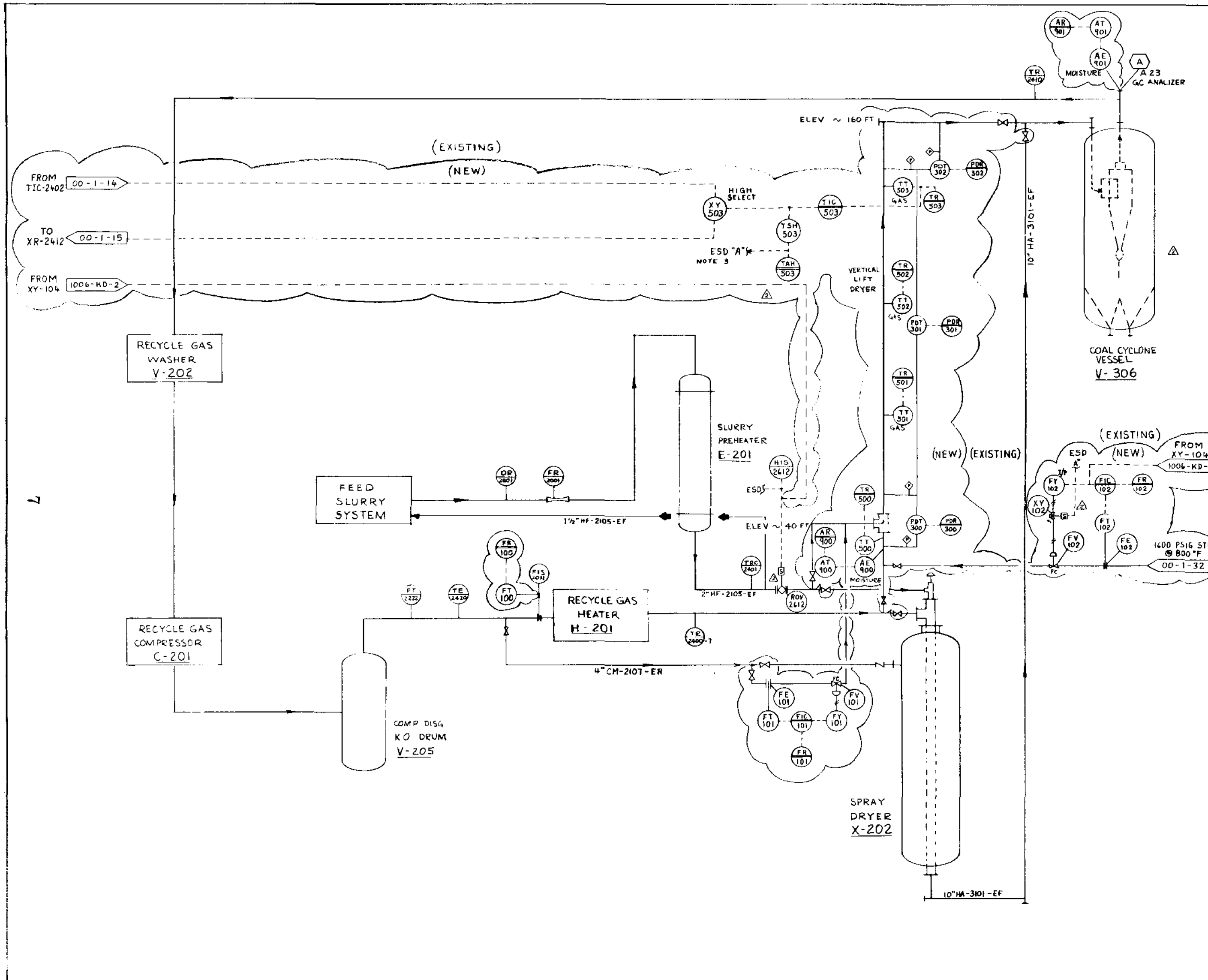
The vertical lift dryer is connected into the emergency shutdown system "A" at TR-503. A tie-in to the Recycle Gas Heater Control system is also provided. The high select relay, XY-503, chooses the temperature control signal from the dryer being used - either the vertical lift dryer or the downflow dryer.

Auxiliary steam may be added to the hot gas using flow control loop 102. The purpose of adding steam is to control the moisture content of the inlet hot gas stream.

A supply of atomizing gas is added to the coal slurry shortly before it flows to the injection nozzle. The purpose of the atomizing gas is to exercise some control over the droplet size and spray pattern. Flow control loop 101 sets the rate of flow of this gas.

Two moisture analyzers are provided. These two instruments provide essential data needed to evaluate the drying of coal. AR-900 records the moisture content of the hot gas stream before it mixes with the coal slurry. AR-901 records the moisture content of the gas after coal has been removed from the gas.

Temperature and differential pressure instruments are also provided to give additional operating data.



NOTES

1. THIS FLOW SKETCH SHOWS RECOMMENDED REVISIONS TO PROVE FEASIBILITY OF THE VERTICAL LIFT DRYER. IT ALSO SHOWS MAJOR EQUIPMENT AND INSTRUMENTATION REQUIRED TO OBTAIN DRYING RATE DATA.
2. ALL EQUIPMENT IS EXISTING, EXCEPT VERTICAL LIFT DRYER.
3. CONNECT TSH-503 TO THE EXISTING ESD SYSTEM "A".
4. REFER TO STEARNS-ROGER MECHANICAL FLOW DIAGRAM DRAWINGS 22221-00-1-14
   -15
   -16
5. THE FOLLOWING NOTES APPLY FROM 4568-1006-KD-2: 3, 4, 6.

REV	DATE	DESCRIPTION	BY	CHECKED	DESIGNED	APPROVED
2		DESIGN ISSUE				ALW
1	12/1	APPROVAL ISSUE				ALW
0	11/3	PLANNING ISSUE				ALW

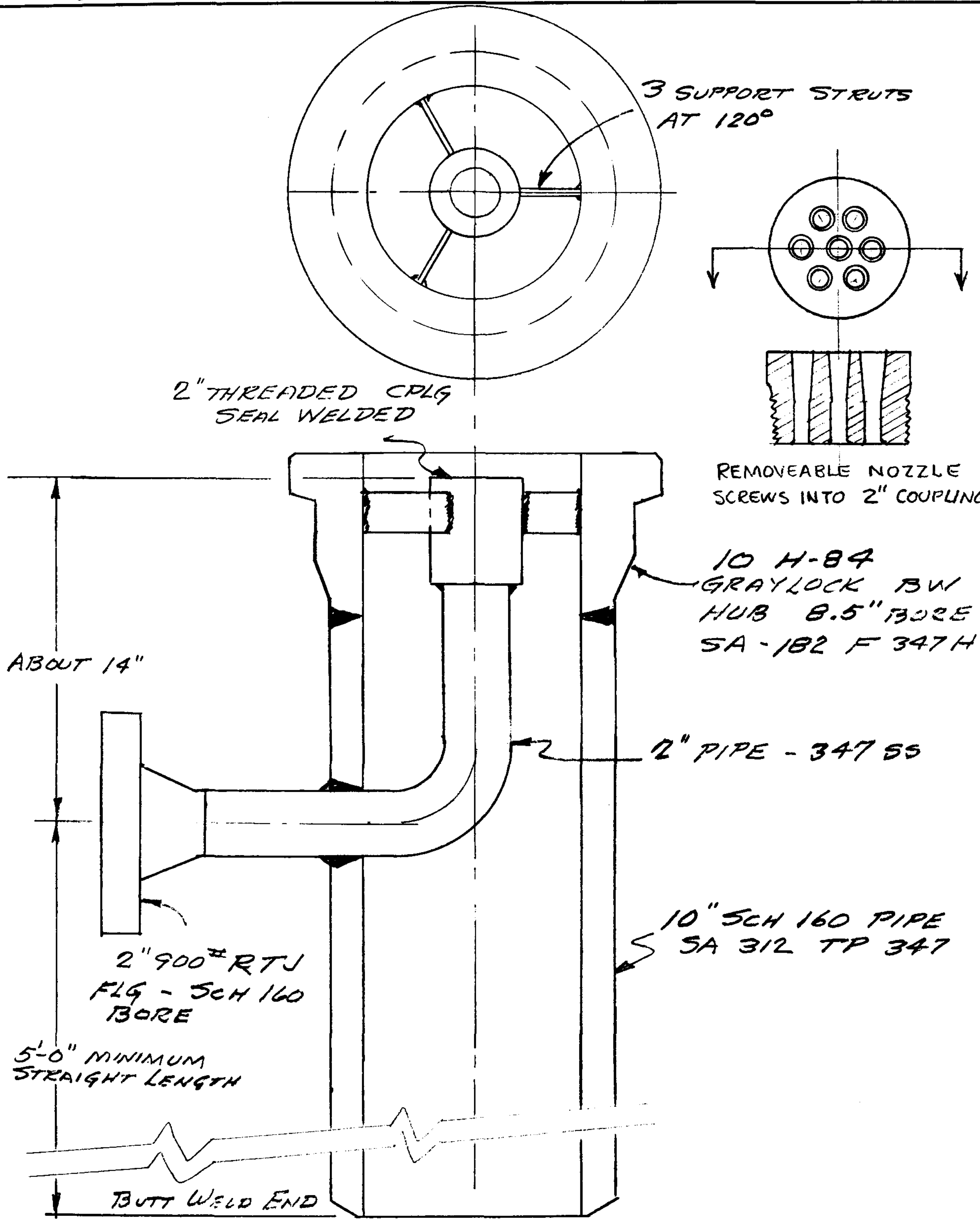
ISSUED FOR CONSTRUCTION — BY — DATE
CUSTOMER APPROVAL
DESIGNED — DRAWN — CHECKED — APPROVED

FOR DOE-GRI
AT WASHINGTON DC

VERTICAL LIFT DRYER
BI-GAS PILOT PLANT
COAL DRYING

ALHAMBRA **C F BRAUN & CO** CALIFORNIA

SCALE	DRAWING NUMBER	REVISION
NONE	4568-1006-KD-1	2
DATE NOV 3, 1977		


3 SUPPORT STRUTS
AT 120°
2" THREADED CPLG
SEAL WELDED
REMOVEABLE NOZZLE
SCREWS INTO 2" COUPLING
10 H-84
GRAYLOCK BW
HUB 8.5" BORE
SA-182 F 347H
ABOUT 14"
2" PIPE - 347 SS
10" SCH 160 PIPE
SA 312 TP 347
2" 900# RTJ
FLG - SCH 160
BORE
5'-0" MINIMUM
STRAIGHT LENGTH
BUTT WELD END

COAL HANDLING

The dry coal is separated from the hot gas in the Coal Cyclone Vessel, V-306. The coal handling system is shown in Drawing Number 4568-1006-KD-2. This system is designed to provide the following capabilities.

1 The vertical lift dryer can be operated to obtain test data while the gasifier is out of service.

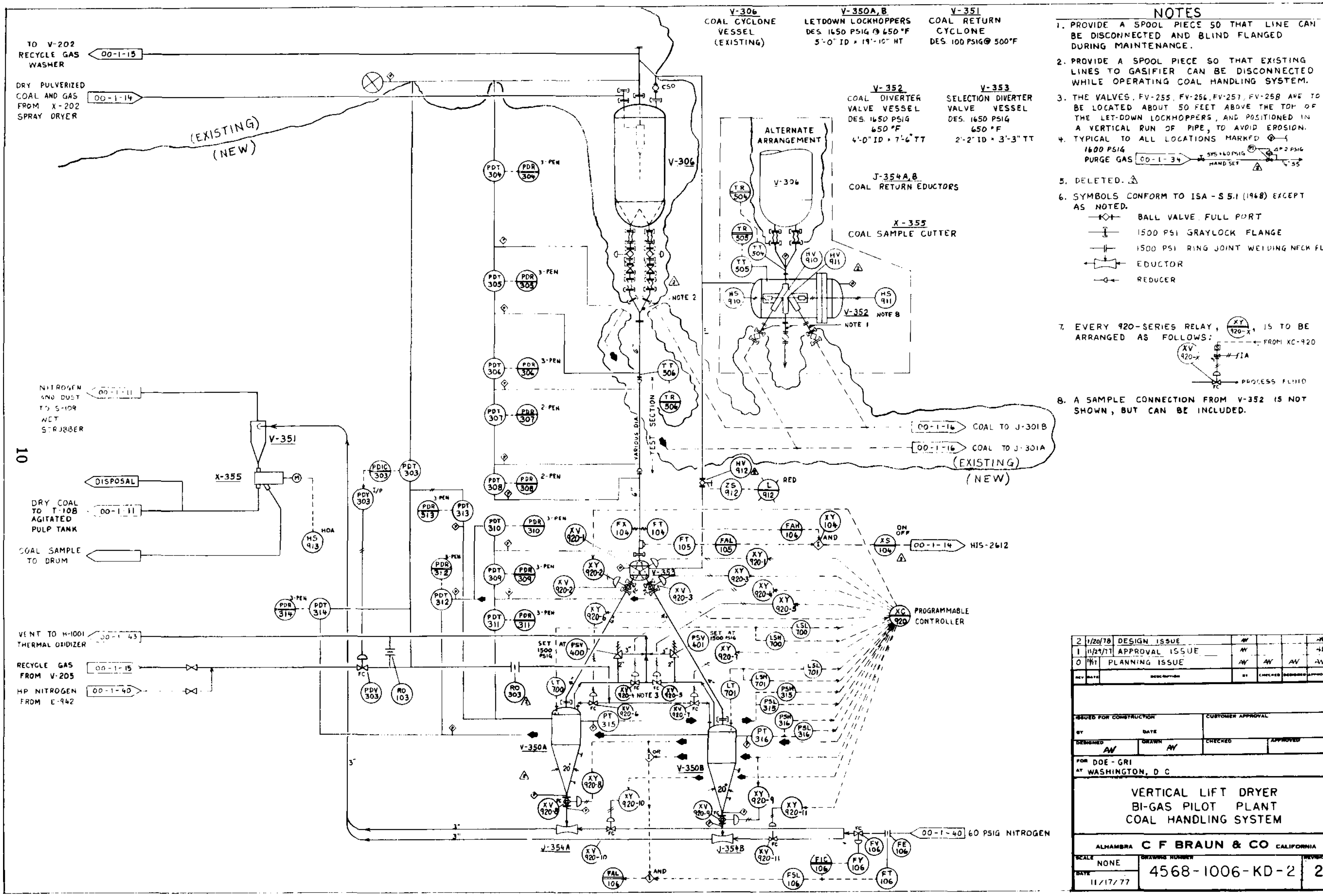
2 For safety purposes the gasifier can be isolated from the coal feed system so that the operation of the vertical lift dryer can be completely independent.

   The coal feed pipes are readily disconnected from the gasifier at the two elbows, MK-HA-3102-1-9 and MK-HA-3102-1-10. Those two elbows are rotated and connected to the Y-shaped spool piece at the top of the coal downflow pipe. The pipes leading to the gasifier are to be blind flanged at this time to isolate the gasifier and keep unwanted material out of the pipe.

3 The vertical lift dryer can be operated at widely varying test conditions without upsetting the entire plant. Widely varying operating conditions are necessary in order to obtain the design data.

4 The downflow characteristics of dry coal flowing against a pressure gradient can be evaluated. A vital part of the design information to be obtained is the pressure drop in the dry coal piping. Any location where coal tends to plug up should be determined.

   There is a test section in the coal downflow pipe where various shapes of reducers and bends can be tested. The drawing shows a straight piece of pipe in the test section, which can be changed out to accommodate other test configurations.



V-306
COAL CYCLONE VESSEL (EXISTING)
V-350A,B
LETDOWN LOCKHOPPERS
DES 1650 PSIG @ 650 °F
5'-0" ID × 19'-10" HT
V-351
COAL RETURN CYCLONE
DES 100 PSIG @ 500°F
V-352
COAL DIVERTER VALVE VESSEL
DES. 1650 PSIG
650 °F
4'-0" ID × 7'-6" TT
V-353
SELECTION DIVERTER VALVE VESSEL
DES. 1650 PSIG
650 °F
2'-2" ID × 3'-3" TT
J-354A,B
COAL RETURN EDUCTORS
X-355
COAL SAMPLE CUTTER
NOTES
1. PROVIDE A SPOOL PIECE SO THAT LINE CAN BE DISCONNECTED AND BLIND FLANGED DURING MAINTENANCE.
2. PROVIDE A SPOOL PIECE SO THAT EXISTING LINES TO GASIFIER CAN BE DISCONNECTED WHILE OPERATING COAL HANDLING SYSTEM.
3. THE VALVES, FV-255, FV-256, FV-257, FV-258 ARE TO BE LOCATED ABOUT 50 FEET ABOVE THE TOP OF THE LET-DOWN LOCKHOPPERS, AND POSITIONED IN A VERTICAL RUN OF PIPE, TO AVOID EROSION.
4. TYPICAL TO ALL LOCATIONS MARKED
1600 PSIG PURGE GAS 00-1-34
5. DELETED.
6. SYMBOLS CONFORM TO ISA - S 5.1 (1968) EXCEPT AS NOTED.
BALL VALVE FULL PORT
1500 PSI GRAYLOCK FLANGE
1500 PSI RING JOINT WELDING NECK FLG.
EDUCTOR
REDUCER
7. EVERY 920-SERIES RELAY, XY 920-X, IS TO BE ARRANGED AS FOLLOWS:
FROM XC-920
PROCESS FLUID
8. A SAMPLE CONNECTION FROM V-352 IS NOT SHOWN, BUT CAN BE INCLUDED.
TO V-202 RECYCLE GAS WASHER 00-1-15
DRY PULVERIZED COAL AND GAS FROM X-202 SPRAY DRYER 00-1-14
(EXISTING)
(NEW)
ALTERNATE ARRANGEMENT
NITROGEN AND DUST TO S-109 WET SCRUBBER 00-1-11
DISPOSAL
DRY COAL TO T-108 AGITATED PULP TANK 00-1-11
COAL SAMPLE TO DRUM
VENT TO H-1001 THERMAL OXIDIZER 00-1-43
RECYCLE GAS FROM V-205 00-1-15
HP NITROGEN FROM E-942 00-1-40
00-1-16 COAL TO J-301B
00-1-16 COAL TO J-301A
00-1-14 HIS-2612
PROGRAMMABLE CONTROLLER
00-1-40 60 PSIG NITROGEN
TEST SECTION
VARIOUS DIA
2 1/20/78 DESIGN ISSUE
1 11/29/77 APPROVAL ISSUE
0 11/1 PLANNING ISSUE
FOR DOE - GRI
AT WASHINGTON, D C
VERTICAL LIFT DRYER
BI-GAS PILOT PLANT
COAL HANDLING SYSTEM
ALHAMBRA C F BRAUN & CO CALIFORNIA
SCALE NONE
DATE 11/17/77
4568-1006-KD-2
2

A safety interlock system is provided. FAH-104 is an Ohmart radiation type density gage which will give an alarm when the pipe fills with coal caused by a downstream plug. FAL-105 is a sonic listening device which can detect the noise from flowing coal. The following table gives the possible conditions.

Number	Condition	FAH-105	FAL-104
1	No coal flows, pipe is empty	OFF	ON
2	Coal is flowing normally	OFF	OFF
3	No coal flows, pipe is full of coal	ON	ON

Condition 1 will occur at startup. After the dry coal begins flowing, condition 2 prevails. If for any reason coal flow stops due to upstream difficulties, condition 1 will alert the operator. Plugging in the dryer, for example, will bring about condition 1.

Condition 3 occurs if coal plugs up somewhere downstream of the two instruments. The line quickly fills with coal and both alarms activate. With both alarms on, XY-104 sends a signal to HIS-2612 to stop the flow of coal slurry. Disconnect switch XS-104 is provided so that the operator can by-pass the shutdown feature.

Coal is directed into one of the Letdown Lockhoppers, V-350A or B. The diverter valve, XV-920-1 directs the coal to the proper vessel. While one lockhopper is receiving coal, the other is being emptied. The programmable controller, XL-920 controls the entire operation.

Each lockhopper is sized to accept coal for at least one hour at maximum flow rate. A lockhopper can be emptied, repressurized, and put on standby in thirty minutes. Figure 2 depicts the sequence of operations.

The coal which is discharged from the bottom of the lockhoppers is pneumatically conveyed either to a disposal pile, or to the agitated pulp tank, T-108. Experimental work in the Braun laboratory indicated that some types of coal can be recycled without significant deterioration.(2)

Cycle No	Time Min	Valve Number XV-920-											NOTES
		1	2	3	4	5	6	7	8	9	10	11	
0	- 1	B	x	0	0	x	x	0	x	x	x	x	Filling V-350B, V-350A is empty
1	0				x			x					Isolate V-350A
	1						0						Begin presurizing V-350A
	5		0										Put V-350A on standby, then wait
	10	A											Switch coal flow to V-350A
	11			x									Isolate V-350B
	12					0							Begin depressurizing V-350B
	15									0		0	Begin draining V-350B
2	30					x	x			x		x	Isolate V-350B
	31							0					Begin pressurizing V-350B
	35			0									Put V-350B on standby, then wait
	40	B											Switch coal flow to V-350B
	41		x										Isolate V-350A
	42				0								Begin depressurizing V-350A
	45								0		0		Begin draining V-350A
3	60				x			x	x		x		Isolate V-350A

X is valve closed
0 is valve open
A or B is diverter valve flow direction

Figure 2 Sequence of operation and typical timing for letdown lockhoppers V-350A and B, assuming a wait time of five minutes.

DESIGN PROCEDURE

Experimentally determined drying rates will be expressed as overall bulk heat transfer coefficients, Ua_C for the constant rate drying period, and Ua_F for the falling rate period when the coal is drier than the critical moisture content. Correlations for Ua as functions of gas velocity, slurry nozzle pressure drop, atomizing gas rate, coal size distribution, etc will be developed.

Ua is defined by equating heat transfer by the rate equation to the sensible heat transfer from the gas.

$$Ua = \frac{G(1 + Y_1)\ Cp\ (T_1 - T_2)}{L \qquad \Delta T_{LM_{1-2}}}$$

G is the dry gas rate, pounds dry gas per hour - square foot of dryer cross section
Subscripts 1 and 2 refer to inlet and outlet

Y is gas humidity, pounds water per pound dry gas

Cp is the average specific heat of the inlet gas at Y_1 over the temperature range of T_1 to T_2, Btu per pound-degree fahrenheit.

L is the length of the drying section under consideration, feet.

T is gas temperature and t is the coal temp, °F.
The units of Ua are BTU per hour-cubic feet of dryer volume - °F temp driving force.

During the constant rate drying period the wet coal is assumed to be approximately at the adiabatic saturation temperature, t_{as}, of the inlet gas. After the coal moisture is reduced to below the critical value, X_{CRIT} pounds of water per pound of dry coal, the coal temperature increases above t_{as}. The above equation can be rewritten for these two drying periods.

$$Ua_c = \frac{G\ (1 + Y_1)\ C_{Pc}}{L_c} \ln \frac{T_1 - t_{as}}{T_2 - t_{as}}$$

$$Ua_F = \frac{G\ (1 + Y_2)\ C_{Pc}}{L_F} \quad \frac{(T_2 - T_3)}{\Delta T_{LM_{2-3}}}$$

T_2 is the gas temperature at the point where X_{CRIT} is reached and the gas humidity is $Y_2 = Y_1 + (S/G)(X_1 - X_{CRIT})$.

S is the coal rate, pounds of dry coal per hour - square foot of dryer cross section.

X_1 is the inlet water concentration of the coal slurry, pounds of water per pound of dry coal.

T_3 and t_3 are the temperatures of the gas and coal out of the dryer section under consideration.

For the proposed testing at BCR, the terminal temperatures and moisture contents will be measured. The dryer wall surface temperature will be measured along the length of the dryer.

For an adiabatic dryer, the ratio of the local heat transfer coefficients equals the ratio of the temperature differences.

$$\frac{(h_c' + h_r)\ \text{wall to solids}}{(h_c + h_r)\ \text{gas to wall}} = \frac{T_G - T_w}{T_w - t_s}$$

By assuming that this ratio changes smoothly from inlet to outlet, the gas and coal temperature profiles can be determined.

Heat and material balance calculations will be used to determine the coal critical moisture content and correlate it with atmospheric values.

OPERATING PROCEDURE

The general procedures which have been developed by Stearns-Roger and Phillips for their operations should be applied to the dryer whenever they are applicable. During testing careful attention to control and data recording is required to achieve steady state in a reasonable elapsed time and to obtain samples at appropriate times.

The first operation is to be with the half capacity slurry injection nozzle and is conducted to determine feasibility, although drying and pressure drop data will be collected. Startup is with water at zero solids concentration, afterward the solids concentration is increased to about 35 percent by weight, as is the current practice at BI-GAS. After successful continuous operation for an extended period, say several days, and some periods of steady state approximating test Series 16 through 20, the dryer design can be considered feasible. The dryer is then shut down for inspection of the slurry injection nozzle.

Typical startup operation of the dryer is as follows. Recycle N_2 through the system at a convenient low rate with the heater outlet at about 600°F. Start the atomizing gas at a rate of about 200 pounds per hour controlled by FIC-101. Start water at a low rate into slurry injection nozzle. Increase recycle gas rate and temperature to maintain about 600°F on TR-2410 at cyclone outlet while simultaneously increasing water rate. Adjust downward the atomizing gas rate as the water rate increases to maintain the mixture velocity through the nozzle ports in the range of 90 to 130 feet per second - see nozzle design calculations. When the water rate is increased to the test condition rate, adjust the water temperature to slightly above the adiabatic saturation temperature of the inlet gas at test conditions. Adjust all variables to the test conditions. Collect coal sample when required after steady state is achieved. Adjust variables to new test conditions and repeat.

The humidity of the recycle gas at the dryer inlet is a variable and in the outline of test runs the range of values are referred to as low, medium and high. Low is about 0.01 pounds water per pound of dry gas - saturated with water from the washer-scrubber at about 190°F. Medium is about 0.1 and high is about 0.2 pounds of water per pound of dry gas and is achieved by adding steam through FIC-102.

The normal value of the atomizing gas rate[2] is initially the value to give a mixture velocity through the nozzle ports, in feet per second, equal to $85 + 100\ X_{vg} + 105(X_{vg})^2$ as indicated in the nozzle design calculations. (X_{vg} is the volume fraction of gas in the mixture.) The low value might be 80 percent of the normal rate and the high value 120 percent of normal. As drying rate data is evaluated, the normal rate may be changed to give an optimum rate. The high and low excursions from the new normal are continued as indicated in the test run outline.

TEST PROGRAM

VARIABLES

Pressure	750 and 1200 psig
Injection Nozzle	1/2 or full capacity
Atomizing Gas	Low, Normal and High
Slurry Concentration	Zero and 35% wt solids
Slurry Rate	60 and 30 gpm
Slurry Size	Normal and Large
Recycle Gas	N_2 or Purge Gas
Recycle Gas, Rate	160, 140, 120, 100, 80 thousands of lbs/hr
Recycle Gas, Humidity	Lo, Med or High
Recycle Gas, Temperature	1200, 1100, 1000, 900 °F

RUNS ARE DESIGNATED BY THE ABOVE VALUES IN ORDER The first series is at 750 psig with water through the one-half capacity nozzle at 30 gpm and using recycle N_2 at 160,000 pounds per hour without adding steam to increase the inlet humidity. Gas inlet temperature and injection nozzle atomizing gas are varied for this first series. Samples of dried coal are taken for runs marked with an asterisk (*).

SERIES 1

750, 1/2, Hi, zero, 30, -, N2, 160, Lo,	1200
N	1200
Lo	1200
Lo	1100
N	1100
Hi	1100
Hi	1000
N	1000
Lo	1000
Lo	900
N	900
Hi	900

SERIES 2

750, 1/2, N, Zero, 30, -, N_2, 140, Lo,	1200
	1100
	1000
	900

SERIES 3

750, 1/2, Hi, Zero, 30, -, N_2, 120, Lo,	1200
N	1200
Lo	1200
Lo	1100
N	1100
Hi	1100
Hi	1000
N	1000
Lo	1000

SERIES 4

750, 1/2, N, Zero, 30, -, N_2, 100, Lo,	1200
	1100
	1000

SERIES 5

750, 1/2, Hi, Zero, 30, -, N_2, 80, Lo,	1200
N	1200
Lo	1200
Lo	1100
N	1100
Hi	1100

SERIES 6

750, 1/2, N, Zero, 30, -, N_2, 80,	Med,	1100
	Med,	1200
	Hi,	1200
	Hi,	1100

SERIES 7

750, 1/2, N, Zero, 30, -, N_2, 120,	Hi	1100
	Hi	1000
	Med	1000
	Med	1100

SERIES 8

750, 1/2, N, Zero, 30, -, N_2, 160,	Med,	1000
	Med,	900
	Hi,	900
	Hi,	1000

SERIES 9

1200, 1/2,	Hi,	Zero, 30, -, N_2, 160, Med	900
	N		900
	Lo		900
	Lo		1000
	N		1000
	Hi		1000
	Lo		1100
	N		1100
	Hi		1100

SERIES 10

1200, 1/2, N, Zero, 30, -, N_2, 140, Med,	1200
	1100
	1000
	900

SERIES 11

1200, 1/2, N, Zero, 30, -, N_2, 120,	Lo,	1000
	Lo,	1100
	Lo,	1200
	Med,	1200
	Med,	1100
	Hi,	1000
	Hi,	1100
	Hi,	1200

SERIES 12

1200,	1/2,	N,	Zero,	30,	-,	N_2,	100,	Med,		1200
										1100
										1000

SERIES 13

1200,	1/2,	Hi,	Zero,	30,	-,	N_2,	80,	Med,		1200
		N								1200
		Lo								1200
		Lo								1100
		N								1100
		Hi								1100

SERIES 14

1200,	1/2,	N,	Zero,	30,	-,	N_2,	80,	Lo,		1000
							70			
							60			
							50			
							45			
							40			
							38			
							37			

SERIES 15

750,	1/2,	N,	Zero,	30,	-,	N_2,	80,	Lo,		1000
							70			
							60			
							50			
							45			
							40			
							38			
							37			

SERIES 16

750, 1/2,	Hi, 35%, 30, N, N_2, 160, Lo,	1200
	N	1200*
	Lo	1200
	Lo	1100
	N	1100*
	Hi	1100
	Hi	1000
	N	1000*
	Lo	1000
	Lo	900
	N	900*
	Hi	900

SERIES 17

750, 1/2, N, 35%, 30, N, N_2, 140,	Lo	1200
	Lo	1100
	Lo	1000*
	Med	1000*
	Med	1100
	Med	1200
	Hi	1200
	Hi	1100
	Hi	1000*

SERIES 18

750, 1/2,	Hi, 35%, 30, N, N_2, 120, Lo,	1200
	N	1200
	Lo	1200
	Lo	1100
	N	1100
	Hi	1100
	Hi	1000
	N	1000*
	Lo	1000

SERIES 19

750, 1/2, N, 35%, 30, N, N_2, 100,	Lo	1000
	Lo	1100
	Lo	1200
	Med	1200
	Med	1100
	Med	1000
	Hi	1000*
	Hi	1100*
	Hi	1200*

SERIES 20

750, 1/2,	Hi, 35%, 30, N, N_2, 80, Lo,	1200
	N	1200
	Lo	1200
	Lo	1100
	N	1100
	Hi	1100

SERIES 21

1200, 1/2,	Hi, 35%, 30, N, N_2, 80, Lo,	1100
	N	1100*
	Lo	1100
	Lo	1200
	N	1200*
	Hi	1200

SERIES 22

1200, 1/2, N, 35%, 30, N, N_2, 100,	Lo	1200
	Lo	1100*
	Med	1100
	Med	1200
	Hi	1200
	Hi	1100*

SERIES 23

1200, 1/2, Hi, 35%, 30, N, N_2, 120, Lo,	1200
N	1200
Lo	1200
Lo	1100
N	1100
Hi	1100
Hi	1000
N	1000*
Lo	1000

SERIES 24

1200, 1/2, N, 35%, 30, N, N_2, 140, Lo,	1000
Lo,	1100
Med,	1100
Med,	1000
Hi,	1000*
Hi,	1100

SERIES 25

1200, 1/2, Hi, 35%, 30, N, N_2, 160, Lo,	1100
N	1100
Lo	1100
Lo	1000
N	1000*
Hi	1000
Hi	900
N	900*
Lo	900

SERIES 26

1200, 1/2, N, 35%, 30, N, N_2, 80, Lo,	1000
70	
60	
50	
45	
40	
38	
37	

Series 26 is run with decreasing gas rates until the dryer slumps. The dryer is then disassembled for cleaning and inspection.

These 26 series of runs will require about 200 hours of operation. This estimate includes eight hours for startup, eight hours to shift to coal slurry feed, about one hour for each run, and an additional hour for each run requiring a coal sample.

The next series of runs should be made with dried coal fed to the gasifier and with recycle purge gas. In this case the dried coal rate and the dryer system pressure will be set by gasifier operation. Variables will be slurry concentration, atomizing gas rate, recycle gas rate, temperature and humidity.

A later series of test runs should be made with the full scale nozzle, that is 5 tons per hour coal capacity, when the gasifier is down or if the gasifier feed rate can be increased to that amount.

Another important series of runs should be made with a much larger size distribution of coal corresponding to another process such as HYGAS or Synthane. This series will probably be made with the gasifier down and with major operating changes in the coal grinding and slurry preparation areas.

LOG SHEET
Drying Rate Data

DATE				
TIME				
SERIES DESIGNATION				
SYSTEM PRESSURE PR-2202				
COAL SAMPLE, TAG NO				
TIME				
SLURRY DENSITY DR-2801				
RATE FR-2001				
TEMP TR-2401				
ATOMIZING GAS RATE FR-101				
RECYCLE GAS TYPE				
RATE FR-100				
TEMP TR-500				
HUMIDITY AR-900				
HUMIDITY STEAM RATE FR-102				
DRYER WALL TEMPERATURE TR-501				
TR-502				
TR-503				
DRYER PRESSURE DROP PDR-300				
PDR-301				
PDR-302				
GAS OUTLET TEMP TR-2410				
HUMIDITY AR-901				
COAL OUTLET TEMP TR-504				

REFERENCES

1 Wilson, A.L., "Mechanical Development Recommendations Interim Report", June, 1977, Report No FE-2240-44, DOE Contract EX-76-C-01-2240.

2 Diehl, J.E., "Slurry Injection Nozzle for a Vertical Lift Dryer", 1978, Report No FE-2240-58, DOE Contract EX-76-C-01-2240.

DEVELOPMENT HISTORY

Braun recognized the advantage of a vertical lift dryer in 1973. With the approval of the government, preliminary investigation began, and a recommendation memo was issued. That memo was included in a report[1] published in 1977.

Additional investigations were authorized, and Braun sent out inquiries to several firms regarding design and testing of the vertical lift dryer principle. Another recommendation report was sent to DOE. The government elected to design a pilot plant size vertical lift dryer to be installed at the BI-GAS pilot plant in Homer City, Pennsylvania in preference to construction of a bench scale test unit by an independent contractor.

On July 28, 1977, a meeting was held at BI-GAS to discuss details of the design. Representatives attended the meeting from Braun, Phillips, and Stearns-Roger. Agreement was reached on division of responsibility. Braun would do the process design and specification of major components, operating procedure, test plan, and design method.

On December 27, 1977, the A.G.A. Advisors recommended and the DOE-GRI Operating Committee authorized Braun to proceed with the design according to the approval drawings and recommendations previously submitted on December 5, 1977.

☆U.S. GOVERNMENT PRINTING OFFICE: 1979-640-092/509