Industrial Fuel Gas Demonstration Plant Program

Prepared For
The Department of Energy
Under Contract ET-77-C-01-2582

MEMPHIS LIGHT, GAS AND WATER DIVISION
P.O. BOX 430, MEMPHIS, TENNESSEE 38101

In Association with
FOSTER WHEELER ENERGY CORPORATION
INSTITUTE OF GAS TECHNOLOGY
DELTA REFINING COMPANY

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Industrial Fuel Gas Demonstration Plant Program

MONTHLY, QUARTERLY AND ANNUAL

PROGRESS REPORT

FOR DECEMBER 1978 AND
CALENDER YEAR 1978

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**Prepared For
The Department of Energy
Under Contract ET-77-C-01-2582**

MASTER

**MEMPHIS LIGHT, GAS AND WATER DIVISION
P.O. BOX 430, MEMPHIS, TENNESSEE 38145**

**In Association with
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INSTITUTE OF GAS TECHNOLOGY
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MEMPHIS INDUSTRIAL FUEL GAS

DEMONSTRATION PLANT PROJECT

ANNUAL REPORT
(Deliverable #14)

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MEMPHIS LIGHT, GAS & WATER DIVISION

P.O. Box 430

MEMPHIS, TENNESSEE 38101

PREPARED FOR THE
U. S. DEPARTMENT OF ENERGY
ASSISTANT SECRETARY OF FOSSIL ENERGY

UNDER CONTRACT DE-AC02-77ET13406
(FORMERLY CONTRACT ET-77-C-01-2582)

MLGW/DOE INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM

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**MLGW/DOE INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM**

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MTSR-14
1978

GLOSSARY

THE INDUSTRIAL TEAM

- MLGW - Memphis Light, Gas and Water Division
(prime contractor)
- DRC - Delta Refining Company
(operator)
- IGT - Institute of Gas Technology
(Process Developer)
- FWEC - Foster Wheeler Energy Corporation
(Engineer)
- EIA - Energy Impact Associates
(Environmental Consultant)
- MSU - Memphis State University

OTHER TERMS

- DOE - U.S. Department of Energy
- DOE-Ch. - Chicago Operations Office
U.S. Department of Energy
- MRC - Monsanto Research Corporation
(Technical Assistance to DOE-Ch.)
- DPC - Decision Planning Corporation
(Business Advisor to DOE-Ch.)
- ORNL - Oak Ridge National Laboratory
(Preparation Agency for EIS)
- EIS - Environmental Impact Statement
- ER - Environmental Report
- TVA - Tennessee Valley Authority
- EPA - Environmental Protection Agency
- PSD - "Prevention of Significant Deterioration" Requirements
- DCAA - Defense Contractor Audit Agency
- CPSR - Contractor Procurement System Review

1.0 Contract Objective

The objective of the Industrial Fuel Gas Demonstration Plant Program is to demonstrate the feasibility of converting coal to fuel gas and utilizing this gas in a commercial application. Specific objectives of this program are to conduct process analysis, design, construction, testing, operation, and evaluation of a plant based on the U-Gas process for converting coal to industrial fuel gas.

2.0 Contract Tasks

2.1 Task I - Design and Evaluation of Commercial Plant

The Conceptual Design of a 50 MMM Btu per day Commercial Plant was started in December 1977. Engineering work on this design proceeded thru the summer. After the base design was complete, various studies were conducted relating to the configuration of the Demonstration Plant, which were to be included in the Task I report.

During the final quarter of 1978, the Task I report was drafted twice. The first issue, in September, was distributed to the Industrial Team and to MRC for comments. After resolution of the comments, a final draft was distributed to the Industrial Team in November.

Comments from the final draft documents were incorporated and formal issue to DOE of two volumes was made in December. The Task I report is presented in four volumes, as follows:

- Volume I - Executive Summary
- Volume II - Commercial Plant Design (issued 12/29/78)
- Volume III - Economic Analysis (issued 12/21/78)
- Volume IV - Demonstration Plant Recommendations

Volumes II and III are issued. Volumes I and IV will follow in early January.

2.2 Task II - Demonstration Plant Process Design

Process Design of the Demonstration Plant was originally scheduled to start in April. However, due to delays and difficulties at the Pilot Plant, this Task was not started. In June, DOE formally issued a STOP WORK order covering this task. The effects of the STOP WORK order were cancelled in part effective November 1978. During November and December,

various process studies were started in order to allow Phase I completion on December 1, 1979. This study work is authorized only to a limit of 2370 manhours, until further notice from DOE.

2.3 Task III - Demonstration Plant Process and Mechanical Design Package

Task III was originally scheduled to start at the end of May. However, this task was then rescheduled by MLGW to start July 1 because of the delay in design data. In late June, DOE formally stopped work on this task, before any effort was spent.

As with Task II, this task was released, in part, on November 1, 1978. Work in the November-January period, up to 1500 manhours, is authorized as needed to maintain the December 1, 1979 schedule.

2.4 Task IV - Site Evaluation and Selection

A Site Evaluation and Selection effort was conducted in March and April, leading to the selection of the Allen site as the proposed location of the Demonstration Plant. The formal report of this evaluation was almost complete when this task was stopped as a result of DOE's June 23 STOP WORK order.

Site activities necessary for the environmental report were not stopped, however, and steps were taken over the summer and fall to establish a work scope and competitively select a soil boring subcontractor and a topographic survey subcontractor. Both of these contracts were signed in November and work is proceeding through December.

DOE partially lifted the STOP WORK order on this task on September 23. The site report is now scheduled for January submission to DOE as a deliverable.

2.5 Task V - Demonstration Plant Environmental Analysis

A subcontract between FWEC and EIA was signed on January 30, 1978, for the environmental analysis work. At that time, a series of meetings was started with ORNL (EIS preparation agency), DOE-Washington, DOE-Chicago, MRC, and the Industrial Team to establish the required work scope necessary for the Environmental Report required for this task. These meetings spanned the March-July period. A request for contract modification was made to DOE in September for added funds necessary to complete the established work scope. This request is still pending as of December 31, 1978.

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DEMONSTRATION PLANT PROGRAM**

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1978

The site monitoring activities will be completed in January and will include a full 12 month effort.

Specific status of this work as of December is as follows:

Agency Coordination

A meeting was held with EPA Region IV in Atlanta on December 6, 1978 with EIA, FWEC and MLGW in attendance.* The purposes of this meeting were to: (a) inform EPA of the project and the environmental program, (b) obtain any comments about the program and (c) determine EPA involvement and requirements. The environmental program was accepted. Region IV is the agency that will act on the TN recommendation relative to the PSD permit. TN is expected to have regulations to implement The Resource Conservation and Recovery Act (RCRA) when EPA regulations are finalized in 1980. Region IV will have the final or total authority for National Pollution Discharge Elimination System (NPDES) permits depending upon, respectively, whether TN or Region IV receives the NPDES permit application. Region IV can become a "cooperating agency" with DOE/ORNL if they decide to accept a written request from DOE to do so.

EIA recommended to FWEC and MLGW that DOE be contacted relative to having them request that EPA Region IV become a "cooperating agency".

Material requested from EPA Region IV at this meeting was forwarded to FWEC and MLGW.

Plant Systems Description

Work in this subtask has been deferred pending resumption of FWEC engineering activities.

Water Quality and Hydrology

Water Quality

EIA received from Environmental Research Group (ERG) the results of the fall season analyses on water and sediments. No Polycyclic Aromatic Hydrocarbons (PAH) compounds were detected in the water. However, of the fifteen PAH compounds analyzed, six were detected in Lake McKellar sediments and only one in those from the Mississippi River. Variations within replicates for each parameter appear to be within the limits required for quality control. ERG was authorized to conduct analyses for PAH compounds only on elutriates from sediments where PAH's were found.

* DOE-Chicago was notified and invited to the meeting, but did not send a representative.

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EIA began preparing detailed plans for conducting the winter season water quality field trip tentatively scheduled between January 8 and 11, 1979.

A review of the TVA surface water quality information was begun.

Hydrology

The RAMCON groundwater hydrology report was reviewed and is being edited by EIA. Distribution of review copies of this report to FWEC and MLGW is planned for the week of January 8, 1979.

EIA prepared questions to be used in a COE and USGS meeting scheduled in Memphis on 1/9/79.

EPA at the December 6, 1978 meeting, agreed with the EIA approach to groundwater hydrology impact. This approach includes understanding groundwater conditions from a literature search prior to defining a possible field program. EPA also emphasized the importance of knowing the leaching characteristics of the gasifier ash.

An Optional Form 60 for the revised leaching study was prepared for FWEC.

Air Quality and Meteorology

The December audit of air quality monitoring equipment at the long-term site was performed. November air quality data was delivered to Pittsburgh for processing.

Terrestrial Ecology

The winter terrestrial field survey was completed from December 14 through 19, 1978 and the fall survey report from MSU was received. All field activities remaining for the four season terrestrial field program were completed with the exception of permanent storage of tissue samples. Tissue samples are in temporary storage awaiting preparation of suitable storage facilities.

Bird observations included the sighting of 71 species including 6 species of predatory birds. The local Wildlife Resources Officer reported sighting a flock of 127 turkey on President's Island this fall. Tissue samples of sparrows and bobwhite were obtained.

Mammal observations included the capture or sighting of more than 200 animals of which the most significant were the coyote, swamp rabbit and rice rat, species not observed on the site or vicinity during the previous 3 seasons. Observers confirmed the presence

of bobcat in the site vicinity. Mammal tissue samples included the shorttail shrew, house mouse, cotton rat, cottontail rabbit, swamp rabbit and opossum.

Herpetofauna, vegetation and soil investigations were completed. Tissue samples of red-eared turtle, common elderberry, Japanese honeysuckle and sedge were obtained. Soil core samples and additional soil bulk density samples were also obtained.

Additional information regarding listed threatened and endangered bird species in Tennessee, including the Mississippi kite, is being obtained by the Tennessee Resources Agency under contract with East Tennessee State University. Available information regarding the Mississippi kite will be obtained from the principal investigator.

EIA began to prepare an Optional Form 60 for the long-term cold storage of specimens from the MLGW plant site and to arrange for this storage.

Aquatic Ecology

EIA has provided MSU with data and examples for writing their report. Data from the October field trip has been received and is being reviewed and reduced for use in the EIA report.

EIA began preparing detailed plans for conducting the winter season aquatic ecology field trip tentatively scheduled between January 8 and 11, 1979.

Socioeconomics

The MSU Bureau of Business and Economic Research reported to EIA that their work is ninety percent complete.

Noise

EIA has started drafting a description of the existing noise environment.

2.6 Task VI - Materials, Agreements and Licenses

Work on this task started in late spring but was stopped by DOE in June. In September, DOE authorized the task to proceed on a partial basis.

Activity to date has been limited to the preparation of a preliminary permit compliance plan and work associated with the development of a coal supply.

2.7 Task VII - Planning for Final Design Construction and Operation Planning

Work was not started on this task in 1978, and is not scheduled until mid 1979.

2.8 Task VIII - Economic Assessment

Work has not started on this task and is not scheduled until late 1979.

2.9 Task IX - Technical Support

A seven-month program for the Pilot Plant was prepared during July. The Technical Subcommittee, which includes members from DOE and MRC as well as the Industrial Team, formulated the program. Volume I of the program, which includes objectives and schedule, was presented to DOE on August 24, 1978. Volume II, which includes details of proposed work, was submitted in mid-September. At that time, DOE authorized the six-month program, which commenced on September 20.

At a 3 month review meeting, held December 20, 1978 at FWEC, DOE agreed with the Industrial Team that IGT had accomplished the objectives of the first 3 months of the program. DOE also authorized the continuation of the program under the guidance of the Technical Subcommittee chaired by MLGW.

The Appendix to this report details December activity.

2.10 Task X - Long Lead Time Items

Work on this activity was stopped on June 23, 1978. On September 20, DOE authorized an expenditure of no more than 250 manhours through December, for the purpose of identifying long lead items. Work during December continued on the development of procurement procedures.

2.11 Task XI - Program Management

During 1978 a "Steering Committee" was formed to assist in the management of the project. This Committee, chaired by MLGW, is comprised of senior executives of each of the Industrial Team members. The Steering Committee, in turn, established a Technical Subcommittee to report on technical progress at the Pilot Plant. At the Steering Committee's invitation, DOE personnel became members of the Technical Subcommittee.

The Subcommittee oversaw the formulation of the current IGT program and continues to direct the pilot plant program from run to run, thereby allowing IGT suitable flexibility to deviate from the approved plan when the situation warrants. In addition, the Subcommittee supervises the activities of the Industrial Team monitors at the Pilot Plant.

3.0 Project Status

- 3.1 The Milestone Plan and Management Report submitted as part of this report shows the current projected schedule.

Completion of Phase I by December 1, 1979 requires not only the adherence to an engineering schedule, but also is dependent on external factors, mainly Pilot Plant data. In addition, DOE approval to proceed in January is required.

3.2 Cost Status

The current expenditures are shown in the attached Cost Management Reports. In essence, the accrued cost of \$5.8MM thru December is 90% of the original contract value of \$6.46MM. The \$3.685MM additional funding required includes several significant items previously discussed with DOE as indicated below:

<u>Item</u>	<u>Estimated Cost</u>	<u>Reference</u>
a. 6 month Pilot Plant Program	\$1.5MM	Sept. 20, 1978 Authorization to proceed from Contracting Officer
b. Environmental Analysis	.47MM	Request for Contract Modification dated Sept. 15, 1978
c. Combustion/Customer Modification	Est. .30MM	Required Task IX deliverable not included in Contract Work Scope

The remaining \$1.415MM needed to complete Phase I resulted from the following items:

- a. Delay in starting the Pilot Plant Program, together with modification necessary to proceed.
- b. The new schedule which extends Phase I by six months.
- c. Revised engineering estimates reported to DOE in May-September Monthly Reports.

It is hoped that the required additional funding will be approved in time to proceed with the current schedule.

FY 1979 Cost/Manpower Plans were submitted on November 30, 1978.

3.3 Technical Status

A new pilot plant program has been developed by DOE and the team members, and was started on September 20, 1978. Pilot plant operation continued in November. (See Appendix). Pilot plant success was achieved in obtaining an ash balanced condition for several days with ash agglomeration with a pure coal feed. This was the objective of the first three months of the approved program.

3.4 Contractual Status

The EIA/FWEC Contract Modification request has been prepared, reviewed by MLGW, and sent to DOE in mid-September. Resolution of this request was due by mid-December, but is still pending.

3.5 Management Status

No significant management problems exist.

4.0 Technical Approach or Work Plan Changes

No such changes were undertaken during the period except for the stopping of certain work, and the development of a new IGT program. A completely revised schedule for Phase I is attached.

U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
CONTRACT MANAGEMENT SUMMARY REPORT

1. Contract Identification Industrial Low Btu Fuel Gas Demonstration Plant		2. Reporting Period 12/1 through 12/31	3. Contract Number ET-77-C-01-2582
4. Contractor (name and address) Memphis Light, Gas and Water Division P. O. Box 430 Memphis, Tennessee 38101		5. Contract Start Date September 19, 1977 6. Contract Completion Date December 1, 1979	

7. Months	O	N	D	J	F	M	A	M	J	J	A	S	8. FY 1979
-----------	---	---	---	---	---	---	---	---	---	---	---	---	------------

11. Major Milestone Status

a. Task II	██████████	End Feb. 1980
b. Task III	██████████	End Nov. 1979
c. Task IV	██████████	End Sept. 1980
d. Task V	██████████	End Feb. 1980
e. Task VI	██████████	End Oct. 1979
f. Task VII	██████████	End Nov. 1979
g. Task VIII	██████████	End Oct. 1979
h. Task IX	██████████	Mid Nov. 1979
i. Task X	██████████	Dec. 1, 1979
j. Task XI	██████████	

12. Remarks

13. Signature of Contractor's Project Manager and Date R W Gray 1/29 1-9-78	14. Signature of Government Technical Representative and Date
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**MLGW/DOE INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM**

FW FOSTER WHEELER

**RECONCILIATION OF NOVEMBER 1978*
MANAGEMENT REPORTS**

	<u>Cost</u> <u>Management Report</u>		<u>Manpower</u> <u>Management Report</u>	
	<u>Reported</u> <u>in Nov.</u>	<u>Revised</u> <u>Nov. Actuals</u>	<u>Reported</u> <u>in Nov.</u>	<u>Revised</u> <u>Nov. Actuals</u>
MLGW	27	27	13	13
FWEC	86	86	25	25
DRC	9	8	2	2
IGT	244	244	48	48
EIA	<u>50</u>	<u>50</u>	<u>10</u>	<u>10</u>
Program Total	416	415	98	98
October Cumulative Totals	<u>4831</u>	<u>4831</u>	<u>1228</u>	<u>1228</u>
November Cumulative Totals	5247	5246	1326	1326
December Total	<u>--</u>	<u>555</u>	<u>--</u>	<u>134</u>
Cumulative through December		5801**		1460

*To be submitted with December Report.

**Corresponds to Item 21c on Cost and Manpower Management Reports.

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1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program					2. Reporting Period <u>12/1/78</u> through <u>12/31/78</u>		3. Contract Number ET-77-C-01-2582		
4. Contractor (name and address) Memphis Light, Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101					5. Cost Plan Date November 28, 1978		6. Contract Start Date September 19, 1977		
							7. Contract Completion Date December 1, 1979		
8. Government Funding \$6,460,000		9. Contractor Funding 0		10. Number of Invoices Billed 13		11. Frequency Monthly		12. Number of Invoices Paid 11	
						13. Total Invoice Amounts Billed \$4,783,050.86*		14. Total Payment Received \$3,896,652.45*	
15. Identification Number									
16. Reporting Category (e.g., contract line item or work breakdown structure element)									
17. Costs Accrued									
During Reporting Period									
Cumulative to Date									
a. Actual b. Planned c. Actual d. Planned									
18. Projected Accrued Costs									
a. Subsequent Reporting Period b. Balance of Fiscal Year c. Total Contract									
19. Total Contract Value									
20. Variance									
Task									
I Comm. Plt Des. and Eval									
II Demo Plt Process Des									
III Mech. Design Pkg									
IV Site Eval and Selection									
V Env. Analysis									
VI Materials and Licenses									
VII Const and OPN Planning									
VIII Economic Assessment									
IX Tech. Support									
X Long Lead Items									
XI Project Mgt									
21. Total									
22. Remarks Program totals for Contractor and Subcontractor *through 12/31/78.									
23. Dollars Expressed In: Thousands									
24. Signature of Contractor's Project Manager and Date R W Gray / RGT 1/9/78.									
25. Signature of Contractor's Authorized Financial Representative and Date									
26. Signature of Government Technical Representative and Date									

COST MANAGEMENT REPORT

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COST MANAGEMENT REPORT

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U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
COST MANAGEMENT REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program						2. Reporting Period <u>12/1/78</u> through <u>12/31/78</u>		3. Contract Number ET-77-C-01-2582		
4. Contractor (name and address) Memphis Light, Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101						5. Cost Plan Date November 28, 1978		6. Contract Start Date October 24, 1977		
								7. Contract Completion Date December 1, 1979		
8. Government Funding \$2,332,000		9. Contractor Funding 0		10. Number of Invoices Billed 13		11. Frequency Monthly		12. Number of Invoices Paid 11		
						13. Total Invoice Amounts Billed \$2,626,709.19*		14. Total Payment Received \$2,102,899.21*		
15. Identification Number Task	16. Reporting Category (e.g., contract line item or work breakdown structure element)	17. Costs Accrued				18. Projected Accrued Costs			19. Total Contract Value	20. Variance
		During Reporting Period		Cumulative to Date		a. Subsequent Reporting Period	b. Balance of Fiscal Year	c. Total Contract		
		a. Actual	b. Planned	c. Actual	d. Planned					
I	Comm. Plt Des. and Eval	0	0	34	34	0	0	34	74	(40)
II	Demo Plt Process Des	0	0	3	3	15	35	53	154	(101)
III	Mech. Design Pkg	0	0	0	0	0	72	72	240	(168)
IV	Site Eval and Selection									
V	Env. Analysis	0	0	2	2	4	12	18	18	0
VI	Materials and Licenses									
VII	Const and OPN Planning									
VIII	Economic Assessment	0	0	0	0	0	6	6	48	(42)
IX	Tech. Support	228	228	2938	2840	228	527	3693	1395	2298
X	Long Lead Items									
XI	Project Mgt	16	16	189	195	16	114	341	403	(62)
21. Total		244	244	3166	3074	263	766	4217	2332	1885
22. Remarks IGT *through 12/31/78									23. Dollars Expressed in: Thousands	
24. Signature of Contractor's Project Manager and Date <i>R W Gray / RGT 1-9-78</i>				25. Signature of Contractor's Authorized Financial Representative and Date				26. Signature of Government Technical Representative and Date		

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MANPOWER MANAGEMENT REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant					2. Reporting Period 12/1/78 through 12/31/78			3. Contract Number ET-77-C-01-2582							
4. Contractor (name and address) Memphis Light, Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101					5. Manpower Plan Date November 28, 1978			6. Contract Start Date September 19, 1977							
								7. Contract Completion Date December 1, 1979							
8.		9.		10.		11. Monthly		12.		13.					
15. Identification Number		16. Reporting Category (e.g., contract line item or work breakdown structure element)		17. Manpower Expended				18. Projected Manpower Expenditures			19. Total Contract Manpower		20. Variance		
Task				During Reporting Period		Cumulative to Date		a. Subsequent Reporting Period		b. Balance of Fiscal Year		c. Total Contract			
				a. Actual	b. Planned	c. Actual	d. Planned								
I		Comm. Plt Des. and Eval		1	1	224	224	0	0	224	153	71			
II		Demo Plt Process Des		8	17	18	39	17	62	101	130	(29)			
III		Mech. Design Pkg		2	13	3	18	17	412	457	545	(88)			
IV		Site Eval and Selection		5	6	22	28	1	21	48	44	4			
V		Env. Analysis		22	12	162	138	16	47	228	110	118			
VI		Materials and Licenses		0	1	4	6	0	9	14	64	(50)			
VII		Const and OPN Planning		0	0	1	1	0	19	29	46	(17)			
VIII		Economic Assessment		0	0	0	0	0	2	9	21	(12)			
IX		Tech. Support		59	63	643	648	57	175	876	310	566			
X		Long Lead Items		0	1	1	2	2	25	30	78	(48)			
XI		Project Mgt		37	29	382	365	29	175	633	528	105			
21. Total				134	143	1460	1469	139	947	2649	2029	620			
22. Remarks Program total for Contractor and Subcontractor											23. Manpower Expressed In 100 Man-hours				
24. Signature of Contractor's Project Manager and Date RW Gray/RS 1-9-78							25. Signature of Government Technical Representative and Date								

MANPOWER MANAGEMENT REPORT

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									7. Contract Completion Date December 1, 1979							
8.		9.		10.		11. Monthly		12.		13.						
15. Identification Number		16. Reporting Category (e.g., contract line item or work breakdown structure element)		17. Manpower Expended				18. Projected Manpower Expenditures			19. Total Contract Manpower		20. Variance			
Task				During Reporting Period		Cumulative to Date		a. Subsequent Reporting Period			b. Balance of Fiscal Year			c. Total Contract		
				a. Actual b. Planned		c. Actual d. Planned										
I		Comm. Plt Des. and Eval		0 0		13 13		0 0			13			19 (6)		
II		Demo Plt Process Des		3 3		4 7		3 17			28			16 12		
III		Mech. Design Pkg		2 2		3 3		2 14			22			66 (44)		
IV		Site Eval and Selection		5 5		15 20		0 16			35			28 7		
V		Env. Analysis		2 2		12 12		1 12			28			7 21		
VI		Materials and Licenses		0 0		2 2		0 0			2			42 (40)		
VII		Const and OPN Planning		0 0		0 0		0 0			0			9 (9)		
VIII		Economic Assessment														
IX		Tech. Support														
X		Long Lead Items		0 0		0 0		0 0			0			19 (19)		
XI		Project Mgt		10 10		139 129		10 74			243			202 41		
21. Total				22 22		188 186		16 133			371			408 (37)		
22. Remarks MLGW											23. Manpower Expressed In 100 Man-hours					
24. Signature of Contractor's Project Manager and Date R W Gray 1/8/78 1-9-78						25. Signature of Government Technical Representative and Date										

MANPOWER MANAGEMENT REPORT

[illegible]

Page ____ of ____

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant						2. Reporting Period 12/1/78 through 12/31/78			3. Contract Number ET-77-C-01-2582												
4. Contractor (name and address) Memphis Light, Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101						5. Manpower Plan Date November 28, 1978			6. Contract Start Date October 24, 1977												
									7. Contract Completion Date December 1, 1979												
8.		9.		10.		11. Monthly		12.		13.											
15. Identification Number		16. Reporting Category (e.g., contract line item or work breakdown structure element)		17. Manpower Expended				18. Projected Manpower Expenditures			19. Total Contract Manpower		20. Variance								
Task				During Reporting Period		Cumulative to Date		a. Subsequent Reporting Period		b. Balance of Fiscal Year		c. Total Contract									
				a. Actual		b. Planned		c. Actual		d. Planned											
I		Comm. Plt Des. and Eval		0		0		11		11		0		0		11		20		(9)	
II		Demo Plt Process Des		0		0		1		1		4		10		15		36		(21)	
III		Mech. Design Pkg												18		18		62		(44)	
IV		Site Eval and Selection																			
V		Env. Analysis		0		0		1		1		1		4		6		6		0	
VI		Materials and Licenses																			
VII		Const and OPN Planning																			
VIII		Economic Assessment														0		12		(12)	
IX		Tech. Support		55		55		585		584		55		161		801		298		503	
X		Long Lead Items																			
XI		Project Mgt		5		5		46		49		5		35		92		133		(41)	

MANPOWER MANAGEMENT REPORT

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Page: ____ of ____

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant				2. Reporting Period 12/1/78 through 12/31/78				3. Contract Number ET-77-C-01-2582								
4. Contractor (name and address) Memphis Light, Gas and Water Division P.O. Box 430 Memphis, Tennessee 38101				5. Manpower Plan Date November 28, 1978				6. Contract Start Date January 31, 1978								
								7. Contract Completion Date December 1, 1979								
8.		9.		10.		11. Monthly		12.		13.		14.				
15. Identification Number		16. Reporting Category (e.g., contract line item or work breakdown structure element)		17. Manpower Expended				18. Projected Manpower Expenditures			19. Total Contract Manpower		20. Variance			
Task				During Reporting Period		Cumulative to Date		a. Subsequent Reporting Period			b. Balance of Fiscal Year			c. Total Contract		
				a. Actual		b. Planned		c. Actual			d. Planned					
I		Comm. Plt Des. and Eval														
II		Demo Plt Process Des														
III		Mech. Design Pkg														
IV		Site Eval and Selection														
V		Env. Analysis		18		9		137			114			13		
VI		Materials and Licenses												29		
VII		Const and OPN Planning												179		
VIII		Economic Assessment														
IX		Tech. Support														
X		Long Lead Items														
XI		Project Mgt														
21. Total				18		9		137			114			13		
														29		
														179		
														82		
														97		
22. Remarks EIA *This variance has been identified pending approval by DOE of a Contract Modification for that amount.												23. Manpower Expended for 100 Man-hours				
24. Signature of Contractor's Project Manager and Date R W Gray / RGH 1-9-78						25. Signature of Government Technical Representative and Date										

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MILESTONE PLAN AND MANAGEMENT REPORT

1. Contract Identification INDUSTRIAL LOW BTU FUEL GAS DEMONSTRATION PLANT PROGRAM		2. Reporting Period 12/1/78 through 12/31/78		3. Contract Number ET-77-C-01-2582																					
4. Contractor (name, address) MEMPHIS LIGHT, GAS AND WATER DIVISION P. O. BOX 430 MEMPHIS, TENNESSEE 38101				5. Contract Start Date September 19, 1977																					
				6. Contract Completion Date December 1, 1979																					
7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months																10. Percent Complete							
		1978				1979				1980															
		N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	
Task II	Demo Plant Process Design																								
	Basis of Design (Process Concepts)																								
	Process Engineering Design																								
	Process Description & Rationale																								
	Dept. of Energy Approval																								
Task III	Demo Plant Process and Mech. Design Pkg.																								
	Plant Specifications																								
	Prelim. Engineering & Layout																								
	Cost Estimating																								
	Procurement Requisitions																								
	Dept. of Energy Program Evaluation																								
11. Remarks																									
12. Signature of Contractor's Project Manager and Date RW Gray / RSH 1-10-79												13. Signature of Government Technical Representative and Date													

1. Contract Identification INDUSTRIAL LOW BTU FUEL GAS DEMONSTRATION PLANT PROGRAM						2. Reporting Period 12/1/78 through 12/31/78						3. Contract Number ET-77-C-01-2582														
4. Contractor (name, address) MEMPHIS LIGHT, GAS AND WATER DIVISION P. O. BOX 430 MEMPHIS, TENNESSEE 38101												5. Contract Start Date September 19, 1977						6. Contract Completion Date December 1, 1979								
7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months																								10. Percent Complete
		1978												1979												
		N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S		
Task IV	Site Evaluation/ Selection																									
	Site Data																									
	Negotiate Site Agreement																									
	MLGW/DOE Approval																									
Task V	Demo Plant Environmental Analysis																									
	Environmental Analysis																									
	Environmental Report																									
	Environmental Impact Statement (by DOE)																									
11. Remarks																										
12. Signature of Contractor's Project Manager and Date R W Gray / RGS 1-10-79													13. Signature of Government Technical Representative and Date													

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
MILESTONE PLAN AND MANAGEMENT REPORT

1. Contract Identification INDUSTRIAL LOW BTU FUEL GAS DEMONSTRATION PLANT PROGRAM		2. Reporting Period 12/1/78 through 12/31/78		3. Contract Number ET-77-C-01-2582										
4. Contractor (name, address) MEMPHIS LIGHT, GAS & WATER DIVISION P. O. BOX 430 MEMPHIS, TENNESSEE 38101		5. Contract Start Date September 19, 1977		6. Contract Completion Date December 1, 1979										
7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months												10. Percent Complete
		<div style="display: flex; justify-content: space-between;"> 1978 1979 1980 </div> <div style="display: flex; justify-content: space-between;"> NDJFMAMJJASO NDJFMAMJJAS </div>												
Task IX	I.G.T. Pilot Plant Program (Technical Support)													
	Bench Scale Tests													
	Cold Flow Model Studies													
	Pilot Plant Operations													
	Utilization of Output													
	Technical Support													
Task X	Long Lead Items													
	Identify Long Lead Items and Prepare Plan													
	Pricing Long Term Delivery Items													
	Procurement (if approved)													
Task XI	Project Management													
11. Remarks														
12. Signature of Contractor's Project Manager and Date RW Gray / RTS 1-10-79												13. Signature of Government Technical Representative and Date		

APPENDIX TO DECEMBER MONTHLY REPORT PILOT PLANT TEST PROGRAM

INDUSTRIAL LOW-Btu FUEL GAS DEMONSTRATION-PLANT PROGRAM

Submitted by
MEMPHIS LIGHT, GAS AND WATER DIVISION
P.O. Box 430
Memphis, Tennessee 38101

Prepared by
Institute of Gas Technology
IIT Center, 3424 S. State Street
Chicago, Illinois 60616

Prepared for the
UNITED STATES DEPARTMENT OF ENERGY

Under Contract No. ET-77-C-01-2582

PILOT PLANT TEST PROGRAM

Summary

One pilot plant test, Run 131, was carried out in December. In Run 131 the U-GAS® pilot plant operated successfully at the conditions of Set Point 1 with washed Kentucky coal as feed. The results of Run 130 were duplicated, and ash-balanced operation under ash agglomerating conditions was achieved for about 3 days. In all, 69.3 tons of coal were gasified during 4-1/2 days of coal feed. The ash content of the agglomerate discharge varied between 75% and 85% by weight.

For a period of 35 hours at the operating conditions of Set Point 1, the internal cyclone returned most of the reactor fines to the bed, and the conversion of coal reached 86%.

Steady-state operation with the second-stage cyclone fines returned to the bed, corresponding with Set Point 3, was achieved for 3 hours. The coal conversion efficiency during this period was 92%. The second-stage cyclone dipleg experienced backgassing, and the fines recycling ceased. This caused a brief rise in the reactor bed temperature to 1950°F before the oxygen feed could be reduced and the bed temperature lowered back to set point conditions. Ash agglomerates 1/8 to 1/4 inch in diameter, the largest yet made with coal feed, discharged from the venturi following this bed temperature upset.

The internal cyclone failed to function after the recycling of second-stage cyclone fines ended. During attempts to achieve Set Point 2 operating conditions, the dust carryover exceeded 1100 lb/hr and wore a hole in the second-stage cyclone, terminating the run.

A post-run inspection revealed that the reactor grid area was free of ash deposits and undamaged; however, the refractory-lined inlet scroll section of the internal cyclone was nearly plugged with ash deposit.

PILOT PLANT OPERATIONS

Following Run 130, several repairs and changes were made to the pilot plant:

- o The dipleg to the internal cyclone was shortened by 2 feet and reinstalled. The seal pot was repaired, shortened, and put back on the dipleg. The outlet pipe and refractory of the internal cyclone were repaired.
- o The corroded thermowells were replaced and lined with alumina.
- o The worn central jet pipe was recoated with boron oxide.
- o New anchor bolts were emplaced, and the refractory was replaced in the incinerator where a hot spot had developed.
- o The internal scrubber decks that had plugged were removed, making the scrubber a spray chamber.
- o Following the discovery of a leak, the cone to the second-stage cyclone was replaced.
- o A crack in the C-4 hopper shell near the ash nozzle was repaired and reinforced following the discovery of a leak. The C-3 hopper ash nozzle area was also stiffened.

Run 131

The test plan for Run 131 consisted of the following:

- o Achieve ash-balanced operation of the U-GAS pilot plant with the formation of ash agglomerates, using washed Kentucky No. 9 coal as feed.
- o Operate the plant at Set Points 1 through 4 according to Table 1 of this report in order to establish the operating conditions for ash-balanced operation. Originally, Table 1 was Table III in the addendum to the overall program plan for Task IX, Volume II, issued on October 19, 1978, and was revised on November 15.

During Run 131 the U-GAS pilot plant actually operated as follows:

- o The test run spanned 196 hours with metallurgical coke fed into the gasifier for 70 hours and 69.3 tons of washed Kentucky coal fed for 104 hours. Ash agglomerates were produced from coal throughout the run, except during two loss-of-feed process upsets. Ash-balanced operation was maintained for 68 hours.
- o The operating conditions for Set Point 1 were maintained for 35 hours and followed a feed interruption that led to the activation of the internal cyclone. Prior to the feed interruption, the internal cyclone resisted extensive attempts at activation. Ash-balanced operation was maintained at Set Point 1 for 23 hours.
- o Operation at Set Point 2 was postponed. Instead, the second-stage fines were recycled into the reactor, corresponding with Set Point 3.
- o The operating conditions for Set Point 3 were maintained for about 3 hours. Loss of the second-stage fines recycle led to a brief bed temperature excursion that resulted

Table 1. U-GAS PILOT PLANT COAL TEST RUNS
(Revised 11/15/78)

Set Pt.	Period, hr (+2)	Bed Temperature, °F ^c (+15)	Ash Concentration, % (+5)	Superficial Velocity, ft/s (+0.5)	Venturi Velocity, ft/s ^e (+5)	Bed Height, ft (+0.5)	Cyclones	
							Int.	Ext. (Recycle)
1	6	1850	40	4	50	4	Yes	No
2	6	1850	50 ^d	4	50	6	Yes	No
3 ^a	48	1850	50 ^d	4	50	4 ^f	Yes	Yes
4 ^b	6	1850	40	3	50	4 ^f	Yes	Yes

OTHER OPERATING CONDITIONS

Mode: Steam, Oxygen

Process Gas to Grid: Steam only. If oxygen, max. conc. of 15%

Process Gas to Venturi Annulus: 30% oxygen conc. max.

Process Gas to Central Jet: 75% oxygen conc. max.

^aIf external cyclone not successful go back to Set Point 2 conditions.

^bAfter 5 days of coal testing.

^cAs required for agglomeration.

^dMaximum.

^eOr optimum as required to control venturi discharge.

^fSet point at 6-foot depth if Set Point 2 is successful.

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in the production of 1/8 to 1/4-inch-diameter ash agglomerates. The internal cyclone ceased functioning at this time.

- o The operating conditions for Set Point 2 could not be established despite efforts to get the internal cyclone to function again. A 6-foot bed height was maintained for 6 hours until a hole formed in the second-stage cyclone, terminating the run.
- o The post-run inspection revealed a near-plugging of the refractory-lined inlet section of the internal cyclone from a deposit comprised of 98% ash. The seal pot was unobstructed, the grid and venturi area were free of any ash deposits, and the thermowells and central jet pipe were undamaged.

Run 131 Operation

Run 131 started on Monday, December 4, 1978. Stable operation was achieved for Set Point 1 at the specified operating conditions. The operating conditions for Run 131 are shown in Figures 1 through 4.

Feed during Run 131 consisted of Bethlehem coke breeze and washed Kentucky No. 9 coal, both screened to less than 1/4 inch. In all, 69.3 tons of coal were gasified. Steam and oxygen provided the fluidization, and oxygen, diluted with steam, was added through the central jet to maintain bed temperature.

Reactor bed samples were collected and analyzed every hour for ash content. Other solids streams were analyzed at least once during each 8-hour shift. At the start of each hour, process inputs related to each set point variable were recorded and immediately reduced and reported.

Table 2 is a data summary for Run 131, showing process variable values at 2-hour intervals.

Figure 5 shows the process schematic of the U-GAS pilot plant, for reference. The addendum to this appendix report consists of a photograph of venturi solids discharge containing ash agglomerates from Run 130 with coal feed.

Set Point 1

The U-GAS gasifier attained the operating conditions of 1850°F bed temperature at 4 ft/s superficial velocity and a 4-foot bed height with coke feed. The carryover of fines to the second-stage cyclone varied between 196 and 228 lb/hr with coke feeding at the rate of 450 to 600 lb/hr. From 0100 hours on December 5 to 1900 hours on December 6, the seal pot aeration was adjusted in order to activate the internal cyclone and reduce the carryover of fines, as called for in Set Point 1. However, pressure drop measurements along the cyclone dipleg indicated that the seal pot aeration gas was flowing up the dipleg, rather than out of the seal pot, such that the collected fines were not being returned to the reactor bed.

Figure 1. OPERATING SET POINT VARIABLES DURING RUN 131

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Figure 2. SOLIDS RATES DURING RUN 131

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Figure 3. GAS FLOWS DURING RUN 131

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Figure 4. OXYGEN CONCENTRATION DURING RUN 131

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Table 2, Part 1. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE	12/6/78	RUN NUMBER	131							
	TIME	0800	1000	1200	1400	1600	1800	2000	2200	2400
TE 9206.1										
GAS TEMP ENTERING VENTURI, °F		828	643	892	925	821	785	839	813	839
TE 9206.2										
GAS TEMP ENTERING GRID, °F		348	330	367	361	417	437	443	368	368
TE 9206.3										
BED TEMP, °F		1853	1841	1849	1822	1869	1842	1842	1846	1854
TE 9206.16										
GAS TEMP ENTERING QUENCHER, °F		1703	1714	1699	1676	1677	1678	1673	1696	1700
FR 903										
STEAM FLOW TO GRID, mol/hr		30.53	30.04	28.96	17.93	18.60	18.31	18.41	30.99	30.99
FR 904										
STEAM FLOW TO HEATER, mol/hr		35.20	47.21	34.07	38.54	38.63	38.63	38.42	38.20	37.98
FR 905										
STM + O ₂ FLOW TO GRID, mol/hr		0	0	0	6.96	7.23	6.39	6.94	0	0
FR 906										
STM + O ₂ FLOW TO VENTURI, mol/hr		32.23	42.06	35.63	33.01	34.24	32.46	32.90	33.67	34.07
FR 9304										
STEAM TO VENTURI, mol/hr		7.49	9.72	5.13	3.96	3.55	3.95	3.80	7.00	7.10
FR 938										
OXYGEN TO AIR HEATER, mol/hr		7.37	7.32	6.62	4.97	4.99	5.33	5.36	6.85	6.94
FR 9303										
AUX. O ₂ TO REACTOR, mol/hr		4.63	6.77	4.53	4.95	5.42	4.72	4.74	4.51	4.07
FR 9405										
STM + O ₂ FLOW TO CENTER JET (reactor), mol/hr		14.67	17.49	9.10	5.01	8.30	4.91	5.02	17.26	17.46
FR 937										
ATOMIZING N ₂ , mol/hr		5.33	5.28	5.19	5.23	5.73	5.56	5.55	5.42	5.38
FR 918 (1st stage quencher)										
RATE OF QUENCH WATER, mol/hr		36.58	49.15	36.58	34.29	36.58	34.29	34.29	42.29	42.29
FR 9330 (2nd stage quencher)										
RATE OF QUENCH WATER, mol/hr		5.56	5.56	5.56	11.11	11.11	11.11	11.11	21.11	0
FR 995										
AIR TO AIR HEATER, mol/hr		0	0	0	0	0	0	0	0	0
FR 909										
SWEEP GAS (N ₂), mol/hr		0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr		12.58	12.52	13.48	12.52	13.54	13.03	13.54	13.03	12.96
BED DENSITY, lb/ft ³		38.55	39.88	39.88	41.21	39.88	39.88	39.88	41.21	39.88
BED HEIGHT, ft		4.33	4.04	4.19	3.84	4.04	4.04	4.15	3.91	3.76
REACTOR GAS COMPOSITION (dry), %										
N ₂			35.50		37.70		35.50		35.70	
CO			6.50		6.10		5.90		6.40	
CO ₂			38.60		37.00		37.90		39.20	
H ₂			18.90		18.70		20.10		18.20	
CH ₄			0.45		0.46		0.51		0.44	
H ₂ S			0.00		0.00		0.00		0.00	
COKE OR COAL FEED RATE, (wet) (avg), lb/hr		coke 585	585	519	519	519	519	519	40% coal 450	60% coal 450
C-7 BED DISCHARGE RATE, lb/hr		0	0	0	117	29	16	18	20	26
C-4 ASH DISCHARGE RATE, lb/hr		55	32	39	70	55	54	54	41	50
2nd STAGE FINES REMOVAL RATE, lb/hr		228	228	187	187	187	187	187	205	198
3rd STAGE FINES REMOVAL RATE, lb/hr		13	9	9	9	9	9	10	10	10
FEED COMPOSITION, %:										
ASH		16.5		15						
REACTOR BED COMPOSITION, %:										
ASH		28.5	32	45	29	25	24	19	11	13
DISCHARGED BED COMPOSITION, %:										
ASH						24				22
ASH COMPOSITION, %:										
ASH		60.5		59.5		47				
2nd STAGE FINES COMPOSITION, %:										
ASH		17.5		16		11.5				
3rd STAGE FINES COMPOSITION, %:										
ASH		31.5		32		32				

Table 2, Part 2. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE	12/5/78 - 12/6/78	RUN NUMBER	131	12/6							
TIME			1400	1600	1800	2000	2200	2400	0200	0400	0600
TE 9206.1 GAS TEMP ENTERING VENTURI, °F			916	848	804	865	859	795	860	874	820
TE 9206.2 GAS TEMP ENTERING GRID, °F			358	353	345	354	357	350	358	357	367
TE 9206.3 BED TEMP, °F			1849	1854	1851	1858	1857	1858	1851	1836	1856
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F			1685	1687	1684	1688	1698	1695	1699	1698	1708
FR 903 STEAM FLOW TO GRID, mol/hr			30.90	30.90	30.90	31.10	30.98	30.98	30.98	30.98	32.10
FR 904 STEAM FLOW TO HEATER, mol/hr			18.32	18.44	18.21	35.15	35.01	35.01	35.01	35.01	36.34
FR 905 STM + O ₂ FLOW TO GRID, mol/hr			0	0	0	0	0	0	0	0	0
FR 906 HTD. AIR OR STM + O ₂ FLOW TO VENTURI, mol/hr			26.95	27.64	27.89	29.64	29.64	29.23	28.54	28.67	26.48
FR 9304 STEAM TO VENTURI, mol/hr			7.84	7.78	7.78	7.89	7.80	7.41	7.49	7.52	7.49
FR 938 OXYGEN TO AIR HEATER, mol/hr			4.69	4.06	3.70	8.22	7.55	7.43	7.49	7.66	8.63
FR 9303 AUX. O ₂ TO REACTOR, mol/hr			4.26	4.23	4.21	4.26	4.23	5.00	4.25	5.45	4.51
FR 9405 HTD. AIR OR STM + O ₂ FLOW TO CENTER JET (reactor), mol/hr			15.95	15.94	16.13	17.25	21.55	23.81	23.18	21.73	23.88
FR 937 ATMOSPHERIC N ₂ , mol/hr			5.56	5.60	5.45	5.43	5.39	5.42	5.51	5.50	5.35
FR 918 (1st stage quencher). RATE OF QUENCH WATER, mol/hr			41.15	41.15	38.86	43.43	42.29	42.29	41.15	42.29	43.43
FR 9330 (2nd stage quencher). RATE OF QUENCH WATER, mol/hr			11.11	11.11	11.11	11.11	11.11	10.00	5.56	5.56	5.56
FR 995 AIR TO AIR HEATER, mol/hr			19.18	19.68	19.07	0	0	0	0	0	0
FR 909 SWEEP GAS (N ₂), mol/hr			0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr			13.42	12.91	12.47	13.37	12.91	12.97	13.12	13.11	13.48
BED DENSITY, lb/ft ³			42.54	38.55	37.22	38.55	37.22	35.89	35.89	37.22	38.55
BED HEIGHT, ft			4.40	4.48	4.45	4.18	3.87	4.01	4.25	4.18	4.11
REACTOR GAS COMPOSITION (dry), %											
N ₂					52.80		34.10		35.10		30.00
CO					4.90		6.90		8.00		9.50
CO ₂					28.50		39.10		41.60		40.40
H ₂					13.10		19.40		14.70		19.50
CH ₄					0.30		0.45		0.49		0.47
H ₂ S					0.00		0.00		0.00		0.00
COKE FEED RATE, (wet) (avg), lb/hr			581	450	450	450	450	585	585	585	585
C-7 BED DISCHARGE RATE, lb/hr			0	0	0	0	0	0	0	0	0
C-4 ASH DISCHARGE RATE, lb/hr			76	64	54	53	67	63	78	70	91
2nd STAGE FINES REMOVAL RATE, lb/hr			215	199	199	215	215	228	228	228	228
3rd STAGE FINES REMOVAL RATE, lb/hr			14	14	14	29	29	29	29	13	13
FEED COMPOSITION, %: C											
ASH								14.5			
REACTOR BED COMPOSITION, %: C											
ASH			21.5	22	25	21.5	10	9	33	9	12
DISCHARGED BED COMPOSITION, %: C											
ASH											
ASH COMPOSITION, %: C											
ASH				38							
2nd STAGE FINES COMPOSITION, %: C											
ASH				18.5				14			
3rd STAGE FINES COMPOSITION, %: C											
ASH				32				31			

Table 2, Part 3. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE	12/4/78 - 12/5/78	RUN NUMBER	131	12/5							
TIME	2000	2200	2400	0200	0400	0600	0800	1000	1200		
TE 9206.1 GAS TEMP ENTERING VENTURI, °F	925	1023	692	777	880	1020	910	870	975		
TE 9206.2 GAS TEMP ENTERING GRID, °F	435	457	313	319	339	369	364	356	358		
TE 9206.3 BED TEMP, °F	1705	1848	1793	1810	1853	1850	1853	1853	1850		
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F	1094	1353	1476	1529	1577	1623	1650	1664	1676		
FR 903 STEAM FLOW TO GRID, mol/hr	22.31	21.69	32.81	31.24	31.24	31.18	30.04	30.04	29.86		
FR 904 STEAM FLOW TO HEATER, mol/hr	0	0	0	0	0	15.91	17.95	18.01	18.01		
FR 905 HTD. AIR FLOW TO GRID, mol/hr	17.14	16.76	0	0	0	0	0	0	0		
FR 906 HTD. AIR FLOW TO VENTURI, mol/hr	30.91	29.98	39.78	37.35	34.18	24.45	27.06	27.01	27.20		
FR 9304 STEAM TO VENTURI, mol/hr	0	0	0	0	0	7.92	7.85	7.85	7.79		
FR 938 OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	4.61	4.78	4.78	4.69		
FR 9303 AUX. N ₂ or O ₂ TO REACTOR, mol/hr	N ₂ + 4.91	4.89	4.86	3.90	O ₂ + 2.21	5.09	4.78	4.29	4.32		
FR 9405 HTD. AIR FLOW TO CENTER JET (reactor), mol/hr	22.61	22.11	22.57	22.54	19.22	17.32	15.89	16.18	16.34		
FR 937 ATOMIZING N ₂ , mol/hr	5.75	5.66	5.61	5.71	5.92	5.81	5.69	5.60	5.60		
FR 918 (1st stage quencher) RATE OF QUENCH WATER, mol/hr	22.86	25.15	27.43	32.00	32.00	37.72	38.86	36.58	38.86		
FR 9330 (2nd stage quencher) RATE OF QUENCH WATER, mol/hr	11.11	16.66	16.66	13.33	16.66	11.11	11.11	16.66	11.11		
FR 995 AIR TO AIR HEATER, mol/hr	69.48	69.21	59.44	57.31	50.26	19.45	20.96	21.10	20.23		
FR 909 SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0		
NITROGEN PURGE TO REACTOR, mol/hr	15.04	14.97	14.40	14.30	14.98	14.98	15.91	14.44	14.91		
BED DENSITY, lb/ft ³	38.55	37.22	38.55	41.21	39.88	41.21	39.88	38.55	39.88		
BED HEIGHT, ft	3.96	4.14	3.81	3.70	4.04	4.26	4.33	4.63	4.55		
REACTOR GAS COMPOSITION (dry), %											
N ₂				76.10		56.00		51.10			
CO				2.90		5.30		6.00			
CO ₂				15.50		25.20		27.60			
H ₂				4.70		12.80		14.60			
CH ₄				0.13		0.34		0.33			
H ₂ S				0.00		0.00		0.00			
COKE FEED RATE, (wet) (avg), lb/hr	720	525	525	525	600	581	581	581	581		
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	0	0	0	0		
C-4 ASH DISCHARGE RATE, lb/hr	72	73	35	22	37	71	83	63	65		
2nd STAGE FINES REMOVAL RATE, lb/hr	100	100	196	196	237	215	215	215	215		
3rd STAGE FINES REMOVAL RATE, lb/hr	1	1	1	1	15	15	15	15	15		
FEED COMPOSITION, %:											
ASH		13									
REACTOR BED COMPOSITION, %:											
ASH		21.5	10	18.5	17	10.5	21	20	20		
DISCHARGED BED COMPOSITION, %:											
ASH											
ASH COMPOSITION, %:											
ASH				18		32.5			33.5		
2nd STAGE FINES COMPOSITION, %:											
ASH		17				23	14		17		
3rd STAGE FINES COMPOSITION, %:											
ASH		33							33		

Table 2, Part 4. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE	12/7/78	RUN NUMBER 131								
TIME		0200	0400	0600	0800	1000	1200	1400	1600	1800
TE 9206.1										
GAS TEMP ENTERING VENTURI, °F		791	873	887	767	789	952	803	834	886
TE 9206.2										
GAS TEMP ENTERING GRID, °F		361	374	377	384	431	459	458	462	482
TE 9206.3										
BED TEMP, °F		1823	1849	1834	1835	1858	1858	1860	1863	1862
TE 9206.16										
GAS TEMP ENTERING QUENCHER, °F		1704	1744	1753	1749	1766	1767	1761	1761	1765
FR 903										
STEAM FLOW TO GRID, mol/hr		31.38	31.38	31.38	22.86	22.87	22.86	18.22	17.88	17.83
FR 904										
STEAM FLOW TO HEATER, mol/hr		38.20	37.98	38.20	45.79	46.94	47.18	46.94	44.97	38.22
FR 905										
STM + O ₂ FLOW TO GRID, mol/hr		0	0	0	7.44	7.15	7.20	7.32	4.83	6.66
FR 906										
STM + O ₂ FLOW TO VENTURI, mol/hr		33.89	31.24	28.27	35.81	33.91	34.91	35.74	31.68	21.85
FR 9304										
STEAM TO VENTURI, mol/hr		7.10	7.00	7.10	6.12	6.17	6.12	5.92	5.92	16.67
FR 938										
OXYGEN TO AIR HEATER, mol/hr		9.81	11.65	11.63	13.29	13.63	13.52	14.29	14.42	14.62
FR 9303										
AUX. O ₂ TO REACTOR, mol/hr		7.16	11.81	12.79	13.63	13.40	13.58	9.82	10.17	10.29
FR 9305										
STM + O ₂ FLOW TO CENTER JET (reactor), mol/hr		18.55	24.03	25.68	22.43	21.22	25.15	19.60	20.03	23.52
FR 937										
ATMOSPHERIC N ₂ , mol/hr		5.43	5.30	5.25	5.19	5.17	5.09	5.09	5.11	5.03
FR 918 (1st stage quencher)										
RATE OF QUENCH WATER, mol/hr		58.29	72.01	77.72	78.87	80.01	93.73	75.44	73.15	74.30
FR 9330 (2nd stage quencher)										
RATE OF QUENCH WATER, mol/hr		0	0	0	0	0	0	11.11	14.44	15.55
FR 995										
AIR TO AIR HEATER, mol/hr		0	0	0	0	0	0	0	0	0
FR 909										
SWEEP GAS (N ₂), mol/hr		0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr		13.61	12.64	13.93	13.03	13.45	13.41	13.38	12.26	12.46
BED DENSITY, lb/ft ³		39.88	37.22	35.89	34.56	34.56	35.89	37.22	38.55	39.88
BED HEIGHT, ft		3.76	4.26	4.17	4.58	4.58	4.41	4.26	4.11	3.97
REACTOR GAS COMPOSITION (dry), %										
N ₂		28.10		15.50		12.00		13.40		12.50
CO		9.90		20.00		22.80		21.80		21.70
CO ₂		33.70		25.60		21.50		21.40		21.50
H ₂		25.90		31.40		37.70		37.30		36.90
CH ₄		2.20		6.60		5.20		5.40		4.70
H ₂ S		0.00		0.20		0.20		0.10		0.30
COAL FEED RATE, (wet) (avg), lb/hr		1050	1575	1575	1825	1825	1825	1825	1500	1500
E-7 BED DISCHARGE RATE, lb/hr		25	1	43	45	88	48	53	49	0
C-4 ASH DISCHARGE RATE, lb/hr		32	25	31	31	18	40	29	39	44
2nd STAGE FINES REMOVAL RATE, lb/hr		326	631	631	604	604	604	604	450	450
3rd STAGE FINES REMOVAL RATE, lb/hr		10	10	23	23	13	13	19	19	5
FEED COMPOSITION, %: C										
ASH		12.5				10		19		10
REACTOR BED COMPOSITION, %: C										
ASH		11.5	23	17	35.5	44.5	43	42.5	51	50
DISCHARGED BED COMPOSITION, %: C										
ASH		16		19				52.5		
ASH COMPOSITION, %: C										
ASH		18				63		70		58.5
2nd STAGE FINES COMPOSITION, %: C										
ASH		23		23		22		22		22.5
3rd STAGE FINES COMPOSITION, %: C										
ASH		32		28.5		28.5		21		19.5

Table 2, Part 5. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE 12/7/78 - 12/8/78 RUN NUMBER 131		12/8								
TIME		2000	2200	0400	0600	0800	1000	1200	1400	1600
TE 9206.1 GAS TEMP ENTERING VENTURI, °F		848	935	780	639	625	714	777	797	657
TE 9206.2 GAS TEMP ENTERING GRID, °F		477	489	529	465	397	353	376	379	362
TE 9206.3 BED TEMP, °F		1866	1859	1710	1854	1849	1847	1848	1849	1848
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F		1755	1762	1351	1592	1642	1680	1698	1694	1747
FR 903 STEAM FLOW TO GRID, mol/hr		17.92	17.72	14.43	18.74	24.23	31.49	31.57	30.09	29.73
FR 904 STEAM FLOW TO HEATER, mol/hr		31.64	31.46	0	0	0	48.20	49.43	44.21	42.94
FR 905 STM + O ₂ FLOW TO GRID, mol/hr		6.02	5.60	26.34	17.16	11.20	0	0	0	0
FR 906 STM + N ₂ FLOW TO VENTURI, mol/hr		20.24	20.40	26.59	34.55	34.26	37.75	38.05	32.98	32.46
FR 9304 STEAM TO VENTURI, mol/hr		16.84	16.84	5.11	9.30	9.31	7.47	7.50	7.52	7.38
FR 938 OXYGEN TO AIR HEATER, mol/hr		12.33	12.25	0	0	0	7.43	7.97	9.27	10.64
FR 9303 AUX. O ₂ or N ₂ TO REACTOR, mol/hr		12.20	12.12	0	6.93	6.95	4.56	4.56	4.51	4.48
FR 9405 STM + O ₂ FLOW TO CENTER JET (reactor), mol/hr		17.72	17.73	16.40	16.81	16.42	22.10	23.81	25.11	25.30
FR 937 ATOMIZING N ₂ , mol/hr		5.57	5.62	5.71	5.65	5.69	5.61	5.29	5.54	5.60
FR 918 (1st stage quencher) RATE OF QUENCH WATER, mol/hr		68.58	68.58	25.15	41.15	38.86	47.43	48.01	46.86	53.72
FR 9330 (2nd stage quencher) RATE OF QUENCH WATER, mol/hr		14.44	16.66	22.22	0	16.66	0	5.56	5.56	0
FR 995 AIR TO AIR HEATER, mol/hr		0	0	67.46	67.71	61.15	0	0	0	0
FR 909 SWEEP GAS (N ₂), mol/hr		0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr		12.58	12.64	15.34	14.51	14.03	13.54	13.36	12.75	12.64
BED DENSITY, lb/ft ³		37.22	38.55	38.55	36.35	35.25	35.25	37.45	38.55	37.45
BED HEIGHT, ft		4.41	4.41	4.33	4.91	4.90	4.57	4.31	4.48	4.69
REACTOR GAS COMPOSITION (dry), %										
N ₂			13.20		78.70		72.20			
CO			24.00		0.50		3.80			
CO ₂			20.80		14.20		16.80			
H ₂			37.30		5.80		6.40			
CH ₄			4.10		0.16		0.16			
H ₂ S			0.20		0.00		0.00			
COAL OR COKE FEED RATE, (wet) (avg), lb/hr		coal 1500	1500	coke 555	555	555	540	40% coal 600	80% coal 660	coal 600
C-7 BED DISCHARGE RATE, lb/hr		0	0	0	0	0	0	0	21	43
C-4 ASH DISCHARGE RATE, lb/hr		116	35	63	19	11	17	24	28	22
2nd STAGE FINES REMOVAL RATE, lb/hr		450	450	271	271	271	264	314	314	95
3rd STAGE FINES REMOVAL RATE, lb/hr		5	5	10	10	23	23	23	23	8
FEED COMPOSITION, %:										
ASH			9.0		20.5		19.0			
REACTOR BED COMPOSITION, %:										
ASH		24.0	38.5	21.5	13.5	30.0	29.5	33.5	22.0	25.0
DISCHARGED BED COMPOSITION, %:										
ASH										
ASH COMPOSITION, %:										
ASH			69.0		52.5		66.5			
2nd STAGE FINES COMPOSITION, %:										
ASH			21.0		25.0		28.0		36.0	
3rd STAGE FINES COMPOSITION, %:										
ASH			18.0		20.5		25.0			

Table 2, Part 6. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE 12/8/78 - 12/9/78	RUN NUMBER 131	12/9							
TIME	1800	2000	2200	2400	0200	0400	0600	0800	1000
TE 9206.1 GAS TEMP ENTERING VENTURI, °F	656	756	1082	1099	1025	1097	1114	970	1009
TE 9206.2 GAS TEMP ENTERING GRID, °F	362	384	421	422	410	431	426	417	417
TE 9206.3 BED TEMP, °F	1863	1849	1857	1855	1856	1849	1861	1857	1857
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F	1743	1772	1777	1777	1775	1772	1771	1774	1780
FR 903 STEAM FLOW TO GRID, mol/hr	29.72	29.59	29.80	29.60	29.44	29.60	29.44	29.22	27.34
FR 904 STEAM FLOW TO HEATER, mol/hr	42.94	38.17	38.20	38.20	38.20	38.20	38.42	38.31	38.42
FR 905 FLOW TO GRID, mol/hr	0	0	0	0	0	0	0	0	0
FR 906 STN + O ₂ FLOW TO VENTURI, mol/hr	32.67	24.59	19.79	20.49	22.34	20.00	22.12	22.47	23.45
FR 9304 STEAM TO VENTURI, mol/hr	7.38	11.85	10.52	10.60	11.09	11.57	12.80	12.81	12.86
FR 938 OXYGEN TO AIR HEATER, mol/hr	10.56	11.30	10.74	11.40	11.39	11.44	11.41	11.12	10.79
FR 9303 AUX. O ₂ TO REACTOR, mol/hr	9.01	10.93	12.08	12.08	11.85	11.73	10.50	11.70	13.02
FR 9405 STN + O ₂ FLOW TO CENTER JET (reactor), mol/hr	24.80	29.58	32.08	31.84	30.19	32.29	31.11	30.21	29.13
FR 937 ATOMIZING N ₂ , mol/hr	5.51	5.67	5.57	5.62	5.55	5.64	5.55	5.30	5.47
FR 918 (1st stage quencher) RATE OF QUENCH WATER, mol/hr	51.44	64.01	64.01	64.01	64.01	61.72	57.15	57.15	62.87
FR 9330 (2nd stage quencher) RATE OF QUENCH WATER, mol/hr	0	0	0	0	0	0	0	0	17.78
FR 995 AIR TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 909 SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr	12.70	12.72	12.70	12.76	12.76	12.76	13.22	13.67	12.55
BED DENSITY, lb/ft ³	36.41	37.48	36.41	37.48	37.48	38.55	41.77	39.62	39.62
BED HEIGHT, ft	4.74	4.99	5.37	4.84	4.92	5.00	4.48	4.54	4.79
REACTOR GAS COMPOSITION (dry), %									
N ₂					14.10		17.40		12.90
CO					22.20		19.80		22.80
CO ₂					23.50		23.50		22.40
H ₂					37.10		36.10		38.40
CH ₄					2.70		2.70		2.80
H ₂ S					0.20		0.30		0.50
COAL FEED RATE, (wet) (avg), lb/hr	750	1039	1039	1039	1039	1039	1039	1039	1039
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	6	46	46	52
C-4 ASH DISCHARGE RATE, lb/hr	16	20	56	78	81	80	77	75	47
2nd STAGE FINES REMOVAL RATE, lb/hr	95	144	144	144	144	144	144	144	144
3rd STAGE FINES REMOVAL RATE, lb/hr	8	8	8	8	5	5	5	5	5
FEED COMPOSITION, %:									
C			74.11				72.99		71.65
ASH	14.0		16.52		12.5		11.09		12.92
REACTOR BED COMPOSITION, %:									
C			51.88				33.24		33.32
ASH	29.5	19.0	44.54	27.0	50.0	31.0	65.63	61.5	65.66
DISCHARGED BED COMPOSITION, %:									
C									33.4
ASH									65.55
ASH COMPOSITION, %:									
C			36.55				34.76		23.78
ASH	47.5		61.93				64.09		75.06
2nd STAGE FINES COMPOSITION, %:									
C			73.09				80.68		81.21
ASH	30.5		24.56		21.5		16.70		15.96
3rd STAGE FINES COMPOSITION, %:									
C			67.26				69.27		68.83
ASH	31.0		30.77		23.0		26.95		28.05

Table 2, Part 7. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE 12/9/78 - 12/10/78	RUN NUMBER 131		12/10							
TIME	1200	1400	1600	1800	2000	2200	2400	0200	0400	
TE 9206.1										
GAS TEMP ENTERING VENTURI, °F	1001	990	1019	1002	1121	1069	1086	995	977	
TE 9206.2										
GAS TEMP ENTERING GRID, °F	421	412	447	412	415	410	402	394	386	
TE 9206.3										
BED TEMP, °F	1859	1867	1866	1876	1881	1882	1878	1879	1874	
TE 9206.16										
GAS TEMP ENTERING QUENCHER, °F	1773	1777	1769	1768	1768	1778	1775	1781	1782	
FR 903										
STEAM FLOW TO GRID, mol/hr	26.29	25.57	19.48	27.70	27.91	28.06	28.05	27.89	27.89	
FR 904										
STEAM FLOW TO HEATER, mol/hr	31.80	29.54	32.58	33.70	33.72	31.66	31.46	31.37	31.46	
FR 905 STN + O ₂										
FLOW TO GRID, mol/hr	0	0	6.93	0	0	0	0	0	0	
FR 906 STN + O ₂										
FLOW TO VENTURI, mol/hr	22.37	21.07	17.69	18.40	19.22	19.05	18.94	18.79	19.13	
FR 9304										
STEAM TO VENTURI, mol/hr	14.08	16.27	16.49	16.27	16.17	16.28	16.38	16.27	16.38	
FR 938										
OXYGEN TO AIR HEATER, mol/hr	8.52	10.04	8.34	8.52	8.67	8.67	8.39	8.38	8.58	
FR 9303										
AUX. O ₂ TO REACTOR, mol/hr	14.45	15.01	15.79	15.87	15.88	17.20	17.47	17.67	18.02	
FR 9405 STN + O ₂										
FLOW TO CENTER JET (reactor), mol/hr	19.77	19.73	15.67	24.27	25.31	23.92	23.77	23.54	23.24	
FR 937										
ATOMIZING N ₂ , mol/hr	5.44	5.55	5.59	5.58	5.64	5.58	5.54	5.56	5.53	
FR 918 (1st stage quencher)										
RATE OF QUENCH WATER, mol/hr	56.01	51.44	54.86	54.86	57.15	57.15	59.44	65.15	64.01	
FR 9330 (2nd stage quencher)										
RATE OF QUENCH WATER, mol/hr	16.66	16.66	15.55	13.33	13.33	14.44	14.44	14.44	13.33	
FR 995										
AIR TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0	
FR 909										
SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0	
NITROGEN PURGE TO REACTOR, mol/hr	9.82	10.79	9.98	10.13	10.59	10.13	10.13	10.12	10.08	
BED DENSITY, lb/ft ³	40.69	40.69	37.48	37.48	38.41	36.96	36.96	34.56	34.56	
BED HEIGHT, ft	4.74	4.60	4.38	4.23	3.98	3.97	4.05	3.58	4.33	
REACTOR GAS COMPOSITION (dry), %										
N ₂				13.10		11.90		16.70		
CO				25.20		22.20		25.10		
CO ₂				21.00		23.40		21.70		
H ₂				37.20		38.50		38.40		
CH ₄				2.80		3.40		3.20		
H ₂ S				0.50		0.30		0.60		
COAL FEED RATE, (wet) (avg), lb/hr	1163	1163	1163	1176	1176	1176	1176	1176	1350	
C-7 BED DISCHARGE RATE, lb/hr	18	132	0	0	0	0	0	0	0	
C-4 ASH DISCHARGE RATE, lb/hr	60	48	81	91	142	136	135	173	130	
2nd STAGE FINES REMOVAL RATE, lb/hr	111	111	111	113	113	113	113	113	288	
2nd STAGE FINES REMOVAL RATE, lb/hr	5	5	5	5	5	5	5	5	5	
FEED COMPOSITION, %:										
C				71.42		72.62		72.04		
ASH		12.5		12.60		11.90	10.0	12.10		
REACTOR BED COMPOSITION, %:										
C				29.91		25.64		22.47		
ASH	68.0	72.0	61.0	69.03	67.0	73.52	56.0	76.70	67.5	
DISCHARGED BED COMPOSITION, %:										
C										
ASH										
ASH COMPOSITION, %:										
C				19.34		12.99		10.15		
ASH				79.83		86.30		88.74		
2nd STAGE FINES COMPOSITION, %:										
C				79.46		79.90		79.75		
ASH		17.0		17.74		17.22		17.69		
3rd STAGE FINES COMPOSITION, %:										
C				63.77		63.71		63.61		
ASH		34.0		33.73		33.89		33.92		

Table 2, Part 8. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE	12/10/78	RUN NUMBER	131							
TIME		0600	0800	1000	1200	1400	1600	1800	2000	2200
TE 9206.1	GAS TEMP ENTERING VENTURI, °F	905	930	940	946	934	998	923	957	664
TE 9206.2	GAS TEMP ENTERING GRID, °F	382	389	397	399	393	401	408	418	351
TE 9206.3	BED TEMP, °F	1879	1881	1878	1880	1882	1879	1823	1894	1852
TE 9206.16	GAS TEMP ENTERING QUENCHER, °F	1779	1778	1783	1777	1777	1780	1777	1814	1778
FR 903	STEAM FLOW TO GRID, mol/hr	28.05	27.89	27.89	37.88	28.11	28.05	28.06	28.05	28.22
FR 904	STEAM FLOW TO HEATER, mol/hr	31.64	31.46	31.46	31.44	31.62	31.55	29.31	29.21	33.92
FR 905	FLOW TO GRID, mol/hr	0	0	0	0	0	0	0	0	0
FR 906	STM + O ₂ FLOW TO VENTURI, mol/hr	18.95	18.74	18.55	18.89	18.30	18.09	18.97	19.05	17.59
FR 9304	STEAM TO VENTURI, mol/hr	16.38	16.59	16.59	16.58	16.69	16.65	16.60	16.59	16.49
FR 938	OXYGEN TO AIR HEATER, mol/hr	8.93	8.98	8.29	7.54	8.37	7.67	12.07	16.02	9.96
FR 9303	AUX. O ₂ TO REACTOR, mol/hr	18.43	18.33	18.39	15.29	16.53	16.92	20.15	18.96	16.75
FR 9405	STM + O ₂ FLOW TO CENTER JET (reactor), mol/hr	23.60	23.10	23.05	25.57	24.27	23.59	25.05	29.36	26.16
FR 937	ATOMIZING N ₂ , mol/hr	5.55	5.55	5.54	5.28	5.44	5.21	5.12	5.00	5.14
FR 918 (1st stage quencher)	RATE OF QUENCH WATER, mol/hr	60.58	61.72	67.44	57.15	57.15	58.29	82.30	82.30	89.15
FR 9330 (2nd stage quencher)	RATE OF QUENCH WATER, mol/hr	18.89	16.66	17.78	22.22	17.78	17.78	61.11	61.11	22.22
FR 995	AIR TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 909	SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	2.67	2.66	2.93
NITROGEN PURGE TO REACTOR, mol/hr		11.00	11.17	9.98	9.84	9.39	9.01	12.34	11.58	12.47
BED DENSITY, lb/ft ³		33.12	32.64	32.64	33.12	33.60	33.60	36.96	34.56	28.80
BED HEIGHT, ft		4.17	4.24	4.28	4.22	4.20	3.69	3.66	3.75	4.00
REACTOR GAS COMPOSITION (dry), %										
N ₂				10.40		10.40		12.80		
CO				22.90		22.80		21.70		
CO ₂				22.20		22.40		23.10		
H ₂				39.50		38.80		37.60		
CH ₄				4.30		4.50		4.40		
H ₂ S				0.40		0.60		0.00		
COAL FEED RATE, (wet) (avg), lb/hr		1350	1425	1425	1313	1313	1313	1125	1125	1800
C-7 BED DISCHARGE RATE, lb/hr		0	0	0	0	0	0	0	0	0
C-4 ASH DISCHARGE RATE, lb/hr		127	118	128	104	103	140	89	98	320
2nd STAGE PINES REMOVAL RATE, lb/hr		288	296	296	245	245	245	0	0	885
3rd STAGE PINES REMOVAL RATE, lb/hr		5	5	5	5	5	5	53	53	200
FEED COMPOSITION, %:										
C		73.16				73.65		72.94		
ASH		10.98		10.0		10.45		11.40		
REACTOR BED COMPOSITION, %:										
C		32.05				38.11		42.27		
ASH		66.84	67.5	63.5	60.0	60.78	66.0	56.64	75.0	40.0
DISCHARGED BED COMPOSITION, %:										
C										
ASH										
ASH COMPOSITION, %:										
C		11.14				22.84		21.55		
ASH		88.10		82.5		76.01		77.42		96.0
2nd STAGE PINES COMPOSITION, %:										
C		78.92				76.11		78.55		
ASH		17.87		19.0		20.89		18.27		20.0
3rd STAGE PINES COMPOSITION, %:										
C		63.81				63.13		64.20		
ASH		33.74				33.91		32.64		30.0

Table 2, Part 9. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE 12/10/78 - 12/11/78 RUN NUMBER 131		12/11								
TIME	2400	0200	0400	0600	0800	1000	1200	1800	2000	
TE 9206.1 GAS TEMP ENTERING VENTURI, °F	600	652	707	732	705	762	797	402	525	
TE 9206.2 GAS TEMP ENTERING GRID, °F	348	353	362	366	375	365	375	305	369	
TE 9206.3 BED TEMP, °F	1878	1880	1874	1875	1874	1878	1882	457	712	
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F	1794	1786	1786	1782	1781	1780	1785	1028	940	
FR 903 STEAM FLOW TO GRID, mol/hr	28.18	27.66	27.66	27.51	27.73	27.79	27.81	31.95	23.79	
FR 904 STEAM FLOW TO HEATER, mol/hr	33.87	32.58	33.70	33.70	33.80	33.37	34.09	0	0	
FR 905 STM + O ₂ OR HTD AIR FLOW TO GRID, mol/hr	0	0	0	0	0	0	0	22.35	18.97	
FR 906 STM + O ₂ OR HTD AIR FLOW TO VENTURI, mol/hr	19.78	19.02	18.72	19.54	19.57	19.68	19.57	25.36	33.78	
FR 9304 STEAM TO VENTURI, mol/hr	16.48	17.40	17.40	17.40	17.52	15.96	15.87	12.68	0	
FR 938 OXYGEN TO AIR HEATER, mol/hr	11.07	10.47	10.60	10.83	10.54	10.54	10.67	0	0	
FR 9303 AUX. O ₂ OR N ₂ TO REACTOR, mol/hr	17.13	16.55	16.54	15.99	15.99	16.41	16.41	N ₂ = 5.02	5.06	
FR 9405 STM + O ₂ OR HTD AIR FLOW TO CENTER JET (reactor), mol/hr	25.43	25.53	25.49	25.86	25.09	24.85	25.30	16.00	17.25	
FR 937 ATOMIZING N ₂ , mol/hr	5.39	5.56	5.43	5.43	5.37	5.46	5.45	5.48	5.59	
FR 918 (1st stage quencher) RATE OF QUENCH WATER, mol/hr	82.30	76.58	80.01	77.72	68.58	82.30	89.15	22.86	11.43	
FR 9330 (2nd stage quencher) RATE OF QUENCH WATER, mol/hr	0	0	0	0	0	0	0	16.66	16.66	
FR 995 AIR TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	62.62	71.44	
FR 909 SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0	
NITROGEN PURGE TO REACTOR, mol/hr	9.91	9.93	10.79	10.34	9.84	9.33	9.80	16.90	10.19	
BED DENSITY, lb/ft ³	26.40	27.36	28.32	28.80	29.28	29.28	29.76	7.20	37.44	
BED HEIGHT, ft	4.36	4.21	3.86	3.80	3.79	3.93	3.87	2.00	3.08	
REACTOR GAS COMPOSITION (dry), %										
N ₂		10.00		9.80		10.00				
CO		23.20		23.10		21.70				
CO ₂		21.70		23.50		23.30				
H ₂		39.00		38.00		38.80				
CH ₄		3.80		4.80		5.20				
H ₂ S		0.00		0.40		0.50				
COAL OR COKE FEED RATE, (wet) (avg), lb/hr	1800	1725	1725	1725	1725	1725	1725	Coke = 1200	0	
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	0	0	0	0	
C-4 ASH DISCHARGE RATE, lb/hr	57	40	41	39	46	52	63	72	54	
2nd STAGE FINES REMOVAL RATE, lb/hr	472	551	551	551	551	551	551	61	61	
3rd STAGE FINES REMOVAL RATE, lb/hr	11	11	11	12	12	11	11	11	11	
FEED COMPOSITION, %:										
ASH		10.0				11.0				
REACTOR BED COMPOSITION, %:										
ASH	33.5	28.0	37.0	36.5	39.0	46.5	37.0			
DISCHARGED BED COMPOSITION, %:										
ASH										
ASH COMPOSITION, %:										
ASH		76.0		39.5		52.5	62.5			
2nd STAGE FINES COMPOSITION, %:										
ASH		18.5		23.5		21.0				
3rd STAGE FINES COMPOSITION, %:										
ASH				15.5		17.0				

Table 2, Part 10. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 131

DATE 12/11/78 - 12/12/78 RUN NUMBER 131	12/12								
TIME	2200	2400	0200	0400	0600	0800			
TE 9206.1									
GAS TEMP ENTERING VENTURI, °F	605	650	601	790	661	670			
TE 9206.2									
GAS TEMP ENTERING GRID, °F	363	364	400	362	346	354			
TE 9206.3									
BED TEMP, °F	856	1657	1791	1787	1795	1850			
TE 9206.16									
GAS TEMP ENTERING QUENCHER, °F	906	1176	1375	1573	1656	1728			
FR 903									
STEAM FLOW TO GRID, mol/hr	23.79	23.83	22.52	31.85	29.96	29.75			
FR 904									
STEAM FLOW TO HEATER, mol/hr	0	0	0	47.46	52.80	48.55			
FR 905 STM + O ₂ or HTD AIR									
FLOW TO GRID, mol/hr	13.83	17.47	21.80	0	0	0			
FR 906 HTD. AIR or STM + O ₂									
FLOW TO VENTURI, mol/hr	34.03	34.40	37.23	39.64	46.56	39.65			
FR 9304									
TO VENTURI, mol/hr	0	0	0	0	0	0			
FR 938									
OXYGEN TO AIR HEATER, mol/hr	0	0	0	10.20	12.23	12.30			
FR 9303									
AUX. N ₂ or O ₂ TO REACTOR, mol/hr	5.04	5.65	5.04	8.37	12.52	17.06			
HTD. AIR OR									
FR 9405 STM + O ₂ FLOW TO									
CENTER JET (reactor), mol/hr	18.60	15.67	16.20	22.13	24.60	25.76			
FR 937									
ATOMIZING N ₂ , mol/hr	5.43	5.65	5.49	5.60	5.48	5.65			
FR 918 (1st stage quencher)									
RATE OF QUENCH WATER, mol/hr	11.43	22.86	42.29	80.01	76.58	83.44			
FR 9330 (2nd stage quencher)									
RATE OF QUENCH WATER, mol/hr	16.66	13.33	11.11	11.11	14.44	15.55			
FR 995									
AIR TO AIR HEATER, mol/hr	67.23	67.95	72.68	0	0	0			
FR 909									
SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0			
NITROGEN PURGE TO REACTOR, mol/hr	20.37	9.88	10.32	10.38	9.89	9.93			
BED DENSITY, lb/ft ³	31.20	28.80	33.60	32.16	28.80	25.44			
BED HEIGHT, ft	2.95	3.00	3.77	5.91	5.60	5.43			
REACTOR GAS COMPOSITION (dry), %									
N ₂					11.30				
CO					15.70				
CO ₂					28.70				
H ₂					32.10				
CH ₄					10.50				
H ₂ S					0.10				
COAL OR									
COKE FEED RATE, (wet) (avg), lb/hr	0	0	900	1650	2370	2400			
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	0			
C-4 ASH DISCHARGE RATE, lb/hr	24	12	60	70	24	6			
2nd STAGE FINES REMOVAL RATE, lb/hr	61	61	355	769	1134	1313			
3rd STAGE FINES REMOVAL RATE, lb/hr	11	11	11	11	11	18			
FEED COMPOSITION, %:									
ASH			8.0						
REACTOR BED COMPOSITION, %:									
ASH			20.0	18.0	14.0	20.5			
DISCHARGED BED COMPOSITION, %:									
ASH									
ASH COMPOSITION, %:									
ASH			48.0						
2nd STAGE FINES COMPOSITION, %:									
ASH			17.0						
3rd STAGE FINES COMPOSITION, %:									
ASH			26.0

Figure 5. PROCESS SCHEMATIC DIAGRAM OF THE U-GAS PILOT PLANT

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At 1200 hours on December 6, the superficial velocity was reduced to 3 ft/s, but the operation of the internal cyclone did not improve. The set point superficial velocity of 4 ft/s was restored with the introduction of coal feed.

A mixture of coal and coke, initially 20% coal but ultimately increasing to 100% coal, was fed to the gasifier starting at 2115 hours on December 6. By 0135 hours December 7, 100% coal feed was attained. Ash agglomerates began appearing in the discharge of solids from the venturi at 1030 hours on December 7. The side bed withdrawal proved unnecessary and was discontinued at 1700 hours. Ash-balanced operation continued with an increase in the venturi solids discharge rate to 40 to 60 lb/hr. The coal feed rate averaged 1500 lb/hr, and the carryover of fines removed by the second-stage cyclone was 450 lb/hr.

The higher heating value of the nitrogen and water-free reactor gas was 278 Btu/SCF, and the coal conversion was 72%.

At 2300 hours on December 7, a feed interruption occurred that required a checkout of the scale system. Oxygen flow to the reactor was stopped. The bed cooled to 725°F and was drained. The feed problem was traced to the reactor screw feeder; the chain driving it was slipping. A link was removed from the chain, and coke feed was restored at 0100 hours on December 8.

At 1025 hours on December 8, the coal feed was started as a 20% coal mixture with coke, and by 1545 hours 100% coal feed was attained. At this time the internal cyclone began functioning, as indicated by the reduced carryover of fines removed by the second-stage cyclone. The coal feed rate averaged 1039 lb/hr, and the carryover of fines removed by the second-stage cyclone averaged 144 lb/hr. Ash agglomerates again began appearing in the solids discharge from the venturi. These agglomerates were small (–10 mesh), resembling those of Run 130. Although the 80 lb/hr of venturi solids discharge averaged 86% by weight ash, the ash content in the bed rose as high as 70%.

At 1500 hours on December 9, the bed temperature was increased to 1880°F to promote the formation of larger, denser ash agglomerates, and the venturi throat velocity was reduced from 72 to 67 ft/s. The reactor bed ash content decreased to between 50% and 60%. During the ash-balanced operation, the rate of venturi solids discharge varied from 80 to 173 lb/hr. The coal feed rate was 1176 lb/hr, and the fines carryover removed by the second-stage cyclone averaged 113 lb/hr.

The higher heating value of the nitrogen and water-free reactor gas was about 260 Btu/SCF, and the coal conversion was 86%. Based on the coal conversion, 64% of the fines was returned to the bed and gasified to extinction.

At 0140 hours on December 10, the rate of fines carryover from the internal cyclone rose to 288 lb/hr, dropping the fluidized bed height by 0.5 feet. During the next 12 hours, numerous seal pot aeration rate changes were made, but no reduction in fines carryover was achieved.

In the afternoon of December 10, it was decided to bypass Set Point 2 (increasing the bed height to 6 feet), to proceed instead with Set Point 3 at a 4-foot bed height by recycling the second-stage cyclone fines, and to try Set Point 2 conditions later.

Set Point 3

At 1700 hours on December 10, the temperature of the reactor gas from the first-stage quencher was increased to 1000°F, thereby increasing the temperature of the fines returned to the bed from the second-stage cyclone. The bed temperature varied initially, but stabilized within 15 to 20 minutes following the addition of oxygen, as the second-stage cyclone fines were returned to the bed. The quench water flow rate, the bed density, and the fines recycle rate remained steady for about 3 hours. The higher heating value of the nitrogen and water-free reactor gas was 271 Btu/SCF, and the coal conversion was about 92%. At 2030 hours, the recycling of fines abruptly ceased as nitrogen, used to aerate the second-stage cyclone seal pot, backgassed up the dipleg of the second-stage cyclone, the result of a decrease in solids density in the dipleg of the cyclone.

With the loss of the 800°F fines entering the bed, the reactor bed temperature rose rapidly to 1950°F before the operators could reduce the oxygen feed and bring the bed temperature back to set point conditions. In response to this temperature upset, the bed density decreased from about 36 to 30 lb/ft³, and the fluidized bed height dropped. The venturi discharge rate, determined periodically through the discharge of batches through a lockhopper arrangement, increased temporarily by nearly 100% to 320 lb/hr just after the temperature excursion. The venturi discharge was 96% ash by weight and consisted almost entirely of 1/8 to 1/4-inch diameter ash agglomerates, the largest yet produced from operation with coal. The bed ash content simultaneously dropped from 60% to less than 40%.

With the ending of fines recycling, the fines carryover removed by the second-stage cyclone was found to have increased to 551 lb/hr, indicating that the internal cyclone no longer functioned. Over the next 12 hours, various changes in the nitrogen aeration to the internal cyclone dipleg and seal pot were made but did not reduce the fines carryover from the internal cyclone.

Set Point 2

It was decided to proceed with Set Point 2 despite the relatively large fines carryover and, if successful, to return to Set Point 3.

After 3 hours of increased coal feed, the bed height had been raised to 5 feet when the reactor screw feeder jammed at 1400 hours on December 11, temporarily interrupting the coal feed and preventing the attainment of a 6-foot bed height. The reactor was idled while the feed failure was examined. It was found that a roll pin used to secure the handle on the feed sample ball valve had sheared, enabling the valve to remain open. When the feed sample was taken using a lockhopper method with a second valve at 1400 hours, the failed valve enabled the reactor to vent through the reactor feed screw and out the feed sample line. The effect was that the coal discharging from the reactor feed screw was prevented from entering the feed chute, thereby plugging the screw discharge pipe.

By 1700 hours on December 11 the feed chute was cleared of coal, but the reactor bed temperature had dropped to 600°F. The operating conditions of 1850°F and a 6-foot bed height for Set Point 3 were achieved at 0345 hours on December 12, after a period of reheating and start-up with coke feed, followed by blending increasing amounts of coal with the coke feed until 100% coal feed was attained.

Because the internal cyclone was not functioning, the fines carryover removed by the second-stage cyclone was very high (1134 lb/hr). The coal feed rate needed to maintain the bed height was also high (2370 lb/hr), because of the high loss of fines.

At 0820 hours on December 12 the second-stage cyclone developed a product gas and dust leak, forcing the termination of Run 131.

The reactor required about 36 hours to cool so that the internal cyclone could be lifted and inspected. The refractory-lined inlet scroll section was almost completely plugged with a deposit comprised of 98% ash. The seal pot and dipleg were free of any accumulation and were unobstructed.

The reactor grid area, including thermowells, the central jet pipe, and the fines injection and feed nozzles, were free of any deposits.

During Run 131, the product gas scrubber operated for 43 hours during coal feed, the longest of any coal test, but, eventually, the water drain became plugged with tar despite numerous efforts to clear the drain by poking a rod through the obstruction. Twenty-seven pounds of tar were removed from the scrubber following Run 131, representing about 0.02% of the weight of coal fed to the gasifier while the scrubber was operational.

ASH AGGLOMERATE CONCENTRATION TESTS

Introduction

Tests with the half-section cold flow model of the ash agglomerating gasifier show that the weight fraction, or concentration, of ash agglomerates in the reactor bed is one of the variables that most influence the rate of agglomerate discharge from the venturi. Also, the concentration of agglomerates in the discharge of char solids is an important test result; the higher this value, the more the coal carbon converts to gas, rather than dropping out the venturi as unreacted char. However, measuring the fraction of ash agglomerates in a sample has been a tedious, time-consuming task, involving separating the agglomerates by hand. Recently, a much faster, more accurate method was found. This method is described in the following sections.

Apparatus

The equipment used to measure the concentration of ash agglomerates in a sample is a 3-inch-diameter cylindrical fluidized bed made of Plexiglas. Alternatively, a 2-inch column could be used. The gas distributor is a flat, porous plate. Fluidization is provided by plant air and controlled by a rotameter. Conditions within the cylinder are close to ambient, about 1 atm pressure and 70°F temperature.

Procedure

Collect a sample with sufficient agglomerates to form a 1/2-inch layer in the 3-inch column. Pour the weighed sample of mixed ash agglomerates and char into the 3-inch Plexiglas column with the gas flow off. Increase the flow of air through the distributor until the bed is fluidized above a quiescent layer of ash agglomerates lying on top of the distributor. Turn off the gas flow abruptly. Vacuum off the top layer of solids that forms. Vacuum off and weigh the quiescent ash agglomerate layer. This weight divided by the sample weight is the weight fraction of ash agglomerates in the sample.

If the agglomerate layer is colored differently from the remainder of the bed, the determination of weight fraction takes about 15 minutes. If the agglomerate layer is similarly colored, distinguishing the layer requires more time, and the weight fraction determination takes about one-half hour.

ADDENDUM

P01790019

Figure 1. ASH AGGLOMERATE DISCHARGE FROM RUN 130
(A Centimeter-Scale Ruler is Shown in the
Photograph; the Scale is Approximately
3-1/4 x Actual Size)