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 38145

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 AND QUARTERLY
PROGRESS REPORT

FOR THE PERIOD
SEPTEMBER 1, 1978 - SEPTEMBER 30, 1978

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

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MEMPHIS INDUSTRIAL FUEL GAS

DEMONSTRATION PLANT PROJECT

QUARTERLY TECHNICAL PROGRESS REPORT
(Deliverable #12)

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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)

MEMPHIS LIGHT, GAS AND WATER DIVISION

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INTERIM PROJECT OFFICE			
_____ Laza	_____ Polin		
_____ Kline	_____ O'Z		
_____ Selby	_____ Martello		
_____ McConnel	_____ Puccillo		
_____ Lui	_____ Ohlsson		

October 15, 1978
Letter No. ME-25F

U. S. Department of Energy
Interim Project Office, Dr. R. W. Laza
9800 South Cass Avenue
Argonne, Illinois 60439

Attention: Dr. Peter Lui

Subject: MLGW Reference No. 8802
DOE Reference No. 2582
TASK XI - MONTHLY REPORTS

Gentlemen:

Attached are fourteen (14) copies of the Monthly Report covering the period September 1, 1978 through September 30, 1978.

Very truly yours,

RJ Swift
for R. W. Gray
Program Manager

RWG:RJS:au
Attachment.

cc: U. S. Department of Energy (2)
400 First Street, N.W.
Mail Station 504
Washington, D.C. 20545

Attention: E. A. Lloyd
Fossil Fuel Processing

MLGW/DOE INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM

FOSTER WHEELER

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MLGW/DOE INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM

FOSTER WHEELER

MTSR-11

September 1 - September 30, 1978

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

Work during the July-September period was concentrated on the preparation of the Task I report. The Commercial Plant estimate was completed in July and reviewed by MLGW. A MRC review of the estimate was also conducted.

A Plant Configuration study was completed and reviewed by MLGW for enclosure in the Demonstration Plant recommendations. The economic analysis was completed in late August.

In early September, a preliminary draft of the four volumes of the Task I report was provided to all Industrial Team members and MRC for comments, which were received by the week of September 25th.

2.2 Task II - Demonstration Plant Process Design

No work was done on this task in accordance with the stop work order, which expired September 23, 1978. Task II and III work continued to be stopped until a series of meetings to establish the minimum required work necessary to complete Phase I by December 1, 1979.

2.3 Task III - Demonstration Plant Process and Mechanical Design Package

No work was done in this task in accordance with the stop work order. See Section 2.2 above.

2.4 Task IV - Site Evaluation and Selection

Task IV activities, except for soil boring and topographic swing work, was halted by the June stop work order.

Work during the past quarter concentrated on the solicitation of bids for this work. Subcontracts for this work will be let early in October.

In late September, DOE authorized other Task IV work associated with site negotiations and a preliminary levee design. No more than 400 man-hours (\$14,000) and consultant costs (\$20,000) for a total of \$34,000 are to be expended.

2.5 Task V - Demonstration Plant Environmental Analysis

The status of the environmental effort is as follows:

Subtask A - Project Management

During September EIA provided a series of letters to FWEC and MLGW on the subjects of: 1) A-95 Review Program, 2) Water Quality results, 3) Office of Planning and Development comments, 4) Strategy of air monitoring program, and 5) Savings from dropping ozone monitoring. Several of the letters cited above will require decisions from FWEC and MLGW on how to proceed. These decisions are expected during the month of October.

Contract Modification

The EIA contract modification for the environmental program was submitted in August to FWEC and then to MLGW and finally to DOE for review in September. This request identifies \$390,435 worth of work associated with required changes to the original scope, and also reports a \$78,609 forecasted overrun over the original estimated cost.

Engineering Soils Consultant

EIA prepared written guidelines to be followed during pre-construction activities at the proposed coal gasification site, at FWEC's request, and sent these to FWEC and MLGW.

State and Federal Agency Coordination

EIA, FWEC and MLGW had several conference calls with the TN Dept. of Public Health, state and regional EPA regarding acceptance of EIA's air monitoring program and the location of the long-term monitoring station. EIA provided fugitive dust source terms for ash and coal storage at the proposed site to FWEC for inclusion in their input to these agencies as part of the description for the proposed plant.

County Level Coordination

Memphis/Shelby County Health Department personnel reviewed the EIA-prepared documents on the "Systems Manual, Air Quality Monitoring Station" and "Selection of Long-Term Ambient Air Quality Monitoring Site" and provided their comments. They gave tentative approval to the EIA air quality program.

The Health Department informed the project that the proposed gasification plant is not included in the State Implementation Plan strategy because the Health Department consultant does not have sufficient plant design/source term information. FWEC is preparing appropriate point-and area-source data.

TVA Coordination

EIA identified specific meteorological and air-quality data required by EIA from TVA's monitoring network around the Allen Plant. This information is to be requested formally from TVA by MLGW.

Stop Work Order

EIA has revised the schedule of the environmental program because the receipt of engineering process design information will be delayed due to DOE's recent stop work order. Impact and report writing efforts will be delayed about six months, if DOE approves MLGW's recent request for continuation of minimal Task II and III work.

Subtask B - Plant Systems Description

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

Subtask C - Water Quality and Hydrology

EIA received and reviewed the results of laboratory analysis of water sample collected during the summer and determined that the results were similar to the results of the spring survey. EIA provided information on alternative methods of obtaining groundwater samples from the well at the proposed site to FWEC and MLGW at MLGW's request. The fall field program is scheduled for October 18th and 19th.

A draft of portions of the subcontractor's report on hydrology were received and are being reviewed by EIA.

Subtask D - Air Quality and Meteorology

A two-day meeting was held at TVA in Muscle Shoals, Alabama with MLGW, FWEC and EIA in attendance. TVA will cooperate by making available to the program all the data at their disposal from their Allen Plant monitoring network.

EIA has continued to operate the air quality monitors at the interim site. All the components for the long-term monitoring program are in storage in Memphis. EIA is prepared to set up the station as soon as the long-term location receives regulatory agency approval.

Subtask E - Terrestrial Ecology

Reports on field and laboratory work done by MSU subcontractors as part of the summer terrestrial surveys were reviewed and approved by EIA. Preparation for the fall field program began. The fall field program is scheduled for October 11th to 16th.

Subtask F - Aquatic Ecology

EIA received and began reviewing the results of fish, phytoplankton and periphyton sample analysis of samples collected from the area of the site. Analysis of other samples is proceeding on schedule. Preparations for the fall field program are underway, the field work is scheduled for the week of October 16th.

Subtask G - Socioeconomics

Socioeconomic field work is underway, and the local subcontractors report that they are proceeding on schedule. The subcontractor requested a schedule of construction employment.

Subtask H - Noise

Noise monitoring in the site area was conducted by the local subcontractor and his report was received by EIA. EIA has contracted with a consultant to assist in developing noise source terms for plant construction and operation and to assess impact.

2.6 Task VI - Materials, Agreements and Licenses

Work was stopped on this task until September 23. On September 20, DOE authorized the expenditure of 250 man-hours to proceed with commencing license negotiations.

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

Work has not started on this task and is not scheduled until after the three month IGT milestone.

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.

See Appendix A for further details.

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.

2.11 Task XI - Program Management

Contractual management of the program was transferred to the DOE Chicago Operations Office as of June 19, 1978. Technical management was transferred in early September. A series of meetings was held during September to schedule minimum activities necessary to complete Phase I by December 1, 1979.

3.0 Project Status

3.1 Schedule

DOE has rescheduled Phase I to be completed as of December 1, 1979. Discussions between DOE and the Industrial Team were held to determine the engineering activities needed to start in order to maintain that schedule.

3.2 Cost Status

Expenditures continued to diverge from planned values because of the stop work order. The team is required to submit a new Cost Plan for FY 1979. A DOE decision on the recommended Task II and III activities, together with the DOE allocation of the \$1.5MM for the MLGW team and the Pilot Plant.

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.

3.4 Contractual Status

The EIA/FWEC Contract Modification request has been prepared, reviewed by MLGW, and sent to DOE.

3.5 Management Status

No significant management problems exist.

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

FW FOSTER WHEELER

MTSR-11

September 1 - September 30, 1978

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 will be completed during October.

5.0 Program Manager's Assessment

If DOE approves the minimum Task II and III work during the Oct-Dec period, the project schedule will reflect the Dec. 1, 1979 Phase I completion date.

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

1. Contract Identification Industrial Fuel Gas Demonstration Plant	2. Reporting Period 9/1/78: through 9/30/78	3. Contract Number DM 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 May 19, 1979

7. Months	O	N	D	J	F	M	A	M	J	J	A	S	8. FY 1978
-----------	---	---	---	---	---	---	---	---	---	---	---	---	------------

11. Major Milestone Status		
a. TASK I		JULY 15, 1978
b. TASK II		AUG. 25, 1978
c. TASK III		MID MAY, 1979
d. TASK IV		AUG. 25, 1978
e. TASK V		MAR. 2, 1979
f. TASK VI		MID MAY, 1979
g. TASK VII		MAY 4, 1979
h. TASK VIII		MAR. 9, 1979
i. TASK IX		MAR. 9, 1979
j. TASK X		END DEC. 1978
k. TASK XI		END MAY 1979

12. Remarks
*Subcontractor start dates October 24, 1977 and November 11, 1977.

13. Signature of Contractor's Project Manager and Date <i>R.W. Gray / RJS 10-17-78</i>	14. Signature of Government Technical Representative and Date
---	---

MLGW/DOE INDUSTRIAL FUEL GAS
DEMONSTRATION PLANT PROGRAM

FOSTER WHEELER

RECONCILIATION OF AUGUST 1978*
MANAGEMENT REPORTS

	Cost Management Report		Manpower Management Report	
	Reported in August	Revised August Actuals	Reported In August	Revised August Actuals
MLGW	53	52	17	17
FWEC	88	88	22	22
DRC	7	8	3	2
IGT	263	484	50	56
EIA	<u>95</u>	<u>63</u>	<u>22</u>	<u>15</u>
Program Total	506	695	114	112
July Cumulative Totals	<u>3,199</u>	<u>3,199</u>	<u>870</u>	<u>870</u>
August Cumulative Totals	3,705	3,894	984	982
September Total	<u>--</u>	<u>417</u>	<u>--</u>	<u>114</u>
Cumulative through September		4,311**		1,096**

*To be submitted with September Report.

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

Page _____ of _____

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program					2. Reporting Period 9/1/78 through 9/30/78		3. Contract Number EF-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 December 20, 1977		6. Contract Start Date September 19, 1977		
							7. Contract Completion Date May 19, 1979		
8. Government Funding \$6,460,000		9. Contractor Funding		10. Number of Invoices Billed 5		11. Frequency Monthly		12. Number of Invoices Paid 2	
				13. Total Invoice Amounts Billed \$2,808,775.00*		14. Total Payment Received \$1,088,767.76*			
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									
(*) Projected costs for FY 1979 will be determined by Cost/Manpower Plans to be submitted upon approval, by DOE, of revised program schedule									
NOTE: Tasks II, III, part of IV, VI, VII, VIII, and X were affected by a stop work order effective June 23, 1978 for a duration of 90 days or less. The effect on contract value and fiscal year forecasts is not shown. However, DOE has indicated that an additional \$1.5MM will soon be allocated to the program.									
21. Total									
22. Remarks									
Program totals for Contractor and Subcontractor *through 9/30/78									
23. Dollars Expressed in: Thousands									
24. Signature of Contractor's Project Manager and Date R W Gray JRH 10/16/78									
25. Signature of Contractor's Authorized Financial Representative and Date									
26. Signature of Government Technical Representative and Date									

COST MANAGEMENT REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program						2. Reporting Period <u>9/1/78</u> through <u>9/30/78</u>		3. Contract Number EF-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 December 20, 1977		6. Contract Start Date September 19, 1977	
								7. Contract Completion Date May 19, 1979	
8. Government Funding \$745,000.00		9. Contractor Funding 0		10. Number of Invoices Billed 8		11. Frequency Monthly		12. Number of Invoices Paid 5	
				13. Total Invoice Amounts Billed \$171,585.00*				14. Total Payment Received \$87,609.24*	
15. Identification Number									
16. Reporting Category (e.g., contract line item or work breakdown structure element)									
17. Costs Incurred									
18. Projected Accrued Costs									
19. Total Contract Value									
20. Variance									
21. Total									
22. Remarks									
23. Dollars Expressed in:									
24. Signature of Contractor's Project Manager and Date									
25. Signature of Contractor's Authorized Financial Representative and Date									
26. Signature of Government Technical Representative and Date									

Page _____ of _____

Dollars Expressed in:
Thousands

26. Signature of Government Technical Representative and Date

COST MANAGEMENT REPORT

Page _____ of _____

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Page _____ of _____

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program						2. Reporting Period 9/1/78 through 9/30/78		3. Contract Number EF-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 December 20, 1977		6. Contract Start Date October 24, 1977		
								7. Contract Completion Date May 19, 1979		
8. Government Funding \$2,825,000.00		9. Contractor Funding 0		10. Number of Invoices Billed 13		11. Frequency Monthly		12. Number of Invoices Paid 10		
						13. Total Invoice Amounts Billed \$1,550,907.73*		14. Total Payment Received \$1,136,033.90*		
15. Identification Number	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					
Task										
I	Comm. Plt Des. and Eval	(14)	0	582	349			630	349	281
II	Demo Plt Process Des	(1)	8	23	241			178	241	(63)
III	Mech. Design Pkg	0	102	0	379	TBD		1,202	1,202	
IV	Site Eval and Selection	3	0	17	48			43	51	(8)
V	Env. Analysis	4	0	29	32			55	32	23
VI	Materials and Licenses	0	2	1	17			20	27	(7)
VII	Const and OPN Planning	0	6	0	15			47	82	(35)
VIII	Economic Assessment	0	3	0	6			28	28	
IX	Tech. Support	26	3	155	36			302	41	261
X	Long Lead Items	0	29	0	152			111	182	(71)
XI	Project Mgt	38	32	429	338			510	510	
21. Total		56	185	1,236	1,613			3,206	2,825	381
22. Remarks * FWEC invoice figures include EIA charges. Negative () actuals for Tasks I and II reflect invoice credits for reproduction/computer charges.										23. Dollars Expressed in: Thousands
24. Signature of Contractor's Project Manager and Date <i>R W Gray / RSH 10/16/78</i>				25. Signature of Contractor's Authorized Financial Representative and Date				26. Signature of Government Technical Representative and Date		

COST MANAGEMENT REPORT

Page _____ of _____

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant Program						2. Reporting Period 9/1/78 through 9/30/78		3. Contract Number EF-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 December 20, 1977		6. Contract Start Date January 31, 1978		
								7. Contract Completion Date May 19, 1979		
8. Government Funding		9. Contractor Funding		10. Number of Invoices Billed 5		11. Frequency Monthly		12. Number of Invoices Paid 5		
								13. Total Invoice Amounts Billed \$313,757.41		
								14. Total Payment Received \$313,757.41		
15. Identification Number	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		
Task		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	60	24	374	120		0	790	350	440 *
VI	Materials and Licenses									
VII	Const and OPN Planning									
VIII	Economic Assessment									
IX	Tech. Support									
X	Long Lead Items									
XI	Project Mgt									

23. Manpower Expressed in
100 Man-hours

MANPOWER MANAGEMENT REPORT

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant						2. Reporting Period 9/1/78 through 9/30/78		3. Contract Number EF-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 December 20, 1978		6. Contract Start Date September 19, 1977							
								7. Contract Completion Date May 19, 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		3 0		13 19		TBD				16		19 (3)	
II		Demo Plt Process Des		0 0		1 16						7		16 (9)	
III		Mech. Design Pkg		0 6		1 24						52		66 (14)	
IV		Site Eval and Selection		0 0		8 22						27		28 (1)	
V		Env. Analysis		2 0		9 6						13		7 6	
VI		Materials and Licenses		0 3		0 19						26		42 (16)	
VII		Const and OPN Planning		0 1		0 2						8		9 (1)	
VIII		Economic Assessment													
IX		Tech. Support													
X		Long Lead Items		0 2		0 3						17		19 (2)	
XI		Project Mgt		10 12		106 110						242		202 40	
21. Total				15 24		138 221						408		408 0	
22. Remarks MLGW										23. Manpower Expressed In 100 Man-hours					
24. Signature of Contractor's Project Manager and Date R W Gray / 10/16/78						25. Signature of Government Technical Representative and Date									

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MANPOWER MANAGEMENT REPORT

[illegible]

1. Contract Identification Industrial Low BTU Fuel Gas Demonstration Plant				2. Reporting Period 9/1/78 through 9/30/78		3. Contract Number EF-77-C-01-2582	
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						7. Contract Completion Date May 19, 1979	
8.		9.		10.		11. Monthly	
12.		13.		14.		15.	
16. Reporting Category (e.g., contract line item or work breakdown structure element)		17. Manpower Expended		18. Projected Manpower Expenditures		19. Total Contract Manpower	
Task		During Reporting Period		Cumulative to Date		a. Subsequent Reporting Period	
		a. Actual	b. Planned	c. Actual	d. Planned	b. Balance of Fiscal Year	c. Total Contract
I	Comm. Plt Des. and Eval						
II	Demo Plt Process Des						
III	Mech. Design Pkg						
IV	Site Eval and Selection						
V	Env. Analysis	14	8	88	30	TBD	174
VI	Materials and Licenses						
VII	Const and OPN Planning						
VIII	Economic Assessment						
IX	Tech. Support						
X	Long Lead Items						
XI	Project Mgt						
21. Total		14	8	88	30		174
22. Remarks EIA *This variance has been identified pending approval by DOE of a Contract Modification for that amount.		23. Manpower Expended to 100 Man-hours					
24. Signature of Contractor's Project Manager and Date R W Gray / RGL 10/16/78				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 9/1/78 through 9/30/78		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 May 19, 1979	

7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months F. Y. 1978												F. Y. 1979												10. Percent Complete
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A		
I	Comm Plt Des and Eval																									
I-1	Process Eng Des																									
I-2	Risk Analysis																									
I-3	Proj Eng Des																									
I-4	Cost Est																									
I-5	Econ/Env. Impact																									
I-6	Demo Plt Proc Recomm.																									
II	Demo Plt Proc Des																									
II-1	Basis of Design																									
II-2	Proc. Eng Design																									
II-3	Proc Desc. and Rationale																									
11. Remarks A Stop Work Order was received 6/23/78 for Tasks II, III, Part of IV, VI, VII, VIII and X.																										
12. Signature of Contractor's Project Manager and Date <i>RW Gray</i> 10/17/78													13. Signature of Government Technical Representative and Date													

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

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		F. Y. 1978												F. Y. 1979												
Task		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A		
III	Demo Plt Process and Mech Design Pkg																									
III-1	Prelim Eng and Layouts																									
III-2	Plant Specifications																									
III-3	Cost Est																									
III-4	Proc. Eng Rpt																									
III-5	Failure Analysis																									
III-6	Procurement Req																									
IV	Site Eval/Selection																									
IV-1	Site Data																									
IV-2	Site Agreement																									
11. Remarks																										
12. Signature of Contractor's Project Manager and Date <i>R W Gray / RJJ</i> 10-17-78													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 9/1/78 through 9/30/78		3. Contract Number ET-77-C-01-2582	
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7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months F. Y. 1978												F. Y. 1979												10. Percent Complete
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A		
Task																										
V	Env. Analysis																									
V-1	Basis for Env. Analysis																									
V-2	Proj. Desc. for Env. Anal.																									
V-3	Demo Plt Environment																									
V-4	Proj. Opn																									
V-5	Mitigation Measures																									
V-6	Adverse Env. Effects																									
V-7	Long Term Aspects																									
V-8	Irreversible Commitments																									
V-9	Alternatives																									
V-10	Env. Report																									

11. Remarks

12. Signature of Contractor's Project Manager and Date
R W Gray / RJS 10-17-78

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 9/1/78 through 9/30/78		3. Contract Number EP-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 May 19, 1979	

7. Identification Number	8. Reporting Category (e.g., contract line item or work breakdown structure element)	9. Fiscal Years and Months F. Y. 1978												F. Y. 1979												10. Percent Complete
		O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A		
VII	Const/OPN Planning																									
VII-1	Conf. Mgt Plan																									
VII-2	Staffing Plan																									
VII-3	Safety																									
VII-4	Procurement Plan																									
VII-5	Sched/Controls																									
VII-6	Labor Surveys																									
VII-7	Summary Plans																									
VIII	Economic Assessment																									
VIII-1	Commercial PLT																									
VIII-2	Demo PLT																									

11. Remarks

12. Signature of Contractor's Project Manager and Date
RW Gray / *[Signature]* 10-17-78

13. Signature of Government Technical Representative and Date

R W Gray / RJS. 10-17-78

APPENDIX TO SEPTEMBER 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

Prior to hot shakedown Run 127, several cold shakedown tests of the process system were conducted. Most of this work centered on establishing safe sequential operability of the weigh-scale feed system and inspecting new equipment installed for higher pressure operation. A successful hot shakedown of the pilot plant system was accomplished during Run 127 with metallurgical coke as a feed material. Stable operating conditions were achieved at four set points (1 through 4). Coke ash agglomerates were produced continuously during Set Point 4 operating conditions (1950°F temperature, 4 ft/s superficial velocity, 4-foot deep bed, and 35% bed ash content) using the steam-air-oxygen mode of gasification. The test run was terminated because elutriated solids eroded a hole in the second-stage cyclone. Operations at all four set points were carried out with a deactivated internal cyclone resulting in a high rate of material being conveyed from the gasifier.

PILOT PLANT OPERATIONS

Prior to Run 127, the following cold shakedown tests were conducted with the U-GAS[®] Process equipment:

- The new start-up burner, suitable for pressure operation, was tested and operated up to the heat input range required for bed ignition.
- The air heater was operated in the automatic control mode (for improved temperature control) after installing the new gas and air ratio regulators.
- Weigh screw feeders A and B were calibrated, and graphs were prepared to determine solids flow rate depending on the speed setting of the adjustable gear reducer. Both feeders can be adjusted from 500 to 3500 lb/hr, which will enable feed ratios of coal to coke to range from 12% to 100%.
- A speed change was made on the reactor screw feeder to yield adjustable feed rates from 450 to 2700 lb/hr.
- The reactor system was pressure-tested to 50 psig; small leaks were detected at the reactor screw feeder flanges and at two thermowells. All these connections were tightened to eliminate these leaks.
- Cold tests for the AAG system also included using process air at pressures up to 40 psig while operating the reactor screw feeder to obtain performance data for the newly installed 4-1/2 inch diameter venturi and 1-1/2 inch central jet pipe. Venturi annulus discharge rates were obtained at annulus velocities from 27 to 60 ft/s.
- To prevent possible venting of reactor gas in case of malfunctions within the scale system, lockhopper electrical circuitry, several days of continuous solids feeding to the reactor were completed to test malfunction valve failures. Some circuitry modifications were required.

Run 127

The test plan for Run 127 consisted of the following:

1. Conduct a hot shakedown of the U-GAS Pilot Plant using metallurgical coke as a start-up feed material.
2. Check the operability of the new process equipment consisting of the product gas scrubber, reactor screw feeder, 4-1/2 inch diameter venturi throat, 1-1/2 inch central jet nozzle located in the venturi throat, and the redesigned weigh-scale lockhopper feed system.
3. Conduct pilot plant operations under set point conditions (1 through 17 as described in Volume II of Overall Program Plan for Task IX – Technical Support, published in August 1978).

Actual operation of Run 127 consisted of the following:

1. The test run encompassed 166 hours including 116 hours of metallurgical coke feed.
2. A successful hot shakedown of the pilot plant system was accomplished, and operability of the process equipment was established.
3. Stable operating conditions at four set points (1 through 4 of Volume II of the Overall Program Plan for Task IX – Technical Support) were successfully achieved.
4. At Set Point 4 conditions (1950°F bed temperature, 4 ft/s superficial velocity, and 35% bed ash content) coke ash agglomerates were produced continuously for 20 hours using the steam-air-oxygen mode of gasification.
5. Because of the large elutriation of fines (internal cyclone deactivated), the second-stage cyclone shell was eroded at the inlet. The resulting hole caused a product gas leak, which tripped the carbon monoxide safety alarm. For safety reasons, the run was terminated.

Run 127 Operation

Run 127 was initiated on Wednesday, September 20, 1978. Stable operating conditions were accomplished at four set points. The operating conditions at each set point closely followed the overall test plan. Feedstock used was Bethlehem fine coke breeze scalped to 1/4 x 0 inch. Air-steam was the gasification medium with oxygen added at the center jet when needed to attain the required set point temperatures. The effect of bed temperature on agglomerate formation was investigated at these set points under fixed conditions of superficial velocity, bed height, and bed ash concentration. At no time did the oxygen concentration at the grid, venturi, and center jet exceed the limitations of 15%, 21%, and 50%, respectively. Every attempt was made to hold the fixed parameters within the allowable deviations of ± 0.5 ft/s for the superficial velocity, ± 0.5 feet for the bed height, and $\pm 5\%$ for the bed ash. Bed samples were withdrawn and analyzed every hour for their percent ash content. Other samples (feed, venturi discharge, second- and third-stage cyclone fines, and withdrawn bed) were analyzed at least once in every 8-hour period. A computer check of the reactor operating conditions was obtained once every hour.

Set Point 1

The operating conditions of 1800°F at 4 ft/s superficial velocity were attained on September 22 at 1800 hours. The bed ash content was allowed to rise to achieve Set Point 1 (35%). Although bed height and superficial velocity met set point conditions, the venturi velocity had to be maintained around 60 ft/s. The beginning of Set Point 1 occurred at 1200 hours on September 23 when the bed ash content reached 33%. To maintain the conditions of Set Point 1 (1800°F, 4 ft/s superficial velocity, 4-foot bed

height, and 35% bed ash content), a feed rate of about 470 lb/hr was required. A very occasional solids withdrawal from the bed through the side nozzle was required to control bed ash content. However, the rate of fines collected from the second-stage cyclone (the internal cyclone was deactivated) was about 215 lb/hr and contained approximately 20% ash. An overall ash balance for the system at the operating conditions of Set Point 1 indicated that fines accumulation in the bed was minimal because of the high ash loss in the cyclones. Accordingly, bed ash concentration remained below 30% much of the time.

Set Point 2

Conditions of 1850°F, 4 ft/s superficial velocity, 4-foot bed height, and 35% bed ash content were attained at 0100 hours on September 24, 1978. The increase in bed temperature caused the rate of fines collected from the second-stage cyclone to increase to about 240 lb/hr, still containing about 20% ash. During the next 24 hours, the conditions of Set Point 2 were steadily maintained with the bed ash concentration averaging about 30%. No evidence of ash agglomerates was detected in the venturi discharge. Again, ash balances revealed that most of the ash that entered the reactor left with the overhead fines. The venturi annulus velocity remained at 50 to 60 ft/s.

Set Point 3

The conditions of Set Point 3 (1900°F temperature, 4 ft/s superficial velocity, 4-foot bed height, 35% ash in the bed) were achieved at 0200 hours on September 25, 1978. At this set point, ash levels of 35% were readily obtained during steady operation, yet only a trace of ash agglomerates was visible in the venturi discharge. These tiny agglomerates neither constituted any significant proportion of the discharge, nor did they grow in size. Thus, it was found undesirable to implement Set Point 3A, the diversion of all process oxygen entering the grid to the venturi area. A feed rate of 607 lb/hr was required to maintain a 4-foot bed height. The second-stage cyclone fines rate remained essentially the same as at Set Point 2. The overall ash balance was maintained by withdrawing approximately 50 lb/hr through the side discharge valve.

Set Point 4

Operating conditions at Set Point 4 (1950°F, 4 ft/s superficial velocity, 4-foot bed height, and 35% bed ash content) were achieved on September 26, 1978, at 0200 hours by adding extra oxygen through the center jet via the 9303 loop. The bed temperature was maintained at approximately 1945°F for about 4 hours, during which time the production of ash agglomerates was apparent from direct observation and from the rate of venturi discharge. However, the venturi discharge rate remained low for an overall ash balance. The feed rate at this stage reached about 900 lb/hr, and the second-stage cyclone fines

rate rose to 320 lb/hr at 20% ash. An increase in bed temperature (more oxygen at the jet) of roughly 20°F resulted in a larger ash agglomerate discharge than was necessary in ash balanced operation. The feed rate had to be increased to 1200 lb/hr. Although the rate of fines remained on the high side (400 to 470 lb/hr), the ash content of these fines dropped to about 13%. Production of ash agglomerates continued under Set Point 4 conditions for about 20 hours (until 0400 hours on September 27) when it was discovered that product gas was leaking from the second-stage cyclone. The test run was immediately terminated at this point. Upon inspection, a hole was found in the cyclone.

Figure 1 describes the operating variables (with their set point limits); Figure 2 illustrates the solids rate for the entire duration of the test run. Table 1 contains test data for the complete duration of Run 127.

Problems Encountered During Run 127

- The strainer at the inlet of the slurry pump of the scrubber was clogged with fines. The screen size of the strainer was changed to a 1/4-inch opening.
- The rupture disc on the scrubber that was set for 3 psi ruptured twice. The cause has not yet been determined.
- The cylinder-operated gate valve between the C-3 and C-4 hoppers stuck twice in the closed position and caused the agglomerates to sinter and block the exit of the C-3 hopper.
- Because of a large flow of fines, the second-stage cyclone wore through at its entrance. The cyclone was examined by an ultrasonic method, and it was determined that only a small patch (10 x 4-1/2 inch) was needed.

Conclusions

The following conclusions can be drawn from the Set Points 1 through 4:

- Formation of ash agglomerates from coke feed at fixed conditions of superficial velocity, bed height, and bed ash concentration is a temperature-dependent phenomenon.
- A new 1-1/2 inch central jet nozzle was installed in the venturi throat for Run 127. Calculations were performed to determine the length of jet penetration. Merry's correlation shows a jet penetration length of 19 inches. This penetration length extends to the upper edge of the reactor grid. Accordingly, about 4 feet of bed still exists above the jet.

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Figure 1. OPERATING SET POINT VARIABLES DURING RUN 127

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Figure 2. SOLIDS RATES OF BED ASH CONTENT DURING RUN 127

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Table 1, Part 1. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 127

DATE	9/22-9/23/78	RUN NUMBER	127	9/23+					
TIME	1600	1800	2000	2200	2400	0200	0400	0600	0800
TE 9206.1									
GAS TEMP ENTERING VENTURI, °F	754	812	810	782	694	689	801	818	849
TE 9206.2									
GAS TEMP ENTERING GRID, °F	513	520	472	470	481	443	448	453	456
TE 9206.3									
BED TEMP, °F	1740	1802	1800	1800	1810	1763	1806	1799	1800
TE 9206.16									
GAS TEMP ENTERING QUENCHER, °F	1174	1372	1442	1484	1517	1497	1523	1540	1546
FR 903									
Steam FLOW TO GRID, mol/hr	13.61	14.36	18.78	18.78	18.78	22.91	20.28	21.77	21.78
FR 904									
FLOW TO GRID/HEATER/VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 905									
Htd. Air FLOW TO GRID, mol/hr	26.04	24.32	18.35	18.14	18.36	14.09	12.79	12.89	12.67
FR 906									
Htd. Air FLOW TO VENTURI, mol/hr	31.64	31.56	31.22	31.34	32.47	32.20	29.28	28.64	28.15
FR 9304									
TO VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 938									
OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 9303									
AUX. N ₂ TO REACTOR, mol/hr	5.99	6.74	6.75	6.70	6.72	6.70	6.71	6.51	6.75
FR 9405 Htd. Air FLOW TO CENTER JET (reactor), mol/hr	9.16	9.27	9.14	9.06	9.04	9.06	8.07	8.08	8.06
FR 937									
ATOMIZING N ₂ , mol/hr	1.53	1.73	1.74	1.65	1.66	1.65	1.67	1.65	1.66
FR 910 (1st stage quencher)									
RATE OF QUENCH WATER, mol/hr	0	22.86	25.15	28.58	30.86	27.43	25.15	27.43	27.43
FR 9330 (2nd stage quencher)									
RATE OF QUENCH WATER, mol/hr	0	2.49	2.49	4.97	4.97	0	0	0	0
FR 995									
AIR TO AIR HEATER, mol/hr	67.82	66.31	60.28	58.73	61.11	55.51	49.87	48.45	47.98
FR 909									
SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr	17.21	16.37	15.08	14.48	15.01	14.48	14.55	14.89	14.94
BED DENSITY, lb/ft ³	35.89	38.55	34.56	34.56	35.89	34.56	34.56	34.56	33.23
BED HEIGHT, ft	2.49	5.08	4.58	4.50	4.17	3.67	4.00	4.17	4.59
REACTOR GAS COMPOSITION (dry), %									
N ₂				73.90				74.80	
CO				5.70				4.70	
CO ₂				13.00				13.30	
H ₂				6.70				6.50	
CH ₄				0.09				0.11	
H ₂ S				0.00				0.00	
Coke FEED RATE, (wet) (avg), lb/hr	713	713	713	713	713	480	480	480	480
C-7 BED DISCHARGE RATE, lb/hr	0	0	220	134	134	0	0	0	0
C-4 ASH DISCHARGE RATE, lb/hr	19	24	26	20	15	11	16	17	21
2nd STAGE FINES REMOVAL RATE, lb/hr	282	282	282	282	282	234	234	234	234
3rd STAGE FINES REMOVAL RATE, lb/hr	16	16	16	16	16	10	10	10	10
FEED COMPOSITION, %:									
C									
ASH									
REACTOR BED COMPOSITION, %:									
C									
ASH		12.5	16.0	14.0	15.0	19.0	17.0	18.0	
DISCHARGED BED COMPOSITION, %:									
C									
ASH									
ASH COMPOSITION, %:									
C									
ASH								55.0	53.5
2nd STAGE FINES COMPOSITION, %:									
C									
ASH								19.0	
3rd STAGE FINES COMPOSITION, %:									
C									
ASH									

Table 1, Part 2. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 127

DATE 9/23-9/24/78 RUN NUMBER 127

TIME	1000	1200	1400	1600	1800	2000	2200	2400	0200
TE 9206.1									
GAS TEMP ENTERING VENTURI, °F	881	901	717	870	889	872	892	781	871
TE 9206.2									
GAS TEMP ENTERING GRID, °F	459	431	394	454	434	434	441	470	475
TE 9206.3									
BED TEMP, °F	1813	1732	1792	1809	1799	1802	1797	1847	1855
TE 9206.16									
GAS TEMP ENTERING QUENCHER, °F	1553	1540	1535	1540	1542	1546	1550	1562	1580
FR 903									
Steam FLOW TO GRID, mol/hr	21.78	19.91	19.92	19.59	20.02	20.40	19.59	17.28	17.27
FR 904									
FLOW TO GRID/HEATER/VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 905									
Htd. Air FLOW TO GRID, mol/hr	12.64	9.42	9.40	13.00	9.84	9.88	11.12	15.91	14.75
FR 906									
Htd. Air FLOW TO VENTURI, mol/hr	28.91	28.72	28.66	29.16	29.19	30.16	30.06	30.44	29.59
FR 9304									
TO VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 938									
OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 9303									
AUX. N ₂ TO REACTOR, mol/hr	6.68	6.44	5.28	5.43	5.43	5.50	5.47	0	0
FR 9405									
Htd. Air FLOW TO CENTER JET (reactor), mol/hr	7.93	6.30	6.00	6.00	6.25	6.05	6.20	6.13	6.27
FR 937									
ATOMIZING N ₂ , mol/hr	1.64	1.64	1.71	1.64	1.71	1.72	1.65	1.74	1.67
FR 918 (1st stage quencher)									
RATE OF QUENCH WATER, mol/hr	27.43	25.15	25.15	25.15	25.15	27.43	27.43	27.43	27.43
FR 9330 (2nd stage quencher)									
RATE OF QUENCH WATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 995									
AIR TO AIR HEATER, mol/hr	46.96	42.41	42.38	46.64	43.76	45.38	47.00	54.64	51.28
FR 909									
SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr	14.42	14.35	14.40	14.38	14.42	14.42	14.48	15.01	14.59
BED DENSITY, lb/ft ³	31.23	35.89	35.89	35.89	35.89	37.22	37.22	33.23	33.23
BED HEIGHT, ft	4.51	4.09	4.33	4.49	4.49	4.41	4.64	5.37	5.63
REACTOR GAS COMPOSITION (dry), %									
N ₂	74.90		75.60		72.80				70.10
CO	4.50		4.20		5.30				7.40
CO ₂	13.00		13.10		13.30				13.80
H ₂	6.90		8.40		7.90				7.90
CH ₄	0.11		0.12		0.11				0.12
H ₂ S	0.00		0.00		0.00				0.00
Coke FEED RATE, (wet) (avg), lb/hr	480	480	469	469	469	469	469	540	540
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	0	0	0	64
C-4 ASH DISCHARGE RATE, lb/hr	24	26	22	21	23	21	29	23	16
2nd STAGE FINES REMOVAL RATE, lb/hr	234	234	215	215	215	215	215	238	238
3rd STAGE FINES REMOVAL RATE, lb/hr	10	10	14	14	14	9	9	9	9
FEED COMPOSITION, %:									
ASH						18.0			
REACTOR BED COMPOSITION, %:									
ASH	24.0	33.0	25.5	19.0	20.0	24.5	25.0	26.0	34.5
DISCHARGED BED COMPOSITION, %:									
ASH									
ASH COMPOSITION, %:									
ASH			68.0			53.0			46.0
2nd STAGE FINES COMPOSITION, %:									
ASH			23.0			15.5			
3rd STAGE FINES COMPOSITION, %:									
ASH						33.5			

Table 1, Part 3. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 127

DATE 9/24/78 RUN NUMBER 127

TIME	0400	0600	0800	1000	1200	1400	1600	1800	2000
TE 9206.1									
GAS TEMP ENTERING VENTURI, °F	621	760	813	669	783	667	772	762	759
TE 9206.2									
GAS TEMP ENTERING GRID, °F	394	473	506	515	508	461	483	470	455
TE 9206.3									
BED TEMP, °F	1844	1858	1859	1834	1852	1859	1855	1859	1863
TE 9206.16									
GAS TEMP ENTERING QUENCHER, °F	1578	1585	1588	1585	1579	1598	1598	1605	1597
FR 903									
Steam FLOW TO GRID, mol/hr	18.03	18.39	16.90	15.07	19.15	24.41	23.49	23.29	21.51
FR 904									
FLOW TO GRID/HEATER/VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 905									
Htd. Air FLOW TO GRID, mol/hr	11.71	14.98	15.48	20.17	15.92	17.25	16.36	15.49	15.86
FR 906									
Htd. Air FLOW TO VENTURI, mol/hr	28.64	28.74	27.09	28.76	27.19	28.11	28.44	28.89	29.00
FR 9304									
TO VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 938									
OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 9303									
AUX. N ₂ TO REACTOR, mol/hr	0	0	0	0	0	0	0	0	0
FR 9405 Htd. Air FLOW TO CENTER JET (reactor), mol/hr	6.06	6.21	6.01	5.91	6.10	6.00	6.05	6.41	6.12
FR 937									
ATOMIZING N ₂ , mol/hr	1.68	1.68	1.68	1.65	1.65	1.65	1.64	1.61	1.63
FR 918 (1st stage quencher)									
RATE OF QUENCH WATER, mol/hr	27.43	27.43	26.29	28.58	27.43	32.00	29.72	32.00	30.86
FR 9330 (2nd stage quencher)									
RATE OF QUENCH WATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 995									
AIR TO AIR HEATER, mol/hr	47.89	49.91	49.91	56.67	49.65	50.74	50.34	50.84	50.08
FR 909									
SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr	14.62	15.15	14.55	12.62	11.55	12.53	12.53	11.81	12.40
BED DENSITY, lb/ft ³	34.56	34.56	34.56	34.56	34.56	34.56	33.23	35.84	34.56
BED HEIGHT, ft	4.33	4.00	4.58	2.62	4.37	4.79	4.33	4.17	4.50
REACTOR GAS COMPOSITION (dry), %									
N ₂		70.50		70.40		67.60		69.10	
CO		7.70		7.10		7.70		7.00	
CO ₂		13.10		13.70		14.30		14.10	
H ₂		8.00		8.00		9.60		9.00	
CH ₄		0.12		0.11		0.14		0.15	
H ₂ S		0.00		0.00		0.00		0.00	
Coke FEED RATE, (wet) (avg), lb/hr	540	540	540	540	563	563	563	550	550
C-7 BED DISCHARGE RATE, lb/hr	64	211	211	28	28	28	28	72	72
C-4 ASH DISCHARGE RATE, lb/hr	13	19	16	15	18	8	18	17	18
2nd STAGE FINES REMOVAL RATE, lb/hr	238	238	238	238	205	205	205	240	240
3rd STAGE FINES REMOVAL RATE, lb/hr	9	9	9	9	9	9	13	13	13
FEED COMPOSITION, %:									
ASH			16.0						15.0
REACTOR BED COMPOSITION, %:									
ASH	28.0	30.3	36.0	35.0	24.5	27.0	24.0	32.5	
DISCHARGED BED COMPOSITION, %:									
ASH									
ASH COMPOSITION, %:									
ASH			70.0			94.0			62.5
2nd STAGE FINES COMPOSITION, %:									
ASH			20.5						26.0
3rd STAGE FINES COMPOSITION, %:									
ASH			29.0						28.5

Table 1, Part 4. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 127DATE 9/24-9/25/78 RUN NUMBER 127

TIME	9/25									
	2200	2400	0200	0400	0600	1000	1200	1400	1600	
TE 9206.1										
GAS TEMP ENTERING VENTURI, °F	752	703	744	796	783	785	786	682	716	
TE 9206.2										
GAS TEMP ENTERING GRID, °F	445	442	480	471	470	516	537	490	490	
TE 9206.3										
BED TEMP, °F	1859	1864	1905	1901	1897	1893	1900	1906	1910	
TE 9206.16										
GAS TEMP ENTERING QUENCHER, °F	1609	1605	1630	1637	1633	1591	1616	1625	1623	
FR 903										
Steam FLOW TO GRID, mol/hr	21.78	19.91	18.77	20.28	19.52	14.27	13.07	17.28	16.23	
FR 904										
FLOW TO GRID/HEATER/VENTURI, mol/hr	0	0	0	0	0	0	0	0	0	
FR 905										
Hcd. Air FLOW TO GRID, mol/hr	16.59	16.89	22.90	22.77	20.53	24.69	24.85	21.49	24.65	
FR 906										
Hcd. Air FLOW TO VENTURI, mol/hr	29.09	28.88	29.00	27.95	28.45	27.48	27.18	27.66	28.75	
FR 9304										
TO VENTURI, mol/hr	0	0	0	0	0	0	0	0	0	
FR 938										
OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0	
FR 9303										
AUX. TO REACTOR, mol/hr	0	0	0	0	0	0	0	0	0	
FR 9405										
Hrd. Air FLOW TO CENTER JET (reactor), mol/hr	6.21	6.24	6.28	6.37	6.32	6.36	6.34	6.54	6.80	
FR 937										
ATOMIZING N ₂ , mol/hr	1.64	1.63	1.59	1.66	1.67	1.64	1.65	1.50	1.59	
FR 918 (1st stage quencher)										
RATE OF QUENCH WATER, mol/hr	32.00	29.72	34.29	34.29	32.00	29.72	32.00	32.00	20.57	
FR 9330 (2nd stage quencher)										
RATE OF QUENCH WATER, mol/hr	0	0	0	0	0	0	0	0	0	
FR 995										
AIR TO AIR HEATER, mol/hr	51.33	53.14	59.01	57.64	56.21	59.65	60.45	55.53	60.39	
FR 909										
SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0	
NITROGEN PURGE TO REACTOR, mol/hr	12.07	11.57	11.63	12.12	12.30	12.34	11.65	11.47	12.36	
BED DENSITY, lb/ft ³	34.56	34.56	33.23	33.23	33.23	34.56	34.56	34.56	34.56	
BED HEIGHT, ft	4.67	4.50	4.59	4.51	4.42	4.17	4.37	3.75	4.17	
REACTOR GAS COMPOSITION (dry), %										
N ₂	69.30		68.90		67.70		66.40			
CO	7.10		8.00		8.80		11.80			
CO ₂	14.50		13.70		14.10		13.70			
H ₂	8.30		8.60		8.60		7.70			
CH ₄	0.13		0.12		0.12		0.11			
H ₂ S	0.00		0.00		0.00		0.00			
Coke FEED RATE, (wet) (avg), lb/hr	550	550	607	607	607	607	607	607	607	
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	34	34	47	47	
C-4 ASH DISCHARGE RATE, lb/hr	20	16	12	25	25	106	63	19	20	
2nd STAGE FINES REMOVAL RATE, lb/hr	240	240	278	278	278	229	229	229	229	
3rd STAGE FINES REMOVAL RATE, lb/hr	13	13	12	12	12	12	12	9	9	
FEED COMPOSITION, %:										
ASH										
REACTOR BED COMPOSITION, %:										
ASH	30.0	24.0	32.0	29.0	37.0	36.0	36.0	44.5	33.0	
DISCHARGED BED COMPOSITION, %:										
ASH										
ASH COMPOSITION, %:										
ASH			55.5							
2nd STAGE FINES COMPOSITION, %:										
ASH				18.0						
3rd STAGE FINES COMPOSITION, %:										
ASH				26.0						

Table 1, Part 5. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 127

DATE 9/25-9/26/78 RUN NUMBER 127

TIME	1800	2000	2200	2400	0200	0400	0600	0800	1000
TE 9206.1 GAS TEMP ENTERING VENTURI, °F	693	743	774	768	793	912	888	866	819
TE 9206.2 GAS TEMP ENTERING GRID, °F	472	473	528	536	548	550	549	542	560
TE 9206.3 BED TEMP, °F	1905	1900	1907	1892	1934	1945	1964	1940	1941
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F	1625	1625	1622	1624	1627	1665	1676	1688	1697
FR 903 Steam FLOW TO GRID, mol/hr	14.92	14.27	14.27	13.90	13.90	13.98	13.98	13.98	13.94
FR 904 FLOW TO GRID/HEATER/VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 905 Htd. Air FLOW TO GRID, mol/hr	20.91	21.95	21.22	21.84	22.43	24.96	24.68	26.28	26.53
FR 906 Htd. Air FLOW TO VENTURI, mol/hr	29.51	29.47	27.73	27.65	27.16	27.75	27.66	28.29	27.46
FR 9304 TO VENTURI, mol/hr	0	0	0	0	0	0	0	0	0
FR 938 OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0	0
FR 9303 AUX. O ₂ TO REACTOR, mol/hr	0	0	0	0	3.40	6.44	7.43	7.20	7.12
FR 9405 Htd. Air FLOW TO CENTER JET (reactor), mol/hr	6.72	6.53	6.09	6.39	13.44	13.81	13.98	14.09	13.94
FR 937 ATOMIZING N ₂ , mol/hr	1.67	1.67	1.68	1.65	1.58	1.59	1.59	1.53	1.60
FR 918 (1st stage quencher) RATE OF QUENCH WATER, mol/hr	29.72	29.72	32.00	32.00	38.86	43.43	46.29	49.15	50.29
FR 9330 (2nd stage quencher) RATE OF QUENCH WATER, mol/hr	0	0	0	0	0	4.97	4.97	5.97	5.47
FR 995 AIR TO AIR HEATER, mol/hr	57.64	56.01	55.91	55.91	62.19	67.49	67.49	71.09	70.27
FR 909 SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr	11.01	12.68	13.20	13.76	13.46	13.58	13.58	13.58	13.62
BED DENSITY, lb/ft ³	33.23	33.23	34.56	34.56	33.23	33.23	31.90	34.56	33.23
BED HEIGHT, ft	4.42	4.25	4.33	4.37	4.25	4.25	4.29	3.54	4.12
REACTOR GAS COMPOSITION (dry), %									
N ₂	63.50						53.30		
CO	12.70						27.30		
CO ₂	12.60						9.50		
H ₂	10.50						9.20		
CH ₄	0.10						0.12		
H ₂ S	0.00						0.00		
Coke FEED RATE, (wet) (avg), lb/hr	607	607	607	607	900	900	900	1200	1200
C-7 BED DISCHARGE RATE, lb/hr	70	75	67	416	0	0	0	0	0
C-4 ASH DISCHARGE RATE, lb/hr	26	25	26	32	13	33	77	201	113
2nd STAGE FINES REMOVAL RATE, lb/hr	229	229	229	229	321	321	321	431	431
3rd STAGE FINES REMOVAL RATE, lb/hr	9	9	5	5	5	5	2	2	2
FEED COMPOSITION, %:									
ASH	18.5			15.0				17.5	
REACTOR BED COMPOSITION, %:									
ASH	40.5	39.8	44.0	45.5	33.0	46.0	42.5	35.0	28.5
DISCHARGED BED COMPOSITION, %:									
ASH	46.0			30.0					
ASH COMPOSITION, %:									
ASH	76.0		69.5					84.5	
2nd STAGE FINES COMPOSITION, %:									
ASH	20.5			18.0				13.0	
3rd STAGE FINES COMPOSITION, %:									
ASH	23.0			23.5				43.0	

Table 1, Part 6. ASH AGGLOMERATING GASIFIER — DATA SUMMARY
FOR RUN 127

DATE 9/26-9/27/78 RUN NUMBER 127

TIME	1200	1415	1600	1800	2000	2200	2400	9/27+ 0200
TE 9206.1 GAS TEMP ENTERING VENTURI, °F	831	852	783	787	878	828	643	727
TE 9206.2 GAS TEMP ENTERING GRID, °F	558	568	573	569	561	559	498	527
TE 9206.3 BED TEMP, °F	1961	1938	1949	1949	1944	1959	1957	1958
TE 9206.16 GAS TEMP ENTERING QUENCHER, °F	1699	1691	1697	1698	1699	1702	1705	1709
FR 903 Steam FLOW TO GRID, mol/hr	13.94	13.98	13.98	14.02	13.98	13.98	13.98	13.90
FR 904 — FLOW TO GRID/HEATER/VENTURI, mol/hr	0	0	0	0	0	0	0	0
FR 905 Hrd Air FLOW TO GRID, mol/hr	24.09	22.56	25.04	25.02	23.83	24.40	24.59	24.72
FR 906 Hrd Air FLOW TO VENTURI, mol/hr	22.07	26.02	26.55	26.53	27.20	26.46	26.90	27.03
FR 9304 — TO VENTURI, mol/hr	0	0	0	0	0	0	0	0
FR 938 OXYGEN TO AIR HEATER, mol/hr	0	0	0	0	0	0	0	0
FR 9303 AUX. O ₂ TO REACTOR, mol/hr	7.43	6.97	7.43	7.37	7.03	7.24	7.27	7.30
FR 9405 Hrd Air FLOW TO CENTER JET (reactor), mol/hr	14.15	14.06	14.61	14.59	14.57	14.48	14.50	14.58
FR 937 ATOMIZING N ₂ , mol/hr	1.57	1.49	1.49	1.55	1.55	1.50	1.58	1.51
FR 918 (1st stage quencher) RATE OF QUENCH WATER, mol/hr	50.29	49.15	51.44	49.15	50.29	50.29	51.44	52.58
FR 9330 (2nd stage quencher) RATE OF QUENCH WATER, mol/hr	5.47	5.97	7.46	7.46	7.46	6.96	7.46	7.46
FR 995 AIR TO AIR HEATER, mol/hr	67.46	64.18	67.57	67.10	66.82	66.46	67.31	67.43
FR 909 SWEEP GAS (N ₂), mol/hr	0	0	0	0	0	0	0	0
NITROGEN PURGE TO REACTOR, mol/hr	13.79	13.67	13.23	13.71	13.67	14.12	14.88	13.53
BED DENSITY, lb/ft ³	34.56	35.89	34.56	34.56	35.89	34.56	34.56	33.23
BED HEIGHT, ft	3.75	3.61	4.00	4.17	3.93	4.08	4.08	4.12
REACTOR GAS COMPOSITION (dry), %								
N ₂		57.40		50.80		52.80		51.60
CO		22.20		25.60		23.80		24.90
CO ₂		10.80		9.90		10.20		9.80
H ₂		8.00		12.00		12.50		13.00
CH ₄		0.13		0.13		0.13		0.12
H ₂ S		0.00		0.00		0.00		0.00
Coke FEED RATE, (wet) (avg), lb/hr	1200	1200	1170	1170	1170	1170	1170	1170
C-7 BED DISCHARGE RATE, lb/hr	0	0	0	0	0	0	0	0
C-4 ASH DISCHARGE RATE, lb/hr	99	170	104	78	128	153	125	134
2nd STAGE PINES REMOVAL RATE, lb/hr	431	431	461	461	461	461	461	461
3rd STAGE PINES REMOVAL RATE, lb/hr	2	9	9	9	9	9	9	9
FEED COMPOSITION, %:								
ASH			15.0				16.5	
REACTOR BED COMPOSITION, %:								
ASH	35.5	37.0	28.0	39.0	35.0	39.0	27.0	28.5
DISCHARGED BED COMPOSITION, %:								
ASH								
ASH COMPOSITION, %:								
ASH	95.5		92.5		92.0			
2nd STAGE PINES COMPOSITION, %:								
ASH			13.0		12.5		12.5	
3rd STAGE PINES COMPOSITION, %:								
ASH			38.0		37.0		37.0	

PETROGRAPHIC STUDIES

The difference in behavior between coke and Kentucky coal cannot be attributed to the elemental composition of the ash, because the ash fusion temperature of the coke ash is as high as that of the coal. We believe that one of the most significant differences is the form of the iron and thus its availability, in the gasification bed, for reaction with the clays to form an iron-rich low-melting phase. Petrographic examination of ash particles of C-4 and C-7 discharges from runs on Kentucky coal has shown the presence of substantial amounts of ferrous sulfide. The petrography also indicates that iron in sulfide form must be oxidized before it can react with clay minerals. We have chemically analyzed several samples of C-7 discharge from Run 124 for iron sulfide with the assumption that all the hydrogen sulfide evolved by treatment with hydrochloric acid comes from ferrous sulfide. In the samples analyzed, 43% to 85% of the iron was present as ferrous sulfide. Results will be reported in more detail when the remainder of the C-7 samples from this run have been analyzed.

We have calculated equilibrium constants for oxidation of ferrous sulfide to magnetite by steam. (Magnetite is the most stable iron oxide at the temperature and gas composition in the gasifier bed.) The reaction is -

For the calculation, Rosenqvist's data on equilibrium of hydrogen sulfide and metallic iron with hydrogen and ferrous sulfide* were combined with Barin and Knacke's data for oxidation of iron to magnetite.** The equilibrium constants obtained are plotted in Figure 3. The value of $P_{\text{H}_2\text{O}}/P_{\text{H}_2\text{S}}^{0.75} P_{\text{H}_2}^{0.25}$ is 55 to 56 at 1800° to 1900°F. The value of this ratio in the product gas from Run 124 during a period of operation with steam and air at a bed temperature of 1900°F was 5.9; for the last period of operation with steam and oxygen at a bed temperature of 1800° to 1850°F, the ratio was 39. Thus, oxidation of ferrous sulfide may be limited to regions of the bed close to air or oxygen inlets.

* Rosenqvist, T., "A Thermodynamic Study of the Iron, Cobalt, and Nickel Sulphides," J. Iron Steel Inst. (London) 176, 37-57 (1954) January.

** Barin, I. and Knacke, O., "Thermochemical Properties of Inorganic Substances," Springer-Verlag, Berlin, 1973.

Apparently ferrous sulfide itself can act as an agglutinating agent. By petrographic observation of polished sections of C-7 discharge samples from Run 124, we find a few ash particles consisting of distinctly separate silicate regions joined by ferrous sulfide, as shown in Figure 4. However, most of the ash particles consist of a somewhat rounded low iron-content aluminosilicate core surrounded by a mixture of ferrous sulfide and iron-rich crystalline silicates. The composition and melting behavior of the different regions are being investigated.

Figure 3. EQUILIBRIUM CONSTANT FOR OXIDATION OF FERROUS SULFIDE BY STEAM

P78090875

Figure 4. FeS JOINING MELTED SHALE PARTICLES
IN C-7 DISCHARGE (Run 124)

BENCH-SCALE ASH AGGLOMERATION TESTS

Summary

We performed five additional agglomeration tests in the 2.0-inch ID reactor with coke samples obtained from the pilot plant (Run 124). Indications of agglomeration were obtained with the samples with ash contents of approximately 41% at 2000°F, but sintering was also evident in these cases.

Objective

The objective of the work conducted during this period was to determine the effect of temperature, ash level, and residence time on the agglomeration of Bethlehem coke breeze.

Operation and Results

The proximate and ultimate analyses of the eight coke samples from Run 124 were received and are shown in Table 2. Coke with an ash content in the range of 16% to 42% was available from these samples. Five of these samples were used in the tests conducted in September. The conditions of these tests, along with those of all bench-scale tests conducted to date, are shown in Table 3. The residue from Run AGX-16 indicated that agglomeration had taken place. A partial screen analysis of this run is shown in Table 4. An approximate 7% growth of material above 30 mesh (U.S.S.) was found. The distribution of material in the residue was such, however, that an approximate 6% decrease in particle size (50% cumulative size) of the residue occurred. This was primarily caused by the loss of some +6 mesh material from the feed, possibly the result of attrition or breakage, which compensated, to some extent, for the net growth of material in the -20+30 mesh range. Run AGX-17 was conducted with a coke of similarly high ash content as that used in Run AGX-16, but for a longer test period. At the termination of the test considerable sinter formation was found at the top of the fluidized bed and adhering to the internal wall of the reactor. As a result, we did not perform a screen analysis of the remaining material. A very small degree of sintering was observed in Run AGX-16, but the amount was insignificant, and data analysis could still be performed. A portion of the sinter has been submitted for petrographic analysis. None of the other tests conducted this month resulted in sintering or agglomeration.

Table 2. ANALYSES OF COKE SAMPLES FROM RUN 124

Run No.	<u>AGX-18</u>	<u>AGX-15</u>			<u>AGX-17</u>		<u>AGX-14</u>	<u>AGX-16</u>
Date	5/28/78	5/28/78	5/31/78	5/31/78	6/1/78	6/1/78	6/1/78	6/1/78
Time	1700	2000	2200	2300	0400	1700	1900	2100
Proximate Analysis, wt % (as rec'd)								
Moisture	0.2	0.2	0.3	0.3	0.3	0.2	0.3	0.3
Volatile Matter	1.1	1.5	1.2	1.3	1.4	1.4	0.9	0.7
Ash	31.0	24.4	16.6	18.2	41.7	17.4	31.6	41.1
Fixed Carbon	<u>67.7</u>	<u>73.9</u>	<u>81.9</u>	<u>80.2</u>	<u>56.6</u>	<u>81.0</u>	<u>67.2</u>	<u>57.9</u>
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ultimate Analysis, wt % (dry basis)								
Ash	31.02	24.45	16.63	18.26	41.79	17.47	31.72	41.22
Carbon (total)	67.70	74.20	81.80	80.00	57.40	80.90	67.70	58.60
Hydrogen	0.24	0.28	0.24	0.19	0.22	0.26	0.21	0.18
Sulfur	0.56	0.55	0.56	0.59	0.27	0.60	0.50	0.52
Nitrogen	0.46	0.53	0.55	0.58	0.41	0.57	0.46	0.42
Oxygen (by diff.)	<u>0.02</u>	<u>0</u>	<u>0.22</u>	<u>0.38</u>	<u>0</u>	<u>0.20</u>	<u>0</u>	<u>0</u>
Total	100.00	100.01	100.00	100.00	100.00	100.00	100.59	100.94

Table 3. SUMMARY OF BENCH-SCALE, HIGH TEMPERATURE REACTOR TESTS

AGX Run No.	Sample Batch No.	Nominal Feed Size, U.S.S.	Approximate Ash Content, %	Feed, g	Residue, g	Fines, g	Losses, g	Test Period, min	Temp- erature, °F	L/D	Fluidizing Gases	Superficial Gas Velocity, ft/s	Sinter	Agglom- eration	Comments
1	Run No. 122, Bed Discharge	-3-1/2+325	65.0	269	244.4	28.4	16.2	60	1710	3	N ₂	0.91-1.03	--	No	
2	Run No. 122, Bed Discharge	-3-1/2+325	65.0	267.4	205.8	15.5	--	60	1812	3	N ₂ , Steam	0.33-0.94	--	No	
3	Run No. 122, Bed Discharge	-3-1/2+325	65.0	268.4	193.8	40.5	--	7	1830	3	N ₂ , Steam, O ₂	0.36-0.97	Yes	--	
4	Run No. 122, Bed Discharge	-3-1/2+400	65.0	269	132.5	28.7	7.8	30	2000	3	N ₂	~ 4	Yes	Yes	
5	Run No. 123, C-7, No. 25	-1/4+400	40.0	265.6	131.1	15.0	19.5	30	1900	3	N ₂	~ 4	Yes	--	
6	Run No. 123, C-7, No. 25	-1/4+400	40.0	266.1	32.3	1.4	132.4	30	1900	3	N ₂	~ 2	No	--	Possible weighing error in feed.
7	Run No. 123, C-7, No. 25	-1/4+400	40.0	265.7	104.8	1.5	59.4	30	1900	3	N ₂	~ 2	No	--	
8	Run No. 123, C-7, No. 25	-1/4+400	40.0	265.7	111.5	--	54.2	30	1900	3	N ₂	~ 2	No	--	Weight of residue includes fines.
9	Run No. 123, C-7, No. 25	-1/4+400	40.0	265.0	209.3	1.4	52.3	30	1950	3	N ₂	~ 4	No	--	
10A	Run No. 124, C-7, No. 95A	-1/4+400	69.0	417.4	271.9	33.3	12.2	60	1700	3	N ₂	~ 1	No	--	Conducted to drive off volatile matter.
10B	Run No. 124, C-7, No. 95A	-1/4+400	69.0	264.7	222.9	32.8	9.0	30	1900	3	N ₂	~ 4	Yes	--	Residue and fines of Run No. 10A used for feed.
11	Run No. 126, Raw Coke	-3-1/2+400	13.2	265.2	217.2	30.4	17.6	30	1900	3	N ₂	~ 4	No	No	
12	Run No. 126, Raw Coke	-3-1/2+400	13.2	266.2	220.2	28.4	17.6	30	2000	3	N ₂	~ 4	No	No	
13	Run No. 126, Raw Coke	-3-1/2+400	13.2	265.9	212.2	1.7	17.6	30	2100	3	N ₂	~ 4	No	No	
14	Run No. 124, Coke Bed Sample	-3-1/2+400	31.2	262.5	278.0	53.0	1.5	30	1900	3	N ₂	~ 4	No	No	
15	Run No. 124, Coke Bed Sample	-3-1/2+400	24.5	266.2	218.0	47.2	0.9	30	2000	3	N ₂	~ 4	No	No	
16	Run No. 124, Coke Bed Sample	-3-1/2+400	41.2	249.6	229.7	17.6	2.3	30	2000	3	N ₂	~ 4	Yes	Yes	
17	Run No. 124, Coke Bed Sample	-3-1/2+400	41.8	270.5	212.4	26.1	2.0	120	2000	3	N ₂	~ 4	Yes	No	Extensive sintering occurred, preventing determination of agglomeration.
18	Run No. 124, Coke Bed Sample	-3-1/2+400	31.0	268.0	215.7	29.6	2.7	30	2000	3	N ₂	~ 4	No	No	

Table 4. FEED AND RESIDUE ANALYSES FOR BENCH-SCALE
REACTOR TEST AGX-16

	Absolute Weight, g	
	Feed	Residue
+3-1/2	0	0
+4	1.0	0.9
+6	13.5	11.9
+8	20.2	22.0
+10	9.2	9.0
+12	10.5	11.3
+14	11.0	10.6
+16	11.0	12.4
+18	9.0	9.0
+20	10.2	13.1
+25	13.7	16.1
+30	11.2	13.1
SUM above 30 U.S.S.	120.5	129.4 $\Delta = 8.9$ $\% \Delta = 7.4$

Conclusions

It appears that both the ash level of particles and temperature affect agglomeration of coke breeze at 4 ft/s superficial velocity in a nitrogen atmosphere. It also appears that sintering can occur at these conditions.

Future Test Plans

At least one of the remaining samples will be tested at 2100°F, all other conditions remaining the same. Additional samples from Run 127 will be obtained in a quantity sufficient to permit several tests with a particular material. The details of these tests will depend on the character of the material obtained.

COLD-FLOW MODEL STUDIES

Summary

A series of 5 tests (Runs 78 through 82) were conducted on the half-section cold-flow model with a venturi configuration of 4-1/2 x 2 inches with a center half-tube of 1-1/2 inch ID. In the first two runs (Runs 78 and 79), the tube terminated at the top of the venturi throat where, as in the remaining three tests (Runs 80, 81, and 82), it extended 14 inches above the throat. As reported in the August monthly report, neither the inclusion of the tube at the center nor gas flow through the tube produces any significant effect on the rate of spheres discharge.

Objective

The objectives of Runs 78 through 82 were as follows:

- To determine the effect of concentration of spheres in the bed on the rate of spheres discharge
- To determine the effect of tube length and tube flow on the rate of total discharge and to compare these results with earlier data.

Equipment Setup

There was no major change in equipment setup from that used in earlier runs (Runs 70 through 77). In Runs 78 and 79, the 1-1/2 inch ID center tube terminated at the top of the throat (Figure 5), whereas in Runs 80 through 82, it extended 14 inches above the throat.

Operation And ResultsRun 78

This test run was conducted by allowing the 1-1/2 inch ID half-section tube (terminating at the top of the venturi throat) to fill with spheres and with no gas flow in the tube while varying flows in the annular venturi region. No major change in the rate of sphere discharge as compared with the rate achieved without the tube (Run 57) and with the tube (Runs 76 and 77) was observed.

Run 79

All the test conditions were kept constant in this run, and discharge was collected every 3 minutes, thus enabling us to observe the effect of the mass fraction of spheres in the bed on the rate of spheres discharge as the run proceeded. The data for this run are shown in Table 5, and spheres discharge rate versus initial spheres concentration in the

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Figure 5. COLD-FLOW MODEL UNIT IN OPERATION
(1-1/2 ID Center Tube Terminating at Top
of 4-1/4 inch Throat)

bed is plotted in Figure 6. The relationship is curvilinear, in contrast to previously observed results where a linear relationship was found. The data here extend to much higher concentrations than have been used in previous tests (~16% maximum); this may account for the difference between this and earlier observations.

Run 80

In this test run, tube velocity was varied, and corresponding discharge of the bed material was noted at a constant venturi velocity. No significant change in discharge rate was observed.

Run 81

This test was conducted to determine the effect of venturi velocity on the rate of total bed discharge and to compare the results with those of Run 78. No significant difference was observed in the rate of total discharge using two different lengths of center tube.

Table 5. SUMMARY OF COLD MODEL RUN CONDITIONS (Runs 70 through 82)

Run No. *	Venturi** Configuration	Tube ID, in.	Venturi Velocity (U_v), ft/s	Tube Velocity (U_t), ft/s	Weight Fraction Spheres in Bed, x_b
70	4.5 x 2/0	1.0	31.2-67.1	243.0	0.080-0.097
71	4.5 x 2/0	1.0	34.7-67.4	99.0	0.085-0.099
72	4.5 x 2/0	1.0	43.4	60.7-225.0	0.110-0.130
73	4.5 x 2/0	1.0	26.9-69.2	74.4	0.117-0.154
74	4.5 x 2/14	1.0	31.7-69.5	75.7	0.116-0.149
75	4.5 x 2/14	1.0	43.7	62.5-227.0	0.112-0.131
76	4.5 x 2/0	1.5	0-75.3	60.5	0.119-0.158
77	4.5 x 2/0	1.5	47.2	56.0-105.0	0.126-0.143
78	4.5 x 2/0	1.5	0-75.45	0.00	0.099-0.154
79	4.5 x 2/0	1.5	47.00	55.16	0.022-0.289
80	4.5 x 2/14	1.5	47.5-47.8	61.2-121.6	0.138-0.151
81	4.5 x 2/14	1.5	17.04-76.72	61.3-61.8	0.119-0.153
82	4.5 x 2/14	1.5	18.77-75.58	0.00	0.119-0.157

* The following parameters were common to all tests:

Spheres Diameter = 0.152 in.
Average Particle Diameter = 0.0254 in.
Sphere Density = 157 lb/ft³
Bed Particle Density = 72.0 lb/ft³
Bed Bulk Density = 36.0 lb/ft³
Superficial Velocity = 2.0-2.3 ft/s

** Last number (after /) indicates height of center tube above top of venturi throat.

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Figure 6. RATE OF SPHERES DISCHARGE VERSUS SPHERES CONCENTRATION
 IN BED AT START OF OBSERVATION (Run 79)

9/78

Run 82

This run was the same as Run 78 except that the center tube was extended 14 inches above the throat. No significant change in the rate of total discharge was observed.

Conclusion

The test results of Runs 78 through 82, Run 57, and Runs 70 through 77 confirmed our previous conclusion that the location of a center tube of 1 or 1-1/2 inch ID in relation to the 4-1/2 inch venturi configuration has no effect on the discharge rate, nor does the gas flow rate in the center tube. The discharge rate, however, is dependent on venturi velocity and spheres concentration in the bed.

Other Work Accomplished During the Month

1. Major modifications to the test setup were begun after the performance of Run 82. The purpose of these modifications was to enable the utilization of a 6 x 2 inch venturi configuration. The piping below the venturi section was enlarged to 12 inches, and a new venturi section was fabricated and is being installed. (See Figure 7.)
2. Two films of the fluidization pattern in the bed at varying venturi velocities with 1-1/2 inch ID center tube were made. In one case, the tube terminated at the top of the venturi throat; in the other case, it extended 14 inches above the throat. The photographic record shows similar fluidization with or without a center tube.
3. A computer program to reduce raw cold model data and to establish a data base for a computerized model building and statistical techniques has been prepared. An example output using the data of Run 79 appears in Table 6.

Plans For Future Work

Major equipment revisions to permit the incorporation of the 6 x 2 inch venturi configuration are under way. The first run on this unit is expected to begin the first week of October 1978.

Figure 7. AAG COLD MODEL: VIEW OF THE
6 x 2 INCH VENTURI SECTION

Table 6. SAMPLE COMPUTER OUTPUT OF COLD-MODEL DATA REDUCTION PROGRAM

RUN 79 SUMMARY DATA

PARTICLE DENSITY OF BED MATERIAL (LB/FT²) = 72.0000
 PARTICLE DENSITY OF AGGLOMERATES (LB/FT²) = 157.2000
 AGGLOMERATES PARTICLE SIZE (INCH) = 0.1520
 BED MATERIAL PARTICLE SIZE (INCH) = 0.0254
 TUBE DIAMETER (INCH) = 1.5000
 VENTURI LENGTH (INCH) = 2.0000
 VENTURI DIAMETER (INCH) = 4.5000

VIS AIR	DENSITY AIR	V E L O C I T Y			TOTAL BED MASS	R A T E O F DISCHARGE		W E I G H T F R A C T I O N A G G L O M E R A T E S				
		SUPRFCL	VENTURI	TUBE		AGGLMS	TOT BED	IN DISCHG	IN BED INITIAL	IN BED FINAL	IN BED AVERAGE	
CP	LB/FT3	FT/SEC	FT/SEC	FT/SEC	LB	(1)	(1)	(1)	(1)	(1)	(1)	
.0200	0.0679	2.03	47.00	55.16	562.68	4.5167	4.5300	0.9971	0.2891	0.2716	0.2804	
.0200	0.0679	2.03	47.00	55.16	549.09	4.2367	4.2400	0.9992	0.2716	0.2544	0.2630	
.0200	0.0679	2.03	47.00	55.16	489.63	2.2867	2.3233	0.9842	0.1843	0.1728	0.1785	
.0200	0.0679	2.03	47.00	55.16	482.66	2.0300	2.0367	0.9967	0.1728	0.1622	0.1675	
.0200	0.0679	2.03	47.00	55.16	475.00	2.7640	2.8020	0.9864	0.1579	0.1327	0.1453	
.0200	0.0679	2.03	47.00	55.16	460.99	1.5640	1.5650	0.9937	0.1327	0.1178	0.1252	
.0200	0.0679	2.03	47.00	55.16	453.16	1.2680	1.2760	0.9937	0.1178	0.1052	0.1115	
.0200	0.0679	2.03	47.00	55.16	446.78	1.0860	1.0880	0.9982	0.1052	0.0942	0.0997	
.0200	0.0679	2.03	47.00	55.16	441.34	0.9280	0.9280	1.0000	0.0942	0.0846	0.0894	
.0200	0.0679	2.03	47.00	55.16	436.70	0.7420	0.7440	0.9973	0.0846	0.0768	0.0807	
.0200	0.0679	2.03	47.00	55.16	432.98	0.6340	0.6340	1.0000	0.0768	0.0700	0.0734	
.0200	0.0679	2.03	47.00	55.16	429.81	0.5640	0.5640	1.0000	0.0700	0.0638	0.0669	
.0200	0.0679	2.03	47.00	55.16	426.99	0.4880	0.4880	1.0000	0.0638	0.0584	0.0611	
.0200	0.0679	2.03	47.00	55.16	424.55	0.4360	0.4360	1.0000	0.0584	0.0536	0.0560	
.0200	0.0679	2.03	47.00	55.16	422.37	0.3500	0.3520	0.9943	0.0536	0.0496	0.0516	
.0200	0.0679	2.03	47.00	55.16	420.61	0.3180	0.3200	0.9938	0.0496	0.0460	0.0478	
.0200	0.0679	2.03	47.00	55.16	419.02	0.2940	0.2960	0.9932	0.0454	0.0420	0.0437	
.0200	0.0679	2.03	47.00	55.16	417.54	0.2407	0.2407	1.0000	0.0420	0.0337	0.0379	
.0200	0.0679	2.03	47.00	55.16	413.93	0.1740	0.1740	1.0000	0.0337	0.0275	0.0306	
.0200	0.0679	2.03	47.00	55.16	411.32	0.1467	0.1467	1.0000	0.0275	0.0223	0.0249	