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Second Quarterly Report
DOE-8, GL-10290
September 1, 1978 to November 30, 1978

to

Fuels From Biomass Branch
U. S. Department of Energy
Washington, D.C. 20545

There is no objection from the patent point of view to the publication or dissemination of the document(s) noted in this letter.

BROOKHAVEN PATENT GROUP
2/12 1979 By *[Signature]*

Contract No. ET-78-C-02-4862

AN ASSESSMENT OF THE TECHNICAL AND ECONOMIC
FEASIBILITY OF CONVERTING WOOD RESIDUES TO LIQUID
AND GASEOUS FUEL PRODUCTS USING STATE-OF-THE-ART
AND ADVANCED COAL CONVERSION TECHNOLOGY

by

Gorham International Inc.
Gorham, Maine 04038

MASTER

January, 1979

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I Introduction

Gorham International Inc. has undertaken a 14 month study contract to determine which state-of-the-art and advanced coal gasifiers are technically and economically suitable for gasification of wood residues to produce low, medium, and high Btu gas and synthesis gas and to specify the various modifications necessary to convert these gasifiers for use with wood residues.

The primary goals and objectives of the study are to (1) critically review patents and published literature, (2) conduct 40 to 50 in-depth on-site interviews with gasifier developers, users, and manufacturers, (3) obtain information on specific gasification technologies from over 200 firms and organizations, (4) collect prior art and operating data on wood gasification, (5) estimate operating cost, capital equipment costs, gas costs, and gasification rates for coal gasifiers operating on wood residues, (6) identify advantages and disadvantages of using wood residues, (7) evaluate the sensitivity of capital costs and product costs to plant size, (8) determine wood type, size, shape and moisture content for various gasifiers, (9) identify barriers to implementation of wood gasification plants.

Gorham will deliver the following information in the final report: (1) a narrative discussion and assessment of the thrust of gasification technology, (2) specifications, schematics, process flow diagrams, narrative descriptions, and wood gasification rates for coal gasifiers modified for use with wood residues, (3) specifications, schematics, and process flow diagrams covering the specific modifications required to convert coal gasifiers for use with wood residues, (4) tabular and graphical presentation of comparative capital equipment costs, operating costs, and costs (\$/mm Btu's) for low, medium, and high Btu gas and synthesis gas produced from coal and from wood residues, (5) specifications for wood residues and wood residue preparation and handling equipment,

(6) comparative costs of the materials of construction of coal and wood gasifiers, (7) wood gasifier implementation plan, (8) barriers to implementation plan and alternative strategies to overcome these barriers.

II Contract Task Schedule

The overall contract task schedule is shown in Figure 1 with the progress through November 30, 1978 as indicated.

III Project Status

The October 1978 First Quarter Report presented the basic data gathering activities and the classification matrices being developed to enable an equitable comparison of alternative gasification systems. During the second quarter, efforts were initiated under Task 3, "Identification and Evaluation of Effects of the Use of Wood Residues."

Second quarter activities continued in the Task 1 and 2 data gathering and analysis efforts plus initial Task 3 efforts as planned.

IV Second Quarter Activity and Results

The data gathering efforts continued on schedule for Task 1 and 2. The patent and literature searches, as well as individual corporate contacts, continued as described in the first quarterly report.

The classification matrices presented in the October 1978 report are in varying stages of completion for each of the coal gasification systems included in the study program. The exact status depends upon the phase of discussions with the gasifier developer or the degree of completion of internal system analysis.

Figures 2 through 5 present a summary of the systems under analysis at the current time. The following briefly describes the headings under each basic gasifier type:

Gasifier/Developer: The common name used to identify the specific system and the title of the developer if different than the system name.

Status: The current level of system development.

Operating Units: The capacity of the standard commercial unit or the largest operating if the process is at less than commercial status.

Product Form: The typical gas form(s) derivable from the system's gasifier design. In some cases, the overall process includes additional processing external to the gasifier which results in a high Btu synthetic natural gas.

Coal Feedstock Size: Approximate sieve analysis limits acceptable for current coal gasification system. Wood feedstock size requirements are expected to vary depending on whether the coal size requirement is based on feed system or gasification unit reaction limitations.

Other Feedstocks Tested: Indicates actual testing or use of systems with feedstocks other than coal where at least some degree of operating results are available.

FIGURE 1

CONTRACT TASK SCHEDULE

DOE CONTRACT No. ET-78-C-02-4862

No.*	TASK TITLE	PERFORMANCE PERIOD												
		1978						1979						
		JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
1.	ASSESSMENT OF STATE-OF-THE ART COAL GASIFIERS	<hr/> <hr/>												
2.	ASSESSMENT OF ADVANCED AND DEVELOPING TECHNOLOGY	<hr/> <hr/>												
3.	IDENTIFICATION AND EVALUATION OF EFFECTS OF THE USE OF WOOD RESIDUES	<hr/> <hr/>												
4.	DEVELOPMENT OF PLAN FOR COMMERCIALIZATION OF COAL GASIFIERS OPERATING ON WOOD RESIDUES	<hr/> <hr/>												
5.	FINAL REPORT PREPARATION	<hr/> <hr/>												

* INCLUDES ALL SUBTASKS IDENTIFIED IN CONTRACT DOCUMENTS

===== PROJECT STATUS THROUGH 2ND QUARTER (NOV. 30, 1978)

FIGURE 2

ENTRAINED FLOW GASIFIERS

<u>GASIFIER/DEVELOPER</u>	<u>STATUS*</u>	<u>OPERATING UNITS</u>	<u>PRODUCT FORM</u>	<u>COAL FEEDSTOCK SIZE</u>	<u>OTHER FEEDSTOCKS TESTED</u>	<u>POTENTIAL FOR USE WITH WOOD RESIDUES</u>
1 FLASH HYDROLYSIS/ ROCKWELL INTERNATIONAL	L.S.	.6 TPH COAL	HIGH BTU GAS	90%-200 MESH	-	MEDIUM/LOW
2 BI-GAS/BITUMINOUS COAL RESEARCH INC (SLAGGING)	P.P.	150 TPD	MED. BTU GAS	70%-200 MESH	LIGNITE	MEDIUM/HIGH
3 COMBUSTION ENGINEERING	P.P.	120 TPD	LOW BTU GAS	70%-200 MESH	-	MEDIUM/HIGH
4 RUHRGAS VORTEX/ RUHRGAS A.G.	C.	?	LOW BTU GAS	L/L6"	-	?
5 FOSTER WHEELER (SLAGGING)	P.P.	480 TPD	LOW BTU GAS	70%-200 MESH	-	MEDIUM/HIGH
6 KOPPERS-TOTZEK (SLAGGING)	C.	860 TPD	MED. BTU GAS	70-90%-200 MESH	LIGNITE	MEDIUM/HIGH
7 TEXACO (SLAGGING)	P.P.	15 TPD	MED. BTU GAS	70%-200 MESH	LIGNITE	MEDIUM/HIGH
8 BELL AEROSPACE TEXTRON (SLAGGING)	P.P.	.5 TPH	LOW BTU GAS	70%-200 MESH	PEAT	MEDIUM/HIGH
9 BABCOCK & WILCOX (SLAGGING)	S.C.	400 TPD	MED. BTU GAS	70-90%-200 MESH	-	MEDIUM/HIGH

* COMMERCIAL = C.

DESIGN = D.

PROCESS DEV. UNIT = PDU

PILOT PLANT = P.P.

LABORATORY SCALE = L.S.

SEMI = S.

FIGURE 3

FIXED BED GASIFIERS

<u>GASIFIER/DEVELOPER- MARKETER</u>	<u>STATUS*</u>	<u>CAPACITY</u>	<u>PRODUCT FORM</u>	<u>COAL FEEDSTOCK SIZE</u>	<u>OTHER FEEDSTOCKS TESTED</u>	<u>POTENTIAL FOR USE WITH WOOD RESIDUES</u>
1 LURGI - DRY - SLAGGING	C. P.P.	800 TPD -	MED. BTU GAS MED. BTU GAS	1/8" x 1 1/2" 1/8" x 1 1/2"	LIGNITE -	HIGH ?
2 GEGAS/GENERAL ELECTRIC	P.P.	24 TPD	LOW BTU GAS	1/2" x 1/2"	-	HIGH
3 RILEY MORGAN/ RILEY STOKER	C.	60 TPD	LOW OR MED. BTU GAS	1/2" x 1/2"	-	HIGH
4 I.F.E./SWINDEL DRESSLER	C.	60 TPD	LOW OR MED. BTU GAS	1/2" x 1/2"	PEAT/LIGNITE	HIGH
5 WELLMAN-GALUSHA/ McDOWELL-WELLMAN	C.	60 TPD	LOW OR MED. BTU GAS	1/2" x 1/2"	PEAT/LIGNITE/WOOD	HIGH
6 WILPUTTE/WILPUTTE CORP	C.	30 TPD	LOW OR MED. BTU GAS	1/2" x 1/2"	-	HIGH
7 I.G.I./BABCOCK CONTRACTORS	C.	100 TPD	LOW OR MED. BTU GAS	1/2" x 1/2"	-	HIGH
8 MERC STIRRED BED DOE MORGANTOWN	P.L.	20 TPD	LOW OR MED. BTU GAS	1/2" x 1/2"	LIGNITE	HIGH

* COMMERCIAL = C.

SEMI-COMMERCIAL = S.C.

DESIGN = D.

PROCESS DEV. UNIT = PDU

PILOT PLANT = P.P.

LABORATORY SCALE = L.S.

FIGURE 4

FLUIDIZED BED GASIFIERS

<u>GASIFIER/DEVELOPER-MARKETER</u>	<u>STATUS*</u>	<u>CAPACITY</u>	<u>PRODUCT FORM</u>	<u>COAL FEEDSTOCK SIZE</u>	<u>OTHER FEEDSTOCKS TESTED</u>	<u>POTENTIAL FOR USE WITH WOOD RESIDUES</u>
1 UNION CARBIDE/BATTELLE	PDU	25 TPD	MED. BTU GAS	-8 +100 MESH	-	MEDIUM
2 WESTINGHOUSE	PDU	12 TPD	LOW BTU GAS	1/8" - 1/4"	-	MEDIUM
3 EXXON GASIFICATION/EXXON	P.P.	5 TPD	MEDIUM/HIGH BTU GAS	-	-	LOW
4 HRI/HYDROCARBON RESEARCH	P.P.	30 TPD	MED. BTU GAS	-20 +60 MESH	-	HIGH
5 WINKLER DAVY POWERGAS	C.	1100 TPD	LOW AND MED. BTU GAS	0 - 3/8"	LIGNITE	LOW
6 HYGAS/IGT	P.P.	70 TPD	HIGH BTU GAS	-10 MESH	LIGNITE	LOW
7 U-GAS/IGT	P.P.	6 TPD	LOW AND MED. BTU GAS	0 - 1/4"	-	MEDIUM
8 BCR-LOW-BTU/ BITUMINOUS COAL RESEARCH	PDU	1.2 TPD	LOW BTU GAS	60% +200 40% -200 +325	-	LOW TO MEDIUM
9 CO ₂ ACCEPTOR/CONCO	P.P.	30 TPD	MED. BTU GAS	+100 -8 MESH	LIGNITE	MEDIUM
10 COGAS/COGAS DEVELOPMENT CO.	P.P.	80 TPD	MED. BTU GAS	0 - 1/8"	-	MEDIUM
11 SYNTHANE/PITTSBURGH ENERGY RESEARCH CENTER	PDU	72 TPD	LOW OR MED. BTU GAS	-20 MESH	-	MEDIUM

* COMMERCIAL = C.
 DESIGN = D.
 PROCESS DEV. UNIT = PDU

PILOT PLANT = P.P.
 LABORATORY SCALE = L.S.
 SEMI = S.

FIGURE 5

MOLTEN BED GASIFIERS

<u>GASIFIER/DEVELOPER-MARKETER</u>	<u>STATUS*</u>	<u>CAPACITY</u>	<u>PRODUCT FORM</u>	<u>COAL FEEDSTOCK SIZE</u>	<u>OTHER FEEDSTOCKS TESTED</u>	<u>POTENTIAL FOR USE WITH WOOD RESIDUES</u>
1 AI-MOLTEN SALT/ ATOMIC INTERNATIONAL, DIV. OF ROCKWELL INTERNATIONAL	PDU	24 TPD	LOW AND MED. BTU GAS	1/4"	WOOD AND MISC. WASTES	HIGH
2 OTTO-RUMMEL SLAG BATH/ DR. C. OTTO & CO. (ENTRAINED FLOW SLAG BATH GASIFIER)	C.	264 TPD	LOW AND MED. BTU GAS	-16 MESH	-	MEDIUM TO HIGH
3 ATGAS - PATGAS/ APPLIED TECHNOLOGY CORP. (MOLTON IRON BATH)	P.P.	6 TPD	MED. BTU GAS	CRUSHED	-	LOW

* COMMERCIAL = C.

DESIGN = D.

PROCESS DEV. UNIT = PDU

PILOT PLANT = P.P.

LABORATORY SCALE = L.S.

SEMI = S.

Potential For Use With Wood Residues: A very preliminary qualitative rating of each system's technical potential to utilize wood as a feedstock. This rating is based only on discussion with system designers and existing operating results. This rating does not reflect any of the detailed system analysis being conducted by Gorham International. Also, no consideration of economic feasibility has been made in determining the listed system's ratings.

As described in the first quarter report, the data gathering and analysis for each specific coal gasification system is designed to address the following critical parameters which relate to the contract's technical and economic objectives.

Critical Technical Parameters -

- Feedstock Considerations
- Materials Requirements
- Operational Parameters
- Reactivity Impact
- Product Mix
- Clean-Up Alternatives

Critical Economic Factors -

- Basic Assumptions
- Capital Costs
- Operations Costs
- Accounting System/Ownership Impacts
- Scaling Factors
- Unit Energy Costs

Evaluation of the above inputs for each coal gasification system under study will result in the final rating for Task 1 and 2 activities as well as provide selection criteria for those systems with the best feasibility of successful operation on feedstocks.

In addition to the individual contacts and site visits, Gorham personnel attended the following meetings to gather information and discuss project activity with professionals engaged in related activities:

Fifth Biomass Thermochemical Conversion
Coordination Meeting: Fuels from Biomass
Program

U.S. DOE National Environmental Control Symposium

V Summary and Third Quarter Plans

Overall, the contract effort is on schedule at the end of the second quarter with no major problem areas encountered to date. Third Quarter activities are underway with primary emphasis on completing the Task 1 activities with Task 2 scheduled for completion early in the fourth quarter and Task 3 continuing through the fourth quarter. Task 4, Development of Commercialization Plans will be commenced late in the third quarter with initial attention to state-of-the-art systems reviewed in Task 1 and development of basic commercialization alternatives.

As previously presented, the first major reportable results are expected to be generated during the third quarter.