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UNITED STATES INTERNATIONAL DEVELOPMENT COOPERATION AGENCY
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON D.C. 20523

July 30, 1982

MEMORANDUM

TO: See Distribution

FROM: AFR/DR/SDP, Mark Ward

SUBJECT: Ghana Pyrolytic Conversion Project (693-0135)

Attached for your review and records is the Project Completion Report for a project carried on in Ghana 1978-1980 to test a facility for the pyrolytic conversion of sawmill waste products into fuel. The project and its results to date leave doubts as to the technical, economic and institutional viability of the installation which was designed and tested. Considerable caution is indicated for those contemplating similar experiences.

Attachment

USAID/Ghana
AFR/CWA, D. Walsh
S&T/DIU
S&T/EY, P. Koshel
AFR/DP/PPEA/E, H. Miles
AFR/DR, G. Rublee
AGR/DR/CCHAP, J. Charette

Project Completion Report
Pyrolysis Demonstration Project(698-0135)

1. Summary of services performed and goods furnished by major Project component by contributor:
   (a) AID- under a contract with the Georgia Institute of Technology (GIT), technical assistance, basic converter component parts and the final project report were prepared in accordance with the Project Agreement.
   (b) Government of Ghana-through the Bank of Ghana, the Building and Road Research Institute (BRRI) and the Technical Consultancy Center (TCC) of the University of Science and Technology provided local cost financing for technical assistance, design, planning and construction testing and operation of four pyrolytic Converters in accordance with the approved Project Agreement.
2. Status of completion of Project elements involving construction, import of materials and supplies and technical assistance. All project elements have been completed.
3. Summary of project accomplishments- The activity was funded from Project Development Support. There is therefore no Project Paper. Project accomplishments are listed below in terms of the anticipated end of project results listed in USAID/Ghana Project Agreement No. 624-7844 dated July 28, 1977:
   (a) Demonstration of the economic feasibility of pyrolytic conversion in Ghana.
   Economic feasibility not established. See the GIT Final Report ("Pyrolytic Conversion of Waste Materials: Demonstration in Ghana", Georgia Institute of Technology, October 1981, Prepared under Contract AID/AFR-C-1518), Government of Ghana response (Annex 1) and AID/W comments (Annex 2).

(b) The development of a pyrolytic system design that will be available for use in Ghana and other countries.

System designed and constructed, modified and tested with resulting production of usable char and oils from agricultural and sawmill waste materials.

(c) Information on the feasibility and problems of the building of pyrolytic equipment by local manufacturers and its operation by local labor.

Information contained in the GIT Final Report.

(d) Valuable technical data on the operation of a pyrolysis system.

Covered extensively in the GIT Final Report and Government of Ghana comments.

(e) Guidelines on the requirements for successful pyrolytic conversion technology and operation.

Provided in part by GIT, see Annex 2.

(f) Data available on the extended use of pyrolysis.

Contained in GIT Final Report and available from BRRI.

4. Further inputs into project to be provided by others and expected completion, of such input.

No further AID is necessary. BRRI is providing labor, supervisory assistance and basic waste materials to operate the converters.

5. Recommendations on extent and period of further monitoring and reporting and on further project evaluation required, with special attention to any conditions or covenants included in Project Agreement.

(a) No further monitoring required.

(b) Project Agreement did not have covenants or conditions which require further monitoring.

(c) Although the project has been completed, certain questions as to the technical and economic viability of the technology tested remain obscure, as noted in Annex 2. Examination of continuing experience with pyrolytic conversion technology in this or other projects may yield useful lessons.

Annexes

1. Comments on GIT Final Report prepared by the Government of Ghana Building and Road Research Institute, University P.O. Box 40, Kumasi, Ghana, August 1981.

2. "Pyrolytic Conversion of Waste Materials: Demonstration in Ghana" Africa Bureau observations on the project.

cc:
USAID/Ghana- 10 cc
Ghana Desk, AFR/CWA
Development Information Center, S&T/DIU
SDP project file (698-0135)
Pat Koshel, S&T/EY
H. Miles, AFR/DP/PPEA/E
G. Rublee, AFR/DR
Ghana Projects Officer, AFR/DR/CCWAP

Prepared by: USAID/GHANA and AFR/DR/SDP

Issued: July 23, 1982

ANNEX I

MINISTRY OF FINANCE AND ECONOMIC PLANNING
P.O. BOX M. 40
ACCRA

In case of reply the number and date of this letter should be quoted.

My Ref. No. DL 24/PR 26

Your Ref. No. .....

REPUBLIC OF GHANA

16th September, 81

Dear Sir,

PYROLYTIC CONVERSION OF WASTE MATERIALS DEMONSTRATION IN GHANA

I forward herewith two copies of Ghana Government's comments on "Pyrolytic Conversion of waste materials Demonstration in Ghana" requested by you.

I wish to apologise for the delay in the submission of our comments.

Yours faithfully,

AG. PRINCIPAL SECRETARY (IERD)
(S. P. AGYARKO)

RECEIVED
21 SEP 1981
USAID/GHANA

THE DIRECTOR,
USAID MISSION,
ACCRA.

(Attn: Mr. Gerald Zarr)

Actr. ODA
Info. D.R
AD
PRM
CHRON
RF

DEMONSTRATION PROJECT

PYROLYTIC CONVERSION OF WASTE MATERIALS

COMMENTS ON REPORT BY

MALVAR F.J., JACOBSON, F.J., KOVAC, R.J. and YEBOAH, K.A. -

"PYROLYTIC CONVERSION OF WASTE MATERIALS:

DEMONSTRATION IN GHANA"

Prepared for the Ministry of Finance and Economic Planning, Ghana

BY

BUILDING AND ROAD RESEARCH INSTITUTE (CSIR)
UNIVERSITY P. O. BOX 40
KUMASI - GHANA

AUGUST, 1981

1. INTRODUCTION

A Demonstration Plant for the Pyrolysis of Woodwaste has been installed at the Fumesua (near Kumasi) site of the Building and Road Research Institute (BRRI) since 1980, through a co-operation programme between the Ministry of Finance and Economic Planning, Ghana and the USAID Mission, Ghana. The Bank of Ghana provided funds for local expenditure whilst USAID provided technical services and related foreign exchange component of the Project. The technical services were provided through the Georgia Institute of Technology (GIT) U.S.A. which supplied the preliminary designs of the plant. The Georgia Institute of Technology also collaborated with the Technology Consultancy Centre (TCC) of the University of Science and Technology, Kumasi and the Building and Road Research Institute (BRRI) in the fabrication, assembly, testing and modification of the plant items from 1978 through 1980. The Georgia Institute of Technology and the B.R.R.I. continued with the training of personnel and the preparation of operating and maintenance manuals for the plant. The complete plant was installed at Fumesua in 1980 and the final performance testing of the plant was done by two engineers from the Georgia Institute of Technology and B.R.R.I. staff, which included two engineers. The Building and Road Research Institute has been responsible for running the plant since then, with the objective of improving the process prior to making the technology available for commercial use in Ghana.

Following the final performance testing of the plant, the GIT team and the B.R.R.I. engineer have produced a report entitled "Pyrolytic Conversion of Waste Materials: Demonstration in Ghana" (F.J. Malvar, J.E. Jacobson, R.J. Kovac and K.A. Yeboah) - October, 1980. The report has been studied by the Building and Road Research Institute and this note summarises the Institute's comments.

2. General Comments

The report provides valuable information on the following aspects of the Pyrolysis Project:

(i) Theory of Pyrolysis of Organic Wastes
(ii) Availability of Organic Wastes that may be pyrolysed in Ghana
(iii) Design considerations, Process Description and Fabrication Data of the Plant.
(iv) Operating and Maintenance Manual for the Pyrolysis Plant.
(v) Preliminary Economic Analysis
(vi) Proposals for the Pyrolytic Converter Social Soundness Analysis.

3. Reactor Feed

As previously mentioned a section of the report indicates that sawdust, which was the first major waste material planned for the converters, presented serious handling problems in the converters. The reason given was that the sawdust used as feed in Ghana was much finer and denser than that used to test the prototype converter in the U.S. The trial pyrolysis in the reactors, upon which the report was based, was therefore performed using woodshavings as feed.

Sawdust is however more readily available in Ghana than woodshavings, which are obtainable in large quantities in only timber factories where furniture or other special wood products are made. Besides, woodshavings are currently sold in large quantities to poultry farmers for use as bedding for the birds. The Building and Road Research Institute has run the pyrolytic converters since late 1980 using only sawdust and the major problem encountered was the very poor drying in the gas fired driers. With the four converters in continuous operation for 16 hours (two shifts) a day, the two driers can produce only 15 sacks (average, 40lb per sack) of dry sawdust whilst the converters require a total of 160 sacks of sawdust each day. The kerosene drier and atmospheric drying produce only an additional 15 sacks of dry feed a day. The poor drying is due to the fine nature of the sawdust, which allows only a little voidage in a bed of sawdust for the hot gases to diffuse extensively. The drying process in the drier is therefore very slow and only small quantities of feed may be handled in each drier at a time.

There is, therefore great justification for serious studies to be performed with the aim of improving the drying of sawdust in the pyrolytic system. This issue was worthy of mention in the 'Recommendations' section of the report. For instance, the drier may be modified by fitting perforated steel pipes to

distribute hot gases more evenly in the bed of sawdust. The use of a large enclosed solar drier or a simple fluidised bed drier may also be investigated.

4. Economic Analysis

4.1 Labour Costs

In the cost calculations for operating and maintenance Table 5.2b it is not indicated whether a 5-day or 7-day working week was considered. However, the assumption that the plant runs 310 days a year indicates that either the plant is assumed to run for 6 days each week the whole year (i.e. except Sundays) or it runs 7 days each week for about 10½ months, with about 1½ months devoted for routine maintenance and repairs.

The length of the working week needs to be specified since in Ghana a 5-day working week is generally used, whilst a worker is entitled to overtime claims which are often over five times his daily wage if he works on Saturday or Sunday.

It is also worth mentioning that since the publication of the report, the minimum daily wage in Ghana has been increased from ¢5.00 to ¢12.00 (over 100% increase) whilst the price of oil and char did not rise as much. The profitability of process has been distorted as a result, which calls for a review of the operating and maintenance costs.

4.2 Raw Materials

It appears from the cost calculation for raw materials (Table 5.2c) that it was assumed a truck would be hired each working day to bring just enough feed for the two shifts in the day (i.e. ⅔ truck load per day). This would be highly uneconomical. However, if it is assumed that the return trip from the sawmill to the plant site is 12 miles, a tipper truck may make 10 return trips a day. The plant would require a total of about 210 truck loads of feed for 310 working days in a year. This indicates the truck may be hired for a total of only 21 days for the entire year or for a maximum of only 2 days each month. This arrangement would bring down the cost of transportation of the feed to only 10% of the value originally considered.

The daily cost for truck hire has also risen sharply since the report and it is currently about ¢1,500.00 including fuel and other related costs.

3.3 Calculation of Net Present Value

The calculation of the Net Present Value of the Pyrolysis Plant as presented in Tables 5.3, 5.4 and 5.5 show errors which give the impression that both operating costs and value of outputs are progressively doubled from year to year. The corrected figures are presented in Tables 1, 2, and 3 in the Appendix.

4. Conclusion

The report "Pyrolytic Donversion of Waste Materials: Demonstration in Ghana" (Malvar, Jacobson, Kovac and Yeboah) essentially provides considerable background information, and design data on the Pyrolysis Demonstration Plant. The plant was evaluated, from both technical and economic points of view, using results for 4-5 hour performance test runs on woodshavings, and sometimes, design yields. The preliminary evaluation indicated a promising future of pyrolysis of woodshavings as a feasible alternative energy source for Ghana. However, a few modifications to the plant may be necessary if sawdust is to be dried and pyrolysed satisfactorily. In addition, a review of the economics of the process based on observed capabilities of the plant and current costs need to be done. The Building and Road Research Institute is to handle these assignments.

APPENDIX

TABLE 1: CORRECTED VERSION OF TABLE 5.3 CALCULATION OF NET PRESENT VALUE (IN CEDIS)

	Start-up	Year 1	Year 2	Year 3	Year 4
Cost Component					
Investment					
Land	10,000				
Materials	169,416				
Labour	52,219				
Operating and Maintenance Materials					
1. Consumables					
a. Fuel		*	*	*	*
b. Electricity	[illegible]	15,147	30,294	45,441	60,588
2. Replacements					
a. Parts & Supplies		4,800	9,600	14,400	19,200
		57,000	114,000	171,000	228,000
Labour					
Incidentals					
4. Transport to Markets		0	0	0	0
Raw Materials					
Feedstock		121,933	243,866	365,799	487,732
TOTAL COSTS	231,971	198,880	397,760	596,640	795,520
Benefit Component					
Value of Outputs					
1. Oil		126,554	253,108	379,662	506,216
2. Char		279,000	558,000	837,000	1,116,000
3. Gas		*	*	*	*
Scrap Value of Plant					0
TOTAL BENEFITS	n/a	405,554	811,108	1,216,662	1,622,216
NET ANNUAL NOMINAL BENEFITS	-231,971	206,674	413,348	620,022	826,696
NET PRESENT (RENT) VALUE	594,725				

TABLE 2
CORRECTED VERSION OF TABLE 5.4

CALCULATION OF NET PRESENT VALUE FOR PRIVATE ENTERPRISE

	Start-up	Year 1	Year 2	Year 3	Year 4
Cost Component					
Investment					
Land	o				
Materials	59,186				
Labor	15,479				
Operating and Maint. Materials					
1. Consumables					
a. Fuel	*	*	*	*	*
b. Electricity		15,147	30,294	45,441	60,588
2. Replacements					
a. Parts and Supplies		1,800	9,600	14,400	19,200
Labor		57,000	114,000	171,000	228,000
Incidentals					
1. Transp. to Markets		0	0	0	0
Raw Materials					
Feedstock		0	0	0	0
TOTAL COSTS	74,665	76,947	153,894	230,841	307,788
Benefit Component					
Value of Outputs					
1. Oil		126,554	253,108	379,662	506,216
2. Char		279,000	558,000	837,000	1,116,000
3. Gas	*	*	*	*	*
Scrap Value of Plant					0
TOTAL BENEFITS	n/a	405,554	811,108	1,216,662	1,622,216
NET ANNUAL NOMINAL BENEFITS	-74,665	328,607	657,124	985,821	1,314,428

NET PRESENT (REAL) VALUE $1,239,763

TABLE 3:

CORRECTED VERSION OF TABLE 5..

CALCULATION OF NET PRESENT VALUE FOR GOVERNMENT ENTERPRISE

	Start-up	Year 1	Year 2	Year 3	Year 4
Cost Component					
Investment					
Land	10,000				
Materials	59,186				
Labor	15,479				
Operating and Maintenance Materials					
1. Consumables					
a. Fuel		*	*	*	*
b. Electricity		15,147	30,294	45,441	60,588
2. Replacements					
a. Parts and Supplies		4,800	9,600	14,400	19,200
Labor		57,000	114,000	171,000	228,000
Incidentals					
1. Transport to Mkts.		0	0	0	0
Raw Materials					
Feedstock		121,933	243,866	365,799	487,732
TOTAL COSTS	84,665	198,880	397,760	596,640	795,520
Benefit Component					
Value of Outputs					
1. Oil		200,800	401,600	602,400	803,200
2. Char		279,000	558,000	837,000	1,116,000
3. Gas		*	*	*	*
Scrap Value of Plant					0
TOTAL BENEFITS	n/a	479,800	959,600	1,439,400	1,919,200
NET ANNUAL NOMINAL BENEFITS	-84,665	280,920	571,840	842,760	1,123,680
NET PRESENT (REAL) VALUE	$1,039,015				

JUL 27 1982

MEMORANDUM

TO: Distribution

FROM: Mr. John D. Blumgart

SUBJECT: Pyrolytic Conversion of Waste Materials: Demonstration in Ghana

The attached report, published in October 1981, describes an AID-financed pilot project carried out in Ghana to design, build, test and evaluate a small-scale pyrolytic converter system to produce char, pyrolytic oil and gas from sawmill waste. The technical and economic lessons of this pilot project are, however, not conclusive.

Many problems plagued the construction and testing of the system from its conception. The design of the system had to be modified and adapted substantially during the project's life. This, added to the scarcity or absence of parts, equipment, and lack of adequate transportation in the country made the pyrolysis project a great deal more difficult and expensive than was initially estimated.

After two years of development work by the Technology Consultancy Center (TCC) of the University of Science and Technology in Kumasi, Ghana with assistance from the Georgia Institute of Technology the pyrolytic converter plant performance was raised to near the expected level and was turned over to the Building and Roads Research Institute (BRRI) in August 1980. However, TCC reported in April 1982 that during the previous 9 months the plant had been used only from time to time as the market for the fuel oil is limited.

Experience has shown the technology of the GIT pyrolysis plant to be too labor intensive. Ghanaian labor is expensive and becoming steadily more so. The plant also requires fine tuning by manual controls which demand a high degree of skill on the part of the plant supervisor. Technical problems persist, particularly with sawdust drying and feeding mechanisms.

The project was designed primarily as a technology demonstration. Its economic aspects are, however, of limited value mainly because the project was not designed to meet a defined market need. The economic attractiveness of pyrolysis, or any other biomass conversion technology, must be seen in terms of a market. Once a market share for a particular form of energy can be characterized then there are usually several conversion technologies which can meet that market need. The choice is

determined by the availability of resources. Other constraints such as social, political and manpower availability also are major influences on the decision. One lesson to be learned from this pilot project is that markets and resources should be thoroughly examined before selecting the appropriate conversion technology.

Further testing in a developing country of the marketing, management and technology aspects of pyrolytic conversion, preferably with the involvement of incentive-driven private enterprise in a developing country could yield more generally usable conclusions. We would be interested in any information or views which addressees may care to provide in this regard.

Please write:

1. Energy Advisor, AFR/TR/SDP
   Bureau for Africa
   Agency for International Development
   Washington, D.C. 20523

2. Technical Consultancy Centre
   University of Science and Technology
   University Post Office
   Kumasi
   Ghana, West Africa

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NE/TECH, B. Heyman
AID Development Information Unit
SDP Project file (698-0135)
CDA Energy Committee members