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EVALUATION, ENGINEERING AND DEVELOPMENT OF ADVANCED CYCLONE PROCESSES

QUARTERLY TECHNICAL PROGRESS REPORT

Quarterly Report #13
For The Period October 1, 1993 to December 31, 1993

Work Performed Under DOE Contract # DE–AC22–90PC90177

For

U.S. Department of Energy
Office of Fossil Energy
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By

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DISCLAIMER

EXECUTIVE SUMMARY

The project goal is to develop an advanced coal beneficiation technology that can achieve high recovery of the parent coal's calorific value, while maximizing pyritic sulfur removal. Coal cleaning is to be accomplished by physical means incorporating an advanced form of cycloning or gravimetric process. Evaluation of different media types and their attendant systems for recovery, concentration, and regeneration is to be completed.

Phase I, Media Evaluation, now completed, involved a paper study and a number of laboratory tests to eliminate all but the best media options. Phase II, Media Testing, involved detailed testing of the more promising media and separators in a closed–loop pilot facility.

In the final phase, Phase III, a 1,000 lb/hr open loop, bench scale plant will be designed and constructed using the optimum medium, separator, and medium recovery process based on information acquired during Phases I and II of the project.

Major activities during this reporting period are reviewed below.

The Bench Scale Circuit (BSC) design has been completed by ICF KE. The structural, electrical and other drawings are approved for construction and ready for contractor utilization.

CTC contacted the Regional Office of the Virginia Department of Environmental Quality and ascertained that it was necessary to apply for a permit to operate the BSC. A Permit to construct and operate the BSC was applied for and granted shortly thereafter.

Swenson has completed refurbishing the evaporator needed to regenerate dilute calcium nitrate medium. CTC awaits a suitable stage in construction of the BSC to schedule delivery and placement of the unit.

Quotes were obtained from Power and Heat Systems for a boiler, and from Swenson for an organic medium evaporator/condenser system. Both were specified for a 200 TPH coal feed process and will be used in future economic comparisons.

The exhaust fans, electric heaters, pinch valves, ball mill, density and level transmitters, pH sensors, pumps, and mixers, were received and safely stored on site.

Bids were sought from several firms to fabricate and deliver the structural steel, sumps, platework, steps, and railings of the BSC. Triple S Corporation, Beckley WV, was ultimately selected. Approval by DOE was sought and obtained, and a purchase order was issued to Triple S.

Of the four construction firms invited to bid on erection of the BSC, one declined. Another qualified firm was found and the bidding period was extended to allow time to formulate their bid.

Lauren Engineers and Constructors was consequently selected to erect the BSC and approval by DOE was sought. CTC started negotiations with Lauren in anticipation of the start of construction. Award of the contract awaits formal approval by DOE.

Bids were sought from several firms to wire the BSC building. Clark Electrical Contractors was selected and DOE approval was sought. Award of the contract awaits formal approval by DOE.

There is a delay in obtaining approval of the construction and electrical contractors, or more precisely to start construction of the BSC. The problem is linked to two issues. First, the new building is viewed as a capital improvement of CTC property, which could require special approval if funded by project money. Secondly, NEPA implications must be reconsidered because plans to build the BSC process building conflict with the FONSI statement, which indicates that the circuitry would be housed within an existing structure.

Award of a patent for the calcium nitrate/decanter centrifuge coal cleaning process is not likely. A pre–examination search of the patent literature disclosed that AMAX was awarded patents for fine coal cleaning in 1985 and true heavy liquid media coal cleaning in 1988. The patent, "Method For Cleaning Fine Coal," #4,529,506 describes the use of a decanter centrifuge, and that organic or aqueous solutions of metal salts could be used as parting fluids. There were other examples as well.

In response to the above concerns CTC prepared and submitted via letter the rationale for moving the BSC from within the confines of an existing building to a free standing and separate structure.

INTRODUCTION

"Evaluation, Engineering and Development of Advanced Cyclone Processes" is a research and development project for the reduction of pyritic sulfur content in coal. Minimum project goals are to produce a 6% product ash and 85% pyritic sulfur rejection while retaining 85% of the parent coal's heating value. A number of media and separator options are to be evaluated and tested, culminating in the implementation of the preferred combination in a 1,000 lb/hr bench scale process optimization circuit constructed on a site provided by Coal Technology Corporation (CTC) in Bristol, Virginia.

The project involves the physical beneficiation of coal based on the density differential that exists between clean coal and its impurities, i.e., pyrite and ash bearing minerals. Coal may be beneficiated by employing a parting liquid or pseudo–liquid with a specific gravity between that of coal and its impurities. A number of parting liquids (separating media) were considered for evaluation and testing in this program. They represented three families of liquids: aqueous solutions, organic liquids, and aqueous suspensions. The aqueous suspensions of starch and solutions of sugar, though environmentally benign, were dropped from consideration early in the program because of their high viscosity and handling difficulties. Micronized magnetite, an aqueous suspension, was also dropped because another firm plans to develop it to commercialization.

Except for the aqueous suspensions, the candidate media may be classified as true heavy liquids. True heavy liquids are not affected by the multiple gravities (g) required in fine coal gravimetric separation processes, whereas suspensions may deteriorate if subjected to excessive g force. Multiple gravities in combination with true heavy liquids can be used to increase the speed and efficiency of separation of particles of small size having slight differences in density. Generally, the greater the number of gravities the more precise the separation. This implies the use of small diameter, high–pressure cyclones or high gravity centrifuges. Therefore, the term cycloning encompasses centrifuges and other enhanced–gravity devices where fluid motion or mechanical motion is converted to centrifugal force.

Task 1 - Project Planning and Management

Task Description or Objective(s): The objective of this task is good technical and fiscal control and management of this project, both internally and externally, by Coal Technology Corporation (CTC), the prime contractor. CTC is responsible for interfacing with the DOE and ensuring that all subcontractors fulfill their responsibilities and meet the milestones and goals of the Project Work Plan. The subcontractors are:

- Process Technology, Inc. (PTI) – Subcontractor providing analytical services and conducting Phases I and II laboratory and closed–loop media testing.

- ICF Kaiser Engineers, Inc. (ICF–KE) – Subcontractor performing detailed design of the 1000 lb/hr Bench Scale Circuit.

- Intermagnetics General Corporation (IGC) – Subcontractor providing media, separator, and technical service for magnetically enhanced media.

Project management is an ongoing effort designed to monitor the subcontractors, keep the project running smoothly, resolve problems, and in general ensure that the project is performed on a timely and cost–effective basis.

Task 2 - Coal Procurement and Characterization (Three Phases)

Task Description or Objective(s): The objective of this task is to provide characterized feedstock for all three phases of the program. The three phases are associated with: (I) Separating Media Evaluation, (II) Separating Media Testing, and (III) Process Optimization Testing. A total of four coals have been selected for the program. The four coals constitute a substantial reserve, are technically difficult to clean, and contain significant amounts of pyritic sulfur. The characterization will determine the amount of liberation needed to reach the project goals. This information will be used as a database for the entire program and to measure the performance of individual tests.

The project's requirements for the four coals include:

- Raw coals must have moderate to high pyritic sulfur contents where pyrite is not sufficiently liberated in conventional cleaning.

- Precleaning operations must recover 90 to 95% of the parent raw coal's heating value while principally removing coarse rock and fine clays.

- Raw and clean coal handling systems must facilitate readily obtaining one–to–two ton samples of the raw and precleaned coals for Phase I and III characterization

Activity: No activity during this period.

Task 3 - Evaluation Plan and Test Plan Formulation

Task Description or Objective(s): Task 3 represents the planning stage of the work that will be conducted during Phases I through III of Task 6. It is the technical basis of the program and provides for evaluating the media by paper study supplemented by laboratory study, selection of medium and separator combination, and implementation of one medium/separator option for long–term, open loop testing. The three phases of this task are:

- Phase I — Media Evaluation
- Phase II — Separating Media Testing
- Phase III — Process Optimization Testing

These plans detail Task 6, Scope of Work.

Activity: The Separating Media Evaluation Plan was approved by DOE in February 1991. The Preliminary Separating Media Evaluation Report contains the Separating Media Test Plan, which was carried out during Phase II. The Process Optimization Test Plan for Phase III was submitted on December 18, 1992, and is under revision.

Task 4 - Bench Scale Test Circuit Design

Task Description or Objective(s): This task involves the design of a fully integrated bench scale advanced cycloning test circuit (BSC). The design of the advanced cycloning test circuit will be based on the Separating Media Evaluation and Testing results (Phases I and II) and the detailed characterization of the four proposed test coals. ICF–KE will be the lead team member for Task 4. The duration of the detailed engineering and construction contractor selection tasks is expected to be four months. Scope description is contained in the Project Work Plan.

The BSC will be fully integrated and include all pretreatment, cleaning, and post–cleaning operations necessary to allow continuous steady–state operation including at least one (1) uninterrupted run of 100 hours duration in length for each of the four test coals.

Activity: ICF–KE has completed design of the Bench Scale Circuit. The drawings and specifications are ready for utilization by contractors. For a description of the circuit and process refer to Quarterly Technical Progress Report #12.

Task 5 - Bench Scale Test Circuit Set-Up and Commissioning

Task Description or Objective(s): This task covers the functions necessary to construct and commission the bench scale circuit module at CTC in Bristol, Virginia. The construction will be performed by an experienced contractor with construction management provided by CTC. The start–up will be supervised by CTC and performed by craft labor supplied by the construction contractor.

Activity: Pre–approval of the building permit for the BSC was obtained during the last Quarterly period. There is a delay in obtaining approval of the construction and electrical contractors, or more precisely to start construction of the BSC. The problem is linked to two issues. First, the new building is viewed as a capital improvement of CTC property, which could require specific approval if funded by project money. Secondly, NEPA implications must be reconsidered because plans to build the BSC building conflict with the FONSI statement which indicates that the circuitry would be housed within an existing structure. CTC provided engineering details and drawings to support DOE in resolving these issues.

In anticipation of construction and operation of the BSC, CTC contacted the Regional Office of the Virginia Department of Environmental Quality and ascertained that it was necessary to apply for a permit to operate the BSC. A permit to construct and operate the BSC was applied for and granted shortly thereafter.

Equipment Received

During this reporting period the exhaust fans, electric heaters, pinch valves, ball mill, density and level transmitters, pH sensors, pumps, and mixers, were delivered to the building site. This equipment is intended for use in the advanced cyclone BSC.

Task 6 - Evaluation and Test Plan Implementation

Task Description or Objective(s): This task consists of the technical implementation of plans produced and approved under Task 3. Please refer to the project Separating Media Evaluation Plan and Separating Media Test Plan.

Phase I - Media Evaluation

Activity: The media evaluation has been completed and reported in the revised Preliminary Separating Media Evaluation Report (PSMER) during a prior reporting period. In the PSMER, methylene chloride/perchloroethylene, calcium nitrate/water, MEM (Magnetically Enhanced Media), and water were selected as media for inclusion in the test matrix for performance testing during Phase II.

Phase II - Separating Media Testing

No activity during this period.

Phase III - Process Optimization Testing

Activity: Process Optimization Testing will utilize the Bench Scale Circuit (BSC). A draft plan to test and optimize this circuit, the Process Optimization Test Plan, is under revision. Process Optimization Testing will start when the BSC is constructed and shakedown is complete.

Task 7 - Data Analysis and Reporting

Task Description or Objective(s): This task takes place throughout the project to keep up with the day–to–day logging of data and with reporting requirements. Dissemination of data to the Project Team members is vital to the project. Analysis and interpretation of the data are critical to this task. Numerous reports are required during the life of the project. Technical reports required under the contract include the following: Biweekly and Quarterly Progress/Status Reports, Washability Analyses Report, Preliminary Separating Media Evaluation Report, Final Separating Media Evaluation and Test Report, and the Final Report.

Activity: The Biweekly and Quarterly reports have kept DOE informed concerning the progress of the project. Other reports and plans are covered under their applicable Tasks.

Task 8 - Conceptual Design

Task Description or Objective(s): This task is performed with the objective of providing DOE with a conceptual description and detailed estimate of the cost to construct and operate a 20 tph advanced cycloning test module. This is a modification to the contract, which originally called for detailed design of a 3 tph circuit. CTC will be the lead team member for Task 8. This Task involves the conceptual design of a fully integrated, continuous operation, advanced cycloning test module. The conceptual design will be sized for 20 tph feed rate and will include all necessary pre–treatment, cleaning and post–treatment unit operations. The conceptual design will be based on the results of the Process Optimization Tests performed under Phase III of Task 6.

Activity: No activity during this period.

Power and Heat Systems provided a budget quote of $350,000 for a heating system which provides 100 million Btu/hr of thermal energy. This is the calculated amount of

energy needed for a hot water flash bath process boiler in an organic medium circuit. For the same circuit, the cost of hot water flash clean coal and refuse baths, and an organic vapor condenser was estimated to be $2,350,000 by Swenson. Both estimates are meant for a 200 TPH coal feed organic medium cleaning process circuit utilizing hot water flash evaporation equipment and vessels to disengage and recover the organic medium from coal.

Task 9 - Final Reporting

Task Description or Objective(s): The Project Team members will submit a Draft Final Technical Report in the 41st month of the project. This report will be preceded by a detailed outline to be reviewed by the DOE. The final report will meet contract requirements as stated in the Project Work Plan and will comply with DOE Order 1332.1A (Uniform Reporting System).

Activity: No activity during this period.

Task 10 - Decommissioning

Task Description or Objective(s): CTC shall be responsible for decommissioning, protecting, removing, and disposing of all contractor installed property encompassed by the contract. Contractor procured Government property shall be protected and dispositioned as directed by the DOE Contract Officer. This is strictly limited to the cost of decommissioning, removal, protection, and shipment from CTC to PETC.

Activity: No activity during this period.