DOE/PC/90177--T16

EVALUATION, ENGINEERING AND DEVELOPMENT OF ADVANCED CYCLONE PROCESSES

QUARTERLY TECHNICAL PROGRESS REPORT

Quarterly Report #21

For The Period October 1, 1995, to December 31, 1995

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

For

U.S. Department of Energy
Office of Fossil Energy
Pittsburgh Energy Technology Center
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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 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, the optimum medium, separator, and medium recovery system(s) will be tested with commercial–size equipment.

Major activities and developments that occurred during this reporting period are reviewed below.

Revision of the Component Test Plan continued through this reporting period.

Work on the Component Test Stand included the following. Mixers were installed in the primary sumps. Solids bearing slurry was introduced to the two main sumps and pumped through the system. Several small leaks were detected and repaired. Corrosion was found on the clean coal pump inlet side and repaired. The control system for the filter was wired. Roofing and heating for the Component Test Stand were installed by CTC personnel. Siding was installed by a local contractor.

INTRODUCTION

"Evaluation, Engineering and Development of Advanced Cyclone Processes" is a research and development project aimed at reducing pyritic sulfur in coal products. 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, and performance characteristics of critical process components investigated in a 1,000 lb/hr closed loop test stand 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 higher the gravity, the more precise the separation. This implies the use of small–diameter, high–pressure cyclones or high–gravity centrifuges. Therefore for this project, 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:

- ICF Kaiser Engineers, Inc. (ICF–KE) – performing detailed design of a 1,000 lb/hr Bench Scale Circuit.

- Intermagnetics General Corporation (IGC) – 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.

Activity: No activity during this period.

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) Component Testing. A total of four coals has 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 determined the degree 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 that are not sufficiently liberated by conventional cleaning processes.

- 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 Phase III characterization

Activity: The revised Work Plan dated February 23, 1995 specifies that filter (dewatering) tests will utilize products of froth flotation (froth and tailings) from two new sources other than the four project coals previously identified. An Illinois No. 6 sample for decanter separator tests and the Meigs #31 Preparation Plant samples for dewatering studies are on site. Portions of each of the Meigs samples were placed in the Component Test Stand storage sumps.

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 — Component 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. A draft Process Optimization Test Plan for Phase III was submitted on December 18, 1992, intended as a plan for an integrated circuit; the revised Work Plan requires a Component Test Plan instead.

Revisions to the Component Test Plan continued throughout this reporting period.

Task 4 - Bench Scale Test Circuit Design

Task Description or Objective(s): This completed task has provided the design of a fully–integrated, bench–scale advanced cycloning test circuit (BSC). The design of the advanced cycloning test circuit was 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 was the lead team member for Task 4.

The BSC design fully integrates 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 for each of the four test coals.

Activity: No activity during this period. The revised Work Plan specifies that the bottom portion of the BSC design be used in erecting a smaller facility designated as Component Test Stand (CTS). The CTS will allow closed–loop testing of the capillary–action filter and the Sharples P–3000 decanter centrifuge in lieu of the fully integrated circuit (BSC) previously planned.

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: The revised Work Plan dated February 23, 1995 provides for constructing a Component Test Stand (CTS) for the testing of critical components, i.e., the filter and decanter centrifuge. The revised plan specifies the construction of the bottom portion of the BSC structure, as designed, for utilization as a Component Test Stand.

During this reporting period, work on the Component Test Stand included the following. Mixers were installed in the primary sumps. The refuse slurry sump mixer required a carrier bearing due to shaft flexure. Solids bearing slurry was introduced to the two main sumps and pumped through the system (see Figure 1). Several small leaks were detected and repaired. Corrosion was found on the pump inlet side of the clean coal sump. Corrosion is believed to be due to the high oxygen content of the slurry from mixing, the high liquid velocity at the inlet, and a low pH. The pH of the clean coal slurry was found to be 2.4. This is believed to be due to sulfur leaching from the coal. Repairs to the pump inlet consisted of extending the inlet inside the sump and painting.

The control system for the filter was wired. Roofing and heating for the Component Test Stand were also installed by CTC personnel. Siding was installed by a local contractor.

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, and MEM (Magnetically Enhanced Media)/water were selected as media for inclusion in the test matrix for performance testing during Phase II.

FILTER FLOWSHEET

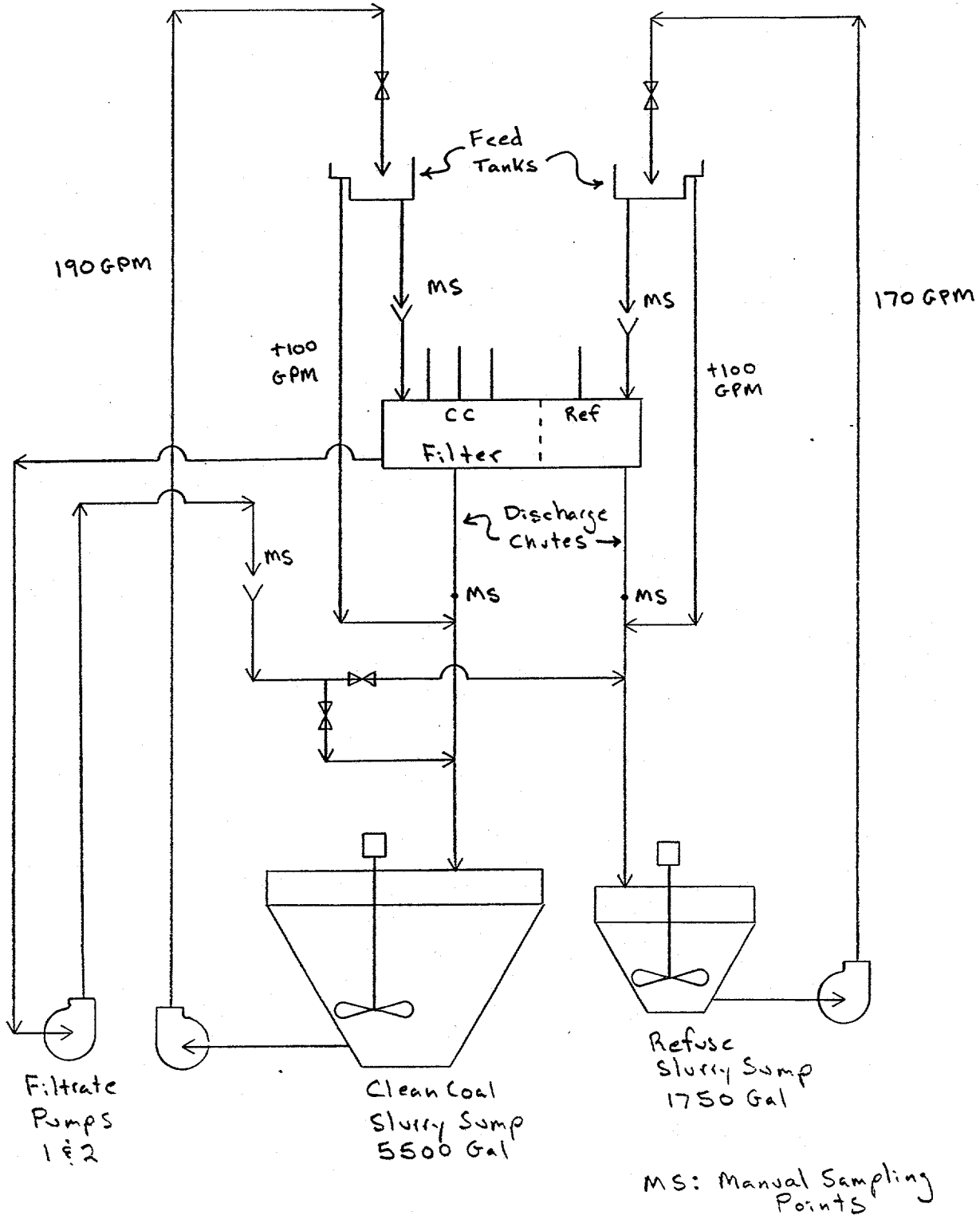

Figure 1

Phase II - Separating Media Testing

Activity: At the conclusion of Phase II calcium nitrate was selected as the preferred medium as reported in the Final Separating Media Evaluation and Test Report (FSMER).

Phase III - Process Optimization Testing

Activity: In the revised Work Plan Process Optimization Testing is replaced by Component Testing.

Task 7 - Data Analysis and Reporting

Task Description or Objective(s): This task takes place throughout the project to keep up with day–to–day data logging and 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 Component Tests performed under Phase III of Task 6.

Activity: No activity during this period.

Task 9 - Final Reporting

Task Description or Objective(s): The Project Team members will submit a Draft Final Technical Report in the 62nd 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 this period.