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DEVELOPMENT OF A
PILOT-SCALE KINETIC EXTRUDER FEEDER
SYSTEM AND TEST PROGRAM

1st Quarterly Technical Progress Report

October-December 1980

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TECHNICAL STATUS

This report is being transmitted in advance of DOE review and no further dissemination or publication shall be made of the report without prior approval of the DOE Project/Program Manager.

Abstract

This report covers the work carried out during the October-December 1980 quarter of the program.

Preparations are being made to ready the equipment for the test program. The main effort described in this report pertains to the redesign of the main shaft bearing and seal system.

Conclusion and Recommendations

To enhance the chances of achieving the program objectives the recommendation was made by Lockheed to use a conventional roller bearing for the present program instead of the advanced water-lubricated bearing. Nevertheless, the need exists for better long term solutions to the bearing and seal problem, especially in view of the eventual requirement to scale the equipment to larger sizes.

It is recommended that the program proceed as planned.

1.0 OBJECTIVE AND SCOPE OF WORK

Under Phase I of this contract, LMSC will perform test and evaluation studies on an upgraded version of the 1-ton/h pilot scale kinetic extruder and ancillary equipment previously developed under the prior DOE contract. Based on the generated test and evaluation data, LMSC will define optimum operating parameters for and limitations in the extruder and ancillary equipment. Evaluation of the results of Phase I will permit a determination of whether or not further DOE-funded development (Phase II) of the extruder and ancillary equipment is warranted.

To accomplish the objectives, seven tasks are to be performed in accordance with the schedule shown in Fig. 1. These tasks are described briefly below.

Task 1 - Bearing and Seal Upgrading

The bearing and seal systems of the current unit require modification for reliable operation at full design pressure, as discussed in the technical proposal. Under this task, design modifications to the existing Kinetic Extruder (KE) machine to accept a new bearing and a new control-gas seal will be made. The new bearing, seal, and associate hardware will be fabricated and installed in KE. Checkout tests of the upgraded system will be conducted.

Task 2 - Update of Test Loop

Under this task required improvements in the test loop will be designed, fabricated, installed, and tested. This includes improved coal storage and loading equipment, moisture addition apparatus, and additional instrumentation and controls.

Task 3 - Design, Specifications, and Operating Instructions

This task covers preparation of engineering drawings and design specifications for the feeder and its ancillary equipment. Also included is preparation of a detailed operating manual for the KE feeder and test loop.

Fig. 1 Program Schedule, Milestone and Status Report for Phase I

Task 4 - Testing

Test runs will be conducted to establish the performance of the feeder with changes in coal type, coal grind, moisture level, and additives. Lockheed's plan provides for 10 weeks of testing. The first week has been set aside for system checkout, calibration, and development of procedures for varying moisture level. Thereafter, the planned test matrix will be conducted and the required test data obtained. The matrix satisfies the requirements outlined in the statement of work. Failures of ancillary equipment will be noted.

Task 5 - Data Analysis

Under this task all test data obtained will be organized and analyzed. Theoretical performance calculations will be made and compared with the test data. The test data will be compiled in a deliverable "Phase I Test Data" package.

Tasks 6 and 7 - Report Preparation

Monthly reports and the final Phase I summary report will be prepared under these tasks. The final Phase I report summary will evaluate the feed system design and give its advantages, applicability, weaknesses, economy, and scalability to commercial plant size. Also, the report will include a detailed summary of how well it met the Phase I objectives and recommendations for future work. The recommendations will be made in light of the success criteria laid down by DOE.

2.0 SUMMARY OF PROGRESS TO DATE

The objective of this program is to determine the ability of the Kinetic Extruder to handle various coal feed stock of varying moisture content. To accomplish this objective the existing equipment had to be modified. A time span of five months was allocated to accomplish this, and this report covers the first three months of this effort. During the

reporting period all engineering for the equipment changes were accomplished and parts are being procured and/or being fabricated. No problems have been encountered.

3.0 DETAILED DESCRIPTION OF TECHNICAL PROGRESS DURING THE QUARTER

3.1 BEARING AND SEAL UPGRADING

During the prior DOE-sponsored program, the Model No. 4 Kinetic Extruder was built and operated. This feeder incorporated several advanced features: Water-lubricated* journal bearings were used for both the shaft bearings and the feedpipe bearings. These bearings also served as the pressure breakdown structure for the face seals, a function normally performed by floating bushing seals or labyrinth seals. The pressure difference across the face seals was maintained at 20 psi by adjusting the liquid pressure supplying the bearing to track the gas pressure inside the housing.

The rotor was designed to permit fluidic turn-down control of the coal throughput.

The pocket type, water-lubricated bearings proved to be deficient. No problems were encountered at high speed and pressure. Eventually, bearing failures (galling and seizure) during the start-up occurred. The Model 4 feeder was then refitted with carbon-bronze plain journal bearings. These bearings solved the problem of galling on start-up, but theoretically they exhibit instability at 3400 rpm and normal design load irrespective of supply pressure. For this reason the machine has been operated only to 2500 rpm at 200 psi pumping pressure.

Under the current DOE program funding restraints, it is prudent to eliminate a potential risk involved in using the improved version of the water-lubricated bearings by substituting rolling element bearings and appropriate seal systems.

*A 50% water, 50% ethylene glycol solution was used.

The present Model 4 control-gas injection-point floating bushing seals have unsatisfactory gas leakage at high operating pressures. The configuration has been changed to a pair of liquid-buffered double seals to eliminate this problem.

The physical arrangement of the parts now being fabricated is shown in Fig. 2. The high-pressure sealing water enters through ports 1 and 1a at a pressure of about 30 psi above case pressure. The water is prevented from entering the case by the low pressure-differential face seal on the inboard side. On the outboard side the pressure is reduced to near atmospheric by flow through the floating bushings and water drains through ports 2 and 2a. Oil for lubricating the bearings enters through ports 5 and 5a, and drains through ports 4 and 4a. The oil is sealed by shaft seals, but some seepage passes through the seals and is scavenged through ports 3, 3a, and 6.

Ports 3 and 3a also scavenge water seepage past the back-up shaft seals.

Control gas for the fluidic coal flow control is admitted through port 10. Sealing water at a pressure of about 30 psi above the control gas pressure enters through ports 8 and 12. Water seepage past the shaft seals is scavenged through ports 9 and 11 by means of a pressure trap. Water pressure is reduced to near atmospheric through floating bushings and drained through ports 7 and 13.

The sealing and bearing system for the stationary coal feedpipe has not been changed. It consists of a low pressure differential water-cooled face seal and a water-lubricated journal bearing which also served as a pressure breakdown structure.

The parts shown in Fig. 2 are now being procured and are expected to be available for installation by mid February 1981.

Fig. 2 Rotor Bearing Seal Assembly

3.2 UPDATE OF TEST LOOP

The layout of the test loop for the Phase I tests is presented in Fig. 3. The main changes to be implemented are the addition of a barrel dump and loading conveyor, centralization of controls and instrumentation, and reconfiguration for control of moisture. The new coal-loading equipment is needed for satisfactory handling of larger quantities of coal. The previous loading method was crude and only suited to bagged coal and infrequent reloading of the test loop. Coal will be loaded into the outside storage hopper and then pneumatically transferred to the KE feed hopper. A water fog nozzle and associated equipment is to be installed in the storage hopper. Moisture will be added and mixed with the coal during repeated transfers back and forth between the coal storage and the feed hoppers. A flow sheet encompassing these two vessels is shown in Fig. 4.

Some improvements in instrumentation and controls are being made, but operation will remain essentially manual. A few valves in the test loop are being equipped with remote actuators so the loop can be run from the control room location for the most part. These include the valves on the receiver main gas inlets and outlets, the fluidization supply, the recycle line and purges, and the transfer lines between the feed hopper and the supply hopper. The receiver-vessel pressure control is being changed from purely manual to an automatic controller with a manual set point. The sprue deplugger device is also being automated.

Details of all subsystems as now configured are being incorporated in the flow diagrams, and will be presented under Task 3 in the next quarterly report.

3.3 DESIGN, SPECIFICATIONS, AND OPERATING INSTRUCTIONS

This task covers preparation of engineering drawings and design specifications for the feeder and its ancillary equipment. Also included is preparation of a detailed operating manual for the KE feeder and test loop.

— PLAN —

— SIDE ELEVATION —
SCALE 1" = 40'

— END ELEVATION —

TEST LOOP - PHASE I

Fig. 3 Coal Feeder Facility
Space Requirement "Heff Site"

Fig. 4 DOE Kinetic Extruder
Coal Feed Flow Sheet

As indicated on the schedule shown in Fig. 1, this task has been delayed due to year-end personnel shortages. Drawings of the ancillary equipment including piping, valving, etc., are under preparation, and the operating instructions are being written. These will be included in the next quarterly report.

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