MASTER

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

Second Quarterly Technical Progress Report

January Through March 1981

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TECHNICAL STATUS

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Abstract

This report covers the work carried out during the January - March 1981 quarter of the program.

Preparations are being made to ready the equipment for the moisture tolerance test program. The main effort described in this report pertains to the redesign and procurement 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, Lockheed will perform test and evaluation studies on upgraded version of the 1-ton/h pilot-scale kinetic extruder (KE) and ancillary equipment previously developed under the prior DOE contract. Based on the generated test and evaluation data, Lockheed 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 KE machine to accept a new bearing and a new control-gas seal are being implemented. The new bearing, seal, and associate hardware are now being fabricated and will be installed in the existing housing. Checkout tests of the upgraded system will be conducted.

Task 2 - Update of Test Loop

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

Fig. 1 Program Schedule, Milestone and Status Report for Phase I (Revision "A")

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.

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 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.

Task 6 and 7 - Report Preparation

Monthly and Quarterly Progress 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 KE 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 7 months was allocated to accomplish this, and this report covers the second quarter of this effort. During the reporting period all engineering for the equipment changes were accomplished and parts are being procured and/or being fabricated. The main problem encountered has been a delay in anticipated availability of the seal components which necessitated a lengthening of the schedule by 2 months. The schedule shown in Figure 1 reflects this change.

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

*A 50 percent water, 50 percent ethylene glycol solution used.

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 3,400 rpm and normal design load irrespective of supply pressure. For this reason the machine has been operated only to 2,500 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.

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 was shown in the First Quarterly Progress Report.

The parts are now being fabricated and are expected to be available for installation by the end of April 1981.

3.2 UPDATE OF TEST LOOP

The layout of the test loop for the Phase-I tests was presented in the First Quarterly Progress Report. 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 hooper. 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.

Some improvements in instrumentation and controls have been made, but operation remains essentially manual. A few valves in the test loop have been equipped with remote actuators so that 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 has been changed from purely manual to an automatic controller with a manual set point. The sprue deplugger device has also been automated.

Details of the system are being presented in a separate report (Ref. 1).

3.3 DESIGN, SPECIFICATIONS, AND OPERATING INSTRUCTIONS

This task covering preparation of engineering drawings and design specifications for the feeder and its ancillary equipment, including detailed operating instructions for the KE feeder and test loop, has been completed and has been reported in a separate report (Ref. 1).

3.4 TESTING

Orders for the test coals have been placed and no delivery problems are anticipated.

REFERENCE

1. One TPH Kinetic Extruder Design Specifications and Operating Instructions, LMSC-D767688, March 1981.