OPERATION, MODIFICATION, AND MAINTENANCE

OF

DOE/PETC 700 H.P. COMBUSTION TEST FACILITY
100-20 FIREFLUE BOILER TEST FACILITY

CONTRACT NO. DE-AC02-78ET13011

QUARTERLY ACTIVITY REPORT
For The Period

October 1, 1979 to December 30, 1979

FOURTH QUARTER

Performed By

General Electric Company
Management and Technical Services Company
626 Cochran Mill Road
Clairton, PA 15025

Prepared for the United States
Department of Energy

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BACKGROUND

The General Electric Company (MATSCO) was awarded the contract to operate, modify, and maintain the DOE/PETC 700 H.P. Combustion Test Facility. The 700 H.P. Combustion Test Facility was designed and built by the Department of Energy at Pittsburgh Energy Research Center and its ultimate success is the responsibility of DOE/PETC. G. E. Co/MATSCO will provide support to assist in the goal of successful operation of this pilot plant facility. The primary objective of the DOE/PETC 700 H.P. CTF is to establish the practicality of coal oil slurry combustion as a technically, economically, and environmentally feasible retrofit technology.

WORKSCOPE SUMMARY

The Contractor shall provide all things necessary for the operation, modification, and maintenance of the plant as provided in the Operating/Maintenance Manual, and carry out the experimental and developmental operations in said plant as directed by the DOE Technical Project Officer.

The operation, modification, and maintenance of the 700 H.P. CTF shall be in accordance with all applicable safety, health codes, standards, and regulations of DOE. The operation, modification, and maintenance shall include the following phases:

a) Phase I - Preparatory Work - includes personnel staffing and training, preparation of detailed operating, maintenance, and safety manuals, purchase of tools, spare parts and initial operating supplies.

b) Phase II - Start-Up and Adjustment Period - Check out and activation of all plant systems and subsystems including run-in adjustment and lubrication of all components, chemical cleaning and flushing of systems and lines, and any other activities necessary to achieve steady-state operating conditions.

c) Phase III - Process Investigation Operations - Experimental establishment of the effect of applicable process variables and changes in configuration on plant parameters to determine optimum conditions and configuration for technical, economical and environmental analysis. This includes varying feed rates of consumables, varying temperatures and pressures, and accomplishing plant configuration changes necessary to investigate and all of the operating alternatives outlined in the Operating Manual as directed by DOE.
PROGRESS DURING THIS REPORT PERIOD
700 H.P. COMBUSTION TEST FACILITY

Four #6 oil and a 40% coal oil mixture test were run to provide check tests for the parametric test program in the 700 H.P. Combustion Test Facility, which officially completed this test series. The remaining three weeks of October were spent preparing for the 500 hour 700 H.P. boiler endurance run scheduled to begin in early November. From November 5 to December 15, the 500 hour endurance test was run without any unscheduled shut downs except to remove an excessive amount of ash which restricted heated gases from entering the convection section of the boiler after 370 hours of operations.

During these tests, measurements were made inside the 700 H.P. boiler and at the stack to assess the performance of the combustor. The boiler was instrumented to permit detailed heat balances, emission measurements and flame characterizations. The particulate level in the stack was monitored using isokinetic stack samples and was compared to opacity data obtained from the transmissometer. The size distribution of the particulate matter in the stack was monitored by a cascade impactor. The average emissivity of the flame was determined using various targets and optical pyrometers.

Flue gas desulfurization tests were run concurrently with the COM combustion tests to study the effectiveness of injection of dry sodium bicarbonate in the removal of SO₂ from the flue gas. These tests were discontinued when the screw feeder failed. The unit is currently being modified to prevent a reoccurrence of this problem.

Below are listed the completed formal tests:

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<th>October</th>
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<td>Test No. 700-C5FATS -</td>
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<tr>
<th>November &amp; December</th>
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<td>500 Hour Endurance Test (40% COM)</td>
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All data for these tests were submitted to D.O.E. personnel.

The boiler operated almost flawlessly during the 500 hours endurance test. It was necessary to change the burner nozzle every 8 hours to prevent nozzle plugging effecting combustion. Nozzle wear was evident throughout the test until TUNGSTEN CARBIDE inserts were tried during the last 40 hours of testing.
Essentially no wear was experienced as compared to 0.0003 and 0.0008 inches wear per hour which resulted using hardened TOOL STEEL and INCONEL X inserts respectively.

Over the 500 hours of operation (1) the steam flow had not decreased and the fuel rate remained constant; (2) the slurry feed pump had not degraded; (3) all equipment had operated acceptably except the main baghouse developed excessive leakage; (4) the sodium bicarbonate feeder failed; (5) ashes had to be removed from the boiler fire box after 370 hours of operation to continue the test; and (6) an acceptable solution to the burner nozzle wear problem was found.

During this quarterly test report period, equipment additions, equipment modifications, and instrumentation developments were performed in preparation for the 500 hour endurance test as indicated below:

A. Raw Coal Acquisition

A reliable source of dry coal was essential to the success of the 500 hour endurance test. Pittsburgh Seam Coal was finally purchased through the Crystal Coal Enterprises which stored and delivered dry coal on a perfectly timed schedule over the 500 hour test.

B. Pulverizer Area

Pulverized coal was increased by 40% as a result of adjustments made to the pulverizing system. The 1,600 lbs. per hour were more than sufficient to supply COM for continuous round the clock operation for the 500 hour endurance test. Other modifications minimizing down time included the installation of screens and a grate magnet in the raw coal bin to prevent tramp metal from jamming the system. A pneumatic slide valve was installed at the bottom of the coal hopper to remove metal attached to the magnets. On several occasions, large rocks were retrieved from the screens during the endurance test. Also installed was a pneumatically operated slide valve separating the pulverized coal hopper and gravimetric feeder. The slide valve improved the performance of the gravimetric feeder. Pulverized coal did not pack in the feeder while the system was down.

C. COM Fuel Transport

1. 3 H.P. Moyno pump

The three horsepower Moyno pump was disassembled and rebuilt with a 10 mil undersized rotor to accommodate an elastomer lined stator. Excellent operation was noted throughout the 500 hour endurance run. A maximum of 1 mil wear was noted on the rotor, which was considerably less than wear experienced when using a hardened steel rotor and stators. The connecting rod pin and hole continues to result in higher wear concentrations. The manufacturer has recently changed this design as noted in their latest bulletins.
2. 5 H.P. Moyno Pump

The large Moyno pump, Model No. 2L8, required a new connecting rod as a result of excessive pin wear and elongation of the hole. The pump rotor chrome plating was worn off on several crests. The chrome plating was removed from the rotor and rechromed several thousands oversize and refinished for a snug fit in the stator.

3. Fuel Adjustment Control

Additional sensitivity for fuel adjustment and control was attained by the addition of a potentiometer to the silicon controlled rectified (SCR) unit. This increased the sensitivity by 10 and thus provided finer adjustment and control of fuel delivered to the boiler.

To enable the operator to maintain vital boiler function within the tolerences specified, oxygen and fuel flow digital readouts were mounted adjacent to the fuel control SCR unit.

D. Alarm Systems

1. Back up Instrument Air

Recent tests including the 500 hour endurance run were not interrupted due to a loss of instrument air. This was attained by using a solenoid operated nitrogen system as a back up in the event the instrument air pressure dropped below 40 PSIG. An alarm system notifies the operator that instrument air is being supplied with nitrogen until the system can be corrected. A check valve allows the nitrogen to supply only those instruments and equipment necessary to maintain continuous boiler operation.

2. High and Low Tank Level Alarms

Dual alarm systems were installed to alarm the operating personnel that the fuel tank level has reached its upper and lower limits of operation. A pneumatic system signals the upper limit and if this signal fails, a float switch set slightly higher provides additional protection. The lower limit warns the operator to provide additional fuel if continued operation is required.

E. Baghouse Ash Removal

To assure continuous removal of ashes from the baghouse, a stainless steel duct joining the rotary valve at the main baghouse to the waste drums was redesigned and installed. A switch to operate the rotary air lock on the main baghouse was installed at the waste drum area to facilitate removal of the ashes and observe the drums being filled.

F. Stack Muffler

To decrease 700 H.P. operating noise, a stack muffler has been installed above the stack blower. This muffler helped to reduce operating noise, especially noise transmitted to the surrounding community.
G. Sodium Bicarbonate Injection System

To improve accuracy and reliability, the sodium bicarbonate injection system was modified by using a screw feeder mounted on a weigh scale. Continuous measurement of sodium bicarbonate injection rates can now be obtained. The system as purchased required additional modification to operate successfully.

H. Main Steam Condenser

The removal of the undersized steam condenser and installation of a larger condenser was accomplished during this test period without interruption of the test schedule. The new condenser has been redesigned to condense the rated capacity of the 700 H.P. boiler. Louvers were also installed to provide variable cooling to convert the steam to condensate under varying temperature conditions. Future consideration is being given to adding a condensate temperature controller and pneumatic cylinder to operate the louvers to accommodate variable steam load conditions.

I. COM Test Loop

After considerable effort to install and calibrate pressure and differential pressure transmitters in the COM test loop, it became evident that the "Ron Petcos" would not hold a charge and the transmitters' zero points drifted more than 10 times the manufacturer's recommended specifications of 0.2% drift. These transmitters were returned to the manufacturer for repair under the warrantee. While waiting for these transmitters to be returned, a method of accurately measuring pressure which does not require "Ron Petcos" has been successfully accomplished in a coal-oil mixture environment. Regulated air is bubbled in the process line at several locations and its reactive pressure is sensed on a differential pressure transmitter. The repeatability, sensitivity and accuracy was measured against a "U" tube manometer, a calibrated strain gage and in line pressure gages. By accurately measuring the flow, temperature and pressure drop across a known distance, viscosities were obtained using the formula \( \mu = \frac{PD^4}{27.3G} \) taken from Marks' Handbook, 5th Edition, Page 248, for flow of liquids in a pipe. It was interesting to note how closely the 40% COM compared to D.O.E.'s Temperature vs. Viscosity curve using a viscometer, even though COM is not a Newtonian fluid.

100 AND 20 H.P. BOILER UNITS

During this test period the 20 H.P. boiler test facility was state inspected, calibrated and modified in preparation for tests to be conducted on #6 oil. Meter versus weigh scale readings were conducted on the 20 H.P. Haliburton and Neptune water flow meters and indicated a 0.6% difference for a ten gallon test run for both meters.
The 20 H.P. oval flow meters were calibrated during November. The meter vs. weigh scale readings were less than 1% over the operating range.

Seven tests were conducted during this test period on #6 oil. Boiler steam pressure was difficult to control. A back pressure regulator has been ordered and is expected during the first week of January. Background experience was gained during these tests to enable adjustments and modifications to be made to improve stabilization of specified operating conditions.

The opacity meter stack flanges were re-installed 18 inches downstream from their previous position. Additional stack penetrations were installed for the D.O.E. chemistry section and also to accommodate the Anderson cascade impactor.

At our request for a fuel rate recommendation, the Johnson Boiler Company suggested 5.5 gallons per hour, as any rate in excess would decrease the boiler factor of safety and boiler service life. It also became apparent from these tests that in order to obtain a steady oxygen level, it was necessary to operate the fuel flow manually.

Safety

Procedures for confined area entry were developed. This procedure including confined entry permit forms have been distributed to the 700 H.P. and the 100 H.P. crews.

Four joint safety meetings have been conducted during this report period, and in addition, a number of employees attended a Cardio Pulmonary Resuscitation (CPR) course given by GE/MATSCO personnel from MHD.

Safety inspections have been performed by the Hartford Steam Boiler Inspection and Insurance Company. Minor recommendations were made and have already been corrected.

700 H.P. Combustion Test Unit Quarterly Forecast

Corrosion, erosion and wear results will be compiled from the 500 hour test. Tests to evaluate the effect of coal particle size in COM fuel are scheduled. A Brooksfield continuous viscometer and Sensall Sludge meter will be evaluated in the COM test loop during the next few months.

100 H.P. and 20 H.P. Combustion Units Quarterly Forecast

Two additional #6 oil and SCR II boiler tests are scheduled for the 20 H.P. unit.

Electrical tie-ins, start-up and boiler modifications to accommodate coal-oil mixtures and alternate fuels are scheduled for the 100 H.P. test facility.

D. Lunifeld
Program Manager