DOE/PC/90169--T4 SEP 09 1991

DOE/PC/90169--T4

DE92 000335

COAL DESULFURIZATION IN A ROTARY KILN COMBUSTOR

Grant No: DE-FG22-90PC90169

Grant Recipient: BCR National Laboratory

Grant Date: April 16, 1990

Principal Investigator: James T. Cobb, Jr.

Contracting Office's Technical Officer: Douglas Gyorke

Reporting Period: April 1, 1991 through July 31, 1991

Quarterly Report No. 5
(BCRNL Letter Report L-1638)

August 29, 1991

Submitted to:

U.S. Department of Energy
Pittsburgh Energy Technology Center
Pittsburgh, PA

BCR National Laboratory
500 William Pitt Way
Pittsburgh, PA 15238

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

COAL DESULFURIZATION IN A ROTARY KILN COMBUSTOR

Table of Contents

COAL DESULFURIZATION IN A ROTARY KILN COMBUSTOR

Progress Report No. 5

BCRNL Report L-1638

1.0 INTRODUCTION

The previous technical report detailed test results in the PEDCO cascading rotary bed boiler. The tests, conducted in March, demonstrated that the PEDCO unit was not properly configured for the combustion of anthracite culm; therefore it was not possible to achieve a sustained period of steady-state combustion.

Subsequent discussions with PEDCO identified several issues that could have an impact on the capability to burn anthracite culm; specifically, questions were raised concerning the specifications of the anthracite culm itself and some relating to the equipment. The anthracite culm delivered to PEDCO was wet, (with more than 10 percent moisture), and coarser than feed material for fluidized boilers. It was felt that using finer fuel, ensuring that it is largely dry, would aid the combustion of anthracite culm. It also appeared that if provisions were made for more efficient internal and external recycle of ash, this would also enhance the combustion of this fuel. Accordingly, the decision was made to conduct an additional campaign of tests that would incorporate these changes.

The tests, conducted on July 15 and 16, 1991, involved an anthracite culm that was, in fact, obtained from a fluidized bed a heating value of 3,000 Btu/lb and came with a top size of 1/4-inch. Despite these changes, sustained combustion could not be achieved without the use of large quantities of supplemental fuel.

Based on these tests, we tend to conclude that the rotary kiln is ill suited for the combustion of hard-to-burn, low-grade solid fuels like anthracite culm.

2.0 PEDCO TESTS USING THE FRACKVILLE CULM

Following the tests in March 1991, discussions were held to determine what changes may be made to enhance the combustion of anthracite culm. PEDCO personnel felt that the moisture and size consist of the test fuel greatly contributed to our inability to achieve sustained combustion. Both the Jeddo and Emerald culms were wetter and coarser than material routinely fed to fluidized-bed boilers.

PEDCO was also planning some changes in the rotary reactor itself which, they felt, would improve combustion efficiency. The focus was on providing better recycle of ash, both internally as well as external recycle of ash leaving the system. Steam production capability was also increased. The specific changes included: (1) installing a cyclone in the fly ash line to the baghouse in order to recycle fly ash to the kiln, (2) enlarging the bottom ash recycle line to increase the bottom ash recycle rate, and (3) reducing the inlet opening on the feed end of the internal solids recirculation chute and increasing the size of the opening to the last (boiler tube) section of the recirculation chute. The last modification was intended to increase the flow of hot solids to the rear boiler tube section, and therefore, increase steam production.

Increasing the recycle of fly ash and bottom ash would aid in the combustion of the anthracite culm, but the increase in steam production increases heat removal from the kiln which proved detrimental for culm combustion.

2.1 Frackville Anthracite Culm Test

The Frackville anthracite culm was obtained from a fluidized bed boiler facility located in eastern Pennsylvania. Analysis of a kiln feed belt sample was as follows:

Moisture, Percent As-received	4.1
Percent Dry Basis	
Ash	67.3
Volatile Matter	7.6
Sulfur	0.36
Calorific Value, Btu/lb	3,018

Initially, the bed inventory was kept at minimum level in order to allow the culm to accumulate in the kiln, without causing problems to the hydraulic drive unit. The test was started by feeding a 50/50 blend of culm and bituminous coal for approximately two hours. Once the feed hopper was emptied, the Frackville culm was loaded. Within 15 minutes the kiln temperature began to drop and supplemental fuel was required. Over the course of the next several hours, a number of attempts were made to reduce the amount of supplemental fuel in conjunction with changes in the culm feed rate. Each attempt soon led to a decline in temperature. After several hours, the test was terminated.

Subsequently North American Rayon's operating personnel suggested two operational changes that may promote combustion: increasing the bed inventory and the kiln rotational speed. The bed inventory had been kept low because of the previous problems with the hydraulic drive system. It was decided that a larger bed inventory could act as a heat sink, holding more heat in the kiln. The increase in speed would improve the gas/solids mixing. It was also agreed to use supplemental fuel in order to maintain the kiln temperature at 1700-1750 °F, which is higher than normal. A test was run the following day incorporating these changes. The results were the same. Combustion without the use of supplemental fuel could not be sustained. Any attempt to reduce supplemental fuel resulted in a sharp drop in temperature.

Fly ash and bottom ash samples as well as operating data were collected during the tests.

2.2 Conclusions

At the outset of this project, we perceived several potential advantages for combustion in a rotary kiln. These included: simple design and easy maintenance and operation, efficient combustion, good control of emissions, and the capability to consume a broad range of fuels of various types. Given all these, the rotary kiln may be competitive and, perhaps in some instances, even superior to fluid-bed boilers. The "open" design of the tubular kiln suggested a capability to accommodate unconventional fuels, including sludge, solid waste, and tires. Indeed, there are many instances in which rotary kiln combustors have been used successfully towards these ends; but our goal was to study the combustion of anthracite culm. The results of our tests suggest that with respect to these low-grade, hard-to-burn fuels, the rotary reactor may be ill-suited. Indeed, with respect to coal in general, the rotary kiln appears inferior to circulating fuel-bed boilers. As noted above, the "open geometry" of the kiln does earmark it for applications involving mass burn of bulky fuels and wastes.

Based on the PEDCO results, testing the combustion of anthracite culm in the Humphrey Charcoal kiln is not warranted. We do not believe the Humphrey kiln, in conjunction with the UEI air distributor, may offer any advantages in solid/gas contact and mixing which would improve the results experienced in the PEDCO unit.

3.0 FUTURE PROJECT ACTIVITIES

It is recommended that no further work be undertaken at the Humphrey facilities. Further discussions with the project sponsors will determine if there is any interest in conducting additional tests in the PEDCO facility involving the combustion of bulky fuels or wastes. If such tests are not deemed to be in the sponsors' interest, then BCRNL would recommend that the project be completed with a comprehensive final report.

END

DATE FILMED

12/18/91