Calderon Cokemaking Process/Demonstration Project

Quarterly Report August 26 - November 25, 1997

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For
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Federal Energy Technology Center
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CALDERON COKEMAKING
PROCESS/DEMONSTRATION PROJECT

Quarterly Technical Report

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FINAL QUARTERLY TECHNICAL PROGRESS REPORT
CALDERON COKEMAKING PROCESS/DEMONSTRATION PROJECT
CALDERON ENERGY COMPANY

COOPERATIVE AGREEMENT NO. DE-FC22-95PC92638

Reporting Period: 8-26-97 to 11-25-97

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Contracting Officer's Representative (COR): Mr. Michael J. Baird

Project Director: Albert Calderon

Abstract

This project deals with the demonstration of a coking process using proprietary technology of Calderon with the following objectives in order to enable its commercialization:

- (i) making coke of such quality as to be suitable for use in high driving (highly productive) blast furnaces;
- (ii) providing proof that such process is continuous and environmentally closed to prevent emissions; and
- (iii) demonstrating that high-coking-pressure (non-traditional) coal blends which cannot be safely charged into conventional by-product coke ovens can be used in the Calderon process.

The activities of the past quarter were entirely focused on operating the Calderon Process Development Unit (PDU-I) in Alliance, Ohio conducting a series of tests under steady state using coal from Bethlehem Steel and U.S. Steel in order to demonstrate the above. The objectives mentioned above were successfully demonstrated.

TABLE OF CONTENTS

Introduction	Page 1
Accomplishments and Discussion	Page 1
Conclusion	Page 4

Introduction

The road to commercialize the Calderon cokemaking process consists of the following phases:

Phase I-- Proof of capability to produce acceptable product coke, proof of the process being environmentally closed, and proof that non-conventional coal blends can be used.

Phase II-- Scale-up of coking reactor to full commercial size (PDU-II) in support of first commercial facility

Phase III-- Construction and operation of first commercial facility

Phase IV-- Worldwide commercialization of the technology

In order to get the support of the steel industry in the demonstration of the Calderon process, U.S. Steel and Bethlehem Steel were approached to participate in tests using their coals to make high quality blast furnace coke in Calderon's Process Development Unit (PDU-I) located in Alliance, Ohio, which had been mothballed since 1992. The activities of the last quarter were focused on the operation of PDU-I to demonstrate Phase I mentioned above.

Accomplishments and Discussion

Operations at PDU-I began the week of the 8th of September 1997. Since the coking reactor was full of char which had been made during the high sulfur steam coal tests in 1992, it was decided that the char would first be purged out of the reactor by charging metallurgical coal and pushing such coal through the reactor in order to discharge the char. Four blends of coal were delivered by the steel companies, one from Bethlehem Steel (Burns Harbor blend) and three from U.S. Steel (two from U.S. Steel's Gary Works and one from its Clairton Works). The testing was begun with the Burns Harbor blend; this blend is known to be one of the superior blends used in the industry. Both

U.S. Steel and Bethlehem Steel felt that they wished to give the best chance for the Calderon process to produce good coke from the outset.

The other three blends, called "White Tag", "Blue Tag" and "Low-Vol", were characterized as follows:- the White Tag was a good blend comparable to the Burns Harbor Blend. The Blue Tag was an inferior blend which conventionally needs to be preheated in order to give a 60 stability which is the ASTM industry standard for high-quality blast furnace coke. The Low-Vol blend was made-up of 50% low-volatile coal, 25% of medium volatile coal and 25% of a low rank volatile coal; this blend is not suitable for use in conventional coke ovens by virtue of the excessive pressure it develops against the walls of the oven.

The burner for the reactor was turned on and it took two days to bring the reactor to temperature. Coal was loaded in the skip hoist and delivered to the lockhopper. The coal being finely ground and wet, would barely flow in the lockhopper. Previously, in handling unprepared steam coal (1990-1992) no such problem was experienced by virtue that the coal was large in size (3" x 0"). The flowability of the Burns Harbor was further diminished since the blend had oil purposely added in order to increase its bulk density. For several days efforts were expended to make the coal flow. By September 16th, 76 pushes occurred when the pusher stalled. Upon cooling the reactor and the removal of the manway, it was observed that the four coke breakers at the end of the reactor prevented further pushing. It was decided to use high pressure water to empty the tube of coke and coal and remove three of the four breakers. It took nine days to accomplish this. The coke removed showed that the reactor did make metallurgical coke and the stability averaged 57.5. The fact that some coke was made during the first run which approached the acceptable stability was quite encouraging to both U.S. Steel and Bethlehem. During this downtime, a vibrating hose activated by pressurized air was installed in the lockhopper to facilitate flowability of the coal.

Run No. 2 began on September 25 and ended on September 28. The coke pushed "green" by virtue of the pushing schedule being based on 12 minute intervals. The number of pushes that occurred during this run was 126.

Run No. 3 began on September 28 and ended on September 30 with 101 pushes taking place. The frequency of pushing was set @ 24 minutes to avoid "green coke". During the three initial tests the coke was not weighed.

Run No. 4 began on September 30 and ended on October 3; many delays were experienced especially in pushing. The problems centered on the hydraulic switching valves and in the stalling of the push. The coke discharged was weighed for the first time--1,748 lbs were produced, and the stability tested @ 60. It was decided to cool the reactor, dig the coke/coal out with high pressure water and remove the last breaker at the discharge end of the reactor.

Run No. 5 was started on October 7 and ended on October 12, making 233 pushes and producing 5,615 lbs of good coke with an average stability of 62 on a continuous basis. At this point Bethlehem and U.S. Steel were satisfied that the Calderon process is capable of continuously making high quality blast furnace coke from a good blend, "the Burns Harbor" blend.

Run No. 6 was continued back to back with Run No. 5 on October 12 using the Blue Tag blend. The test ended on October 14 when the elbow of the reactor was plugged caused by the limestone tracer charged to identify the separation between the Burns Harbor blend and the Blue Tag. During this run 5,961 lbs of coke was made and the stability was 57 which was encouraging because the blend was not preheated. The Blue Tag blend without preheat gives a stability of about 55 in conventional ovens. The elbow was unplugged and the reactor was cooled; with high pressure water, the reactor was emptied again.

Run No. 7 was started on October 17 and ended on October 21; it was continued back to back with Run No. 8 which ended on October 23 using the Blue Tag blend, producing 5,933 lbs of coke and reaching a stability of 61. Run No. 9A started back to back of Run No. 8 on October 23 using U.S. Steel "Low Vol" blend; it ended on October 25 and produced 6,823 lbs of coke with a stability of 57. Run No. 9B followed immediately back to back of Run No. 9A which ended on October 27 producing 4,759 lbs of coke with a stability of 60. Run No. 9C followed immediately back to back with Run No. 9B on October 27 but was interrupted on October 28 by virtue of coal fines having flowed behind the pushing ram thereby preventing the ram from retracting. After cleaning the coal from behind the ram, Run No. 10 was started on October 29 with U.S. Steel's White Tag coal blend, which ran continuously until November 3, during which time there were three coke discharges (October 30, November 1, and November 3) producing 20,537 lbs of coke.

Conclusion

The test conducted in Alliance, Ohio, produced 51,376 lbs of coke in co-operation with the U.S. DOE, Bethlehem Steel and U.S. Steel. The main purpose of the test was to demonstrate the capability of continuously making high-quality blast-furnace coke using the Calderon Tubular coking reactor while charging coal sequentially at 24-minute intervals into the reactor. Another goal was to determine if a high-coking-pressure (non-traditional) coal blend, which cannot be safely charged into a conventional by-product coke battery, can be charged and pushed through the Calderon reactor. The work successfully achieved both goals as indicated by the high coke strength results for cokes produced from the Bethlehem Steel Burns Harbor coal blend and from the U.S. Steel Gary Blue-Tag coal blend and the successful charging of a non-traditional coal blend that contained 50 percent low-volatile, 25 percent medium volatile, and 25 percent high-volatile coal. ASTM coke stabilities, a measurement of coke strength, exceeded 60 which is the current standard for high-quality

blast-furnace coke. In addition to stability, the size and shape of the coke product was similar to conventional by-product oven coke and would be considered acceptable. The apparent specific gravity was slightly higher and the hardness factor, a measure of abrasability, was less than conventional by-product oven coke, however, it is not certain what if any effect this would have on blast-furnace performance.

In summary, the results of the coking trial at Alliance, Ohio, are very encouraging from a technical and from an environmental standpoint because high quality coke was produced continuously and in an entirely closed system. The next step is to accomplish the following:

1. Use the data collected during the tests and update the design of the full size commercial reactor;
2. Incorporate such an update into the design of the first commercial plant;
3. Prepare a revised economic assessment to show continued commercial viability.

Submitted by:

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