DISCLAIMER

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Abstract

This project deals with the demonstration of a coking process using proprietary technology of Calderon, with the following objectives geared to facilitate commercialization:

(i) making coke of such quality as to be suitable for use in hard-driving, large blast furnaces;
(ii) providing proof that such process is continuous and environmentally closed to prevent emissions;
(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; and
(iv) demonstrating that coke can be produced economically, at a level competitive with coke imports.
The activities of the past quarter were focused on the following:

- Conducting bench-scale tests to produce coke and acceptable tar from the process to satisfy Koppers, a prospective stakeholder;

- Consolidation of the project team players to execute the full size commercial cokemaking reactor demonstration;

- Progress made in advancing the design of the full size commercial cokemaking reactor.
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<td>Accomplishments and Discussion</td>
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Introduction

The commercialization path of the Calderon cokemaking process consists of the following general phases:

Phase I--  Proof of capability to produce acceptable product coke, proof of the process being environmentally closed, proof that non-conventional coal blends can be used, and proof that coke can be economically produced domestically using U.S. metallurgical coals at a level competitive with low cost-producer coke produced from foreign countries that are not subjected to U.S. environmental standards.

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 to produce coke competitive with that produced by low-cost producer coke-exporting countries.

Accomplishments and Discussion

During the past quarter the work was focused in three areas:

- Bench scale tests for Koppers to recover acceptable tar;
- Consolidation of the team;
- Progress in design of the full size commercial reactor.

Tests to Recover Tar

As reported in the previous quarterly report, part of Koppers' requirement to join the team was that Calderon conduct bench scale tests to verify that acceptable tar can be produced using Calderon's
technology of cokemaking. A diagram of the equipment assembled for these tests was attached to the previously submitted report. Arrangements were made with Cast Masters, a foundry in Bowling Green, Ohio, which possesses induction furnaces of suitable size to conduct the tests; such arrangements obviated the necessity of purchasing furnaces and installing them thereby eliminating large expenditures for equipment.

Run #1 was scheduled for the 14th of September, 1998 to make sure that all the equipment was functioning. Subsequent to all equipment being delivered to the foundry and all preparations completed, the control cabinet for the operation of the furnaces was not functioning; consequently Run #1 had to be postponed until repairs on the control cabinet were completed. This took two days because of some parts had to be ordered and delivered by U.P.S. Run #2 was conducted on the 18th of September. The equipment was installed in two separate furnaces. In one furnace the coal would be pyrolyzed in order to simulate the Calderon commercial reactor coking step and in the second furnace the cracking would take place to simulate the gas produced which passes through a hot zone before leaving the reactor proper.

Photograph No. 1 shows the two furnaces side by side in which the furnace to the right contains the pyrolysis reactor and the furnace to the left contains the cracker with copper tubing leading to the condensing can (now shown). Photograph No. 2 shows a close-up of the furnace containing the pyrolysis reactor while the cover (flange-blank) was being bolted. Photograph No. 3 shows a close-up of the cracker with the diagonal insulated pipe serving to direct the uncracked gases from pyrolysis into the cracker and the horizontal bare pipe serving to direct the cracked gases away from the cracker. Eleven thermocouples were installed to monitor the temperatures at various locations while a pressure gauge would indicate the pressure. Both the pyrolysis reactor and the cracker were designed to operate at pressure.
Run #2 consisted of three coal feeds; the data sheets for the three feeds are attached to this report. The tar collected was delivered to the Koppers Laboratories in Harmarville, Pennsylvania for evaluation. The attached report from Koppers, in summary form, indicates that the tar produced was found to be “quite valuable” as quoted by Mr. Wombles, Vice-President of Technology at Koppers.

Consolidation of the Project Team Players

To succeed in the full size commercial demonstration of the Calderon cokemaking process, the goal is to have a good technology supported by a good team which is prepared to commit resources. On several occasions the Calderon process has been assessed by many parties as a good process. For the past three years, much effort has been expended to get the team together. The status is as follows:

Bethlehem Steel is committed to invest $5 million, of which $3.3 million is in cash and $1.7 million in the supply of coal and expertise; to-date Bethlehem has spent more than $217,000. Bechtel has recently applied to its management for approval of an investment of $5 million of which $3.75 million is in services and $1.25 million in cash; this is in addition to the investment for the comprehensive assessment of the technology, this investment amounted to $1.08 million.

Koppers was asked to invest $5 million, of which $3 million would be in cash and $2 million in-kind. This request was taken to top management but because of adverse business conditions, Koppers appears to be reluctant to invest at this time (see letter attached).

Calderon has made arrangements to continue discussions with Koppers with the purpose of turning the situation around by proposing the recycling of bottoms which currently is costing Koppers several millions of dollars per year for disposal of such material without deriving any economic benefit. A meeting with the appropriate group of Koppers people was set for the 17th of December.

Vesuvius, the supplier of the tiles for the reactors has been active in making sample tiles for Calderon’s consideration for quite sometime. A meeting with the president of Vesuvius North
America, Foundries Division, is scheduled; he will visit the Calderon’s Site in Alliance on January 4th, 1999. Vesuvius has been made aware that a financial commitment to the project is required; to-date, Vesuvius has invested tens of thousands of dollars in producing sample tiles.

The president of Alliance Machine Company has indicated on various occasions that Alliance Machine would be very interested in joining the team with financial and in-kind support once the rest of the team is committed. Alliance Machine has during the years contributed facilities, and services amounting to several hundreds of thousands of dollars.

It is no secret that the steel industry and the companies that service the steel industry have recently suffered adverse business conditions because of a flood of steel imports, but this situation should change, once the economies in Asia Pacific, Brazil and Russia improve.

**Progress in Design of the Full Size Commercial Reactor**

In the demonstration of the Calderon cokemaking process, the tests conducted at the Alliance pilot facility in 1997 proved that high quality coke can be produced in an environmentally closed system. In the demonstration of the full size reactor the objectives are:

- To produce on a continuous basis at full commercial capacity enough high quality coke for a blast furnace test; and
- To determine the effect of one full year of operation on the tiles which line the internals of the reactor, from the standpoint of erosion, corrosion and structural integrity.

In order to inspect the internals of the reactor at the conclusion of the test period of one year beyond the start-up phase, extensive changes were, and continue to be, incorporated in the design in order to make possible the extraction of the inner tube from the coke discharge end, this inner tube with its lining weighing 160 tons and measuring 74 ft in length. The elbow which supports the inner tube at the discharge is currently being
designed to support the inner tube with a special carriage in order to expose the inner tube out of the outer tube for inspection.

Conclusion

The stakeholders of the team are identified and a commitment from them is expected during the next quarter. In the meantime design of the full size commercial reactor will continue. Once the team is fully committed detailed design would commence which in turn will be used to prepare the package bids for procurement.

Submitted by:

Albert Calderon
Project Director
CALDERON PROCESS TESTING PROGRAM AT CAST MASTERS
BOWLING GREEN, OHIO

MATERIALS TESTED

COAL
(IN PYROLYZER)
CHARGE (WT.) 24át (___ %)

IN CRACKER
CHARGE (WT.) 0 (___ %)

CRACKER
Power Setting 29 kW
Power On 2.35
Power Off 4.05
Raw Gas into Cracker 2.35

PYROLYSIS
Power Setting ____ kW
Power On 2.35
Power Off 4.05
Time Recharged ____

PYROLYSIS & CRACKING TEMPERATURES

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CALDERON PROCESS TESTING PROGRAM AT CAST MASTERS
BOWLING GREEN, OHIO

MATERIALS TESTED

COAL
(IN PYROLYZER)
CHARGE (WT.) 24 # (

CRACKER
Power Setting 20 kW
Power On 5:00
Power Off 7:30
Raw Gas into Cracker 5:05

PYROLYSIS
Power Setting 20 kW
Power On 5:15
Power Off 7:30
Time Recharged

PYROLYSIS & CRACKING TEMPERATURES

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PYROLYSIS & CRACKING TEMPERATURES
CALDERON PROCESS TESTING PROGRAM AT CAST MASTERS
BOWLING GREEN, OHIO

MATERIALS TESTED

COAL
(IN PYROLYZER)
CHARGE (WT.) 24\(^{\circ}\)  (\(\%\))

CRACKER
Power Setting 20 kV
Power On 8:30
Power Off 10:15
Raw Gas into Cracker 8:50

PYROLYSIS
Power Setting 20 kV
Power On 8:45
Power Off 10:15
Time Recharged

PYROLYSIS & CRACKING TEMPERATURES

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Fax

To: Albert Calderon  From: Robert H. Wombles
Fax: 412-353-6293 Date: September 29, 1998
Phone: Pages: 1
Re: Testing of Tar CC:

☐ Urgent ☒ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

*Comments: Albert, the results of Koppers' testing of the tar produced during the recent experiments and some observations regarding the usability of the tar are given below:

- Quinoline Insolubles, wt. %: 19.6
- Specific Gravity, g/cc: 1.256
- Aromatic/Aliphatic Hydrogen Ratio: 32
- Petrographic Analysis: All primary QI with no mesophase

The quinoline insolubles, specific gravity, and aromatic/aliphatic hydrogen ratio of this tar are all higher than conventional high temperature coal tars. I believe the tar will be acceptable for pitch production. We are currently preparing a pitch from the tar and the preparation and characterization will be completed by the end of the week. Because of the high values of these properties, the tar would not be used to produce pitch without being blended with other tars that have lower values for all of these properties. This could make the tar quite valuable as a blending component with other tars that have lower quinoline insolubles contents than desirable.

In summary, I believe the tar produced is acceptable for pitch production. The physical properties of the tar indicate severe thermal exposure, probably related to residence time since the temperature of exposure was approximately 1900°F. Physical properties of pitch produced from the tar will be available in the near future.
To: Alberta Calderon
From: Robert H. Wombles

Fax: 412-353-6293
Date: October 29, 1998

Phone: 412-354-4632
Pages: 1

Re: Koppers Industries

Comments: Albert, as we discussed on the telephone this morning, I have presented my findings to the Koppers Industries decision makers. The technology and the data that have been accumulated impressed everyone. Koppers is predicting a very difficult financial year in 1999 due to competition from import pitches. Although I did not receive a definitive answer regarding Koppers' intent to participate in the development of your coking technology, it is my feeling that the chances are good that the final decision will be negative due to the anticipated poor financial performance of the company in 1999. I plan to continue to push reaching a positive decision, but am not optimistic about my chances for success. I will keep you informed of any further developments.