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CALDERON COKEMAKING
PROCESS/DEMONSTRATION PROJECT

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Principal Author(s): ALBERT CALDERON

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Submitting

Organization(s)

CALDERON ENERGY COMPANY

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QUARTERLY TECHNICAL PROGRESS REPORT
CALDERON COKEMAKING PROCESS/DEMONSTRATION PROJECT
CALDERON ENERGY COMPANY
COOPERATIVE AGREEMENT NO. DE-FC22-95PC92638

Reporting Period: 5-26-00 to 8-25-00

Date of Report: 9-19-00; Award Date: 5-25-95; Anticipated Completion Date: 11-25-00

Total Project: \$ 6,332,060.00 Total DOE Share: \$3,039,389.00

Contracting Officer's Representative (COR): Carl Maronde;

Project Director: Albert Calderon

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;
- (iv) conducting a blast furnace test to demonstrate the compatibility of the coke produced;
- (v) demonstrating that coke can be produced economically, at a level competitive with coke imports; and
- (vi) applying the Calderon technology to making additional iron units.

The activities of the past quarter were focused on the following:

- Bethlehem Steel's withdrawal and efforts expended to substitute U.S. Steel for Bethlehem.
- Assessment work performed with U.S. Steel to show that the Calderon Technology has merit and would add to U.S. Steel's economic benefit by being involved in it, including for making additional iron units.
- Addressing material selection and heat input capacity to increase heat input into the processing reactor by actual modelling of such approach.
- Construction of two full size courses of heating tiles to verify the manufacturing and the fitting of the tiles with one another.
- Making available equipment to test carbon deposition on sorbent.
- Permitting issues.

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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 potentially be economically produced domestically using U.S. metallurgical coals at a level competitive with low cost coke imported from foreign countries that are not subjected to U.S. environmental standards.
- Phase II-- Scale-up of coking reactor to full size Commercial Demonstration Unit (CDU) in support of first commercial facility.
- Phase III-- Construction and operation of first commercial facility.
- Phase IV-- Making use of the Calderon technology for its application to make additional iron units.
- Phase V-- Aggressive worldwide commercialization of the Calderon technology to attain a sizeable market share by producing a premium product at a competitive price.

Accomplishments and Discussion

Bethlehem Steel's Withdrawal and Efforts Expended to Substitute U.S. Steel for Bethlehem

As reported in the several previous reports, the members of the team for this project were Bethlehem Steel representing the steel industry, Bechtel representing the constructor

and Calderon representing the prime mover of the project and the provider of the technology.

On July 17, 2000, Bethlehem Steel wrote a letter of withdrawal from the project to Congressman Regula, Chairman of the House Appropriations Subcommittee for Interior and Related Agencies (see letter attached). The reason for such withdrawal was commercial and did not signify a change in Bethlehem's assessment of the Calderon Cokemaking Process. Bethlehem stated in its letter that it continued to believe that the Calderon Process could provide a much needed method of producing low cost and high quality blast furnace coke; further, the letter encouraged the Subcommittee and the Department of Energy to continue their support of this project as it undergoes restructuring and the sourcing of other private sector funds.

Since having a steel company involved in the project is of great importance, Calderon without delay opened a dialogue with U.S. Steel with the intention of having Bethlehem replaced by U.S. Steel; Calderon apprised NETL of this development. U.S. Steel has excess cokemaking capacity in Clairton, PA, and is selling coke to others. However, in view of U.S. Steel's 1997 support of the successful work done at Alliance to make high quality coke, U.S. Steel agreed to consider the application of the Calderon Process to make coal based directly reduced iron (DRI) in the same reactor as that used for coke. U.S. Steel Research felt that the Calderon technology may produce DRI more efficiently than the DRI produced in a Rotary Hearth furnace which is coal based.

Assessment Work Performed with U.S. Steel

U.S. Steel Research decided that before recommending the teaming with Calderon to upper management that an assessment be made in-house to ascertain whether or not the

Calderon Process has the potential of being economically competitive. Such an assessment was made to produce DRI commercially at a large enough capacity that will make 1.2 million tons of hot metal/year. The assessment concluded that the Calderon Process will have a capital cost of \$90 million against a capital cost of \$195 million for the Rotary Hearth. With respect to operating cost, the Calderon Process will produce DRI for \$63.24/ton against \$80.70/ton with a credit of \$10 for steam for the Rotary Hearth (see report attached). The Calderon process may also have a steam credit, but this issue was not covered in the economic assessment.

U.S. Steel Research decided to recommend to its Vice President of Technology, to support the Calderon Technology to the extent of refurbishing Calderon's pilot facility in Alliance, Ohio, and conduct a series of tests on condition that certain issues relating to material selection and heat input capacity be addressed. A letter from U.S. Steel would be forthcoming after Labor Day. Once such tests are determined to be successful the next step would be to proceed with the construction and operation of a full size commercial reactor.

Addressing Material Selection and Heat Input Capacity to Increase Heat Input into Reactor

The material selection will be addressed by a study made by a German company which has extensive expertise in heating coal. The heat input into the reactor has been initiated by building a model to study the behavior of material at the discharge end of the reactor to increase heat input to the reactor. (See photograph 1 attached).

Construction of Two Full Size Courses of Tiles to Verify Manufacture and Fit

Another area where progress was made during the quarter is in the manufacture of the SiC tiles; two courses were completed (see photograph 2 attached). The third course which consists of the plenum tiles will be completed during the next quarter. A problem was discovered in flue mating with the transition tiles. Changes are being made to the molds to overcome the problem.

Making Available Equipment to Test Carbon Deposition on Sorbent

With respect to the deposition of carbon on the sorbent in the hot gas cleanup, in the event that the hydrocarbons in the volatile matter are pre-cracked within the reactor and the raw gas not having a sufficiency of hydrocarbons for carbon deposition, the following arrangement is now in place which consists of a diesel engine, a bed of sorbent, a drum with diesel fuel and ancillary equipment including a burner to heat the sorbent. The plan is to inject excess diesel fuel (hydrocarbon) into the flue gas from the diesel engine and such flue gas will be fed through the hot sorbent to demonstrate that carbon can be deposited on the sorbent (see photograph 3 of arrangement). Testing will commence after completion of instrumentation and test plan.

Permitting Issues

The permit for the installation of the full size reactor at LTV was not received during the quarter. There are still some minor issues raised by the City of Cleveland's Environmental Division, the local permitting authority which serves as a contractor to Ohio EPA, surrounding the storage and handling of limestone and related particulate emissions control measures. The information most recently requested by the City of Cleveland includes

the size of the limestone sorbent to be used; whether the limestone is in pebble or powder form; moisture maintenance in the limestone to avoid dust; water addition; limestone handling control measures; and how control-scooping and control-dumping of limestone is achieved, and does each function need an emission control measure. These issues will be taken up with the City of Cleveland, Department of Public Health, as agent for Ohio EPA.

At the request of LTV Steel, Calderon applied for on June 8, 2000, and received on July 27, 2000, a guidance letter from U.S.EPA Region 5 (see attached), confirming U.S.EPA's concurrence that the full-size reactor is a separate source of air emissions from LTV Steel's Cleveland Works. U.S.EPA Region 5 also expressed that it looked forward to working with the Ohio Environmental Protection Agency to ensure that Calderon receives any necessary permits and that it anticipated environmentally beneficial results from Calderon's process. Calderon understands that the project and letters received reviews within both Region 5 and the Office of Air and Radiation, in Washington, D.C., prior to the agency's release of its July 27, 2000 guidance letter.

Conclusion

During the coming quarter, it is planned to continue working with U.S. Steel with the goal of U.S. Steel becoming part of the team for the project. Once U.S. Steel joins the team, a revised Statement of Work will be prepared and presented to NETL for approval and work will begin consistent with the revised Statement of Work. Issues regarding the issuance of a Permit will continue to be addressed.

Submitted by:

Albert Calderon
Project Director

Bethlehem Steel Corporation

HOMER RESEARCH LABORATORIES
BETHLEHEM, PA 18016-7699

J. M. CHILTON
Director of Research

Phone: (610) 694-3320
Fax: (610) 694-1739
E-Mail: rjmch@bsco.com

July 17, 2000

Ref: 100-2411

Honorable Ralph Regula
Member of Congress
Chairman, House Appropriations Subcommittee
For Interior and Related Agencies
Washington, DC

Dear Congressman Regula:

We wish to advise you that Bethlehem Steel has decided to withdraw from making an investment in Calderon Coke and the demonstration of the Calderon Process for Metallurgical Cokemaking. We reached this decision very reluctantly and after several months of negotiations concerning commercial joint venture terms with the other proposed members of the venture, Bechtel Corporation and Calderon Energy.

We want you and your subcommittee to know that our withdrawal does not signify a change in our technical assessment of the Calderon Cokemaking Process. We continue to believe that the Calderon Process could provide a much needed method of producing a low cost and high quality blast furnace coke.

We encourage the Subcommittee and the Department of Energy to continue their support of this project as it undergoes restructuring and the sourcing of other private sector funds.

Sincerely,

John M. Chilton

bcc: MJRoberts
RWBouman
JLLazar

Calderon Ironmaking Project *

1. Technology

- Proposed Concept has Foundation in Recently Tested Cokemaking Technology
- USS Tests on Demonstration Unit at Alliance
- DOE Funding for Commercial Demonstration Approved

2. Technical Issues

- Heat Transfer Mechanism
- Operating Problems: Flow of materials, pushing operation
- Degree of Metallization
- Specific Productivity
- Product Physical Characteristics: Size, Strength, Density
- Hot Transport to Melting Unit
- Other : Materials of Construction, Ability to use reverts as feed, Collection of Zn and lead in off-gas

3. Cost Competitiveness with RHF Process

- Lower Capital Costs
 - No Agglomeration Equipment Required
 - Tube Reactor vs. RHF
- Lower Operating Cost
 - No agglomeration of feed
 - Coal is the main fuel compared to natural gas for RHF
 - No possibility of reoxidation because the atmosphere in the reactor is reducing
 - Higher productivity compared to RHF?
 - Less manpower for operation?

4. First Phase Test Objectives

- Prove feasibility of the process (Does it work and to what degree?)
- Operating Problems: Flow of materials, pushing operation
- Operating Characteristics: Temperature, Pressure, Time, Gas Flow Rate, Composition
- Product Characteristics: Degree of Metallization, Chemistry (Gangue, Zn, S, etc.)
Size, Strength

5. Second Phase Test Objectives

- Sensitivity to Various Feed and Reductant Materials (Chemistry, Size, Mineralogy, etc.), Productivity Issues
- Product Characteristics: Metallization, Chemistry, Size, Strength
- Various Concentrates: Minntac, IOC
- Reverts: Blast Furnace and Steelmaking dusts and sludges
- Various Reductants: Coals of different VM
- Miscellaneous: Tires, Plastics
- Process Optimization

* This report was prepared by U.S. Steel Research

Calderon Ironmaking Proposal : Capital Cost

Design Basis	
Feed and Reductant	All purchased ore and coal Ore @ 63% Fe, Coal <30% VM 750 TPD Ore and 250 TPD Coal per Reactor
DRI Product	700 TPD per Reactor Fe (t) 67.5%, 90% Metallization
Hot Metal	500 TPD per Reactor
Design Capacity	1.2 MM TPY Hot Metal
Hours/Year	7885 (90% Availability)
Number of Reactors Required	Annual Production per Reactor: 164,250 TPY Reactors Required : 7.3 (Assume 8)
Capital Cost Estimate	Per Correspondence from Al Calderon **Cost of 4 Reactors: \$18.65 (Assumes 15% discount for multiple reactors) **Cost of Gas Handling Equipment for 4 Reactors: \$4.6 MM (Assumes one gas handling unit per two reactors, cost increase of only 20% assumed from single reactor gas cleaning system)
8 Reactors	\$ 37.3 MM
Hot Gas Treatment	\$ 9.2 MM
Miscellaneous Costs (Piping, Electrical, Construction, Instrumentation, Civil Work, etc.)	\$ 24.7 MM
Ancillary Equipment (Cranes, Lining Towers, Utilities, Spares, etc.)	\$ 4.6 MM
Engineering, Procurement, Construction Services @ 4%	\$ 2.3 MM
Contingency @ 10%	\$ 7.8 MM
Royalty Fees @ 5%	\$ 4.3 MM
Total Estimated Capital	\$ 90.2 MM

Notes

- ... Cost estimates scaled-up from the single demonstration reactor.
- ... *The above costs include reactor and gas handling only.*
- ... Heated area per reactor: 1991 sq. feet, for 8 reactors : 15,928 sq. feet

Capital Costs: RHF vs. Calderon Ironmaking

RHF Process	
Design Basis	
Feed	QCM Concentrate and coal with 75% Fixed Carbon
DRI Product	1.5 MM NTPY (Estimated 1.25 Tons DRI/Ton Hot Metal)
Hot Metal	1.2 MM NTPY
Hours/Year	7500
Rotary Hearth Furnaces	2 Furnaces, 2000 to 2400 F Operating Temperature, Residence Time: 15-20 minutes, Offgas Temp.: 2000 F
Capital Cost Estimate	Estimated from Published Work and Private Communications Applicable to Brown Field Site with Use of Some Existing Facilities
RHF Area Equipment, Freight, and Construction	\$ 105.2 MM
Cold Briquetting Equipment, Freight, and Construction	\$ 39.6 MM
Gas Handling	\$ 10.0 MM
Raw Materials Handling Equipment and Construction	\$ 12.0 MM
Field Services, Construction, Management	\$ 28.4 MM
Total Estimated Capital	\$ 195.2 MM
Calderon Process	
Design Basis	
Feed	QCM Concentrate and Coal with <30% VM 750 TPD Ore and 250 TPD Coal per Reactor
DRI Product	700 TPD per Reactor Fe (t) 67.5%, 90% Metallization
Design Capacity	1.2 MM TPY Hot Metal, 500 TPD per Reactor
Hours/Year	7885 (90% Availability)
Reactors Required	Annual Production per Reactor: 164,250 TPY Reactors Required : 7.3 (Assume 8)
Capital Cost Estimate (Reactor and Gas Handling Only)	Per Correspondence from Al Calderon **Cost of 4 Reactors: \$18.65 (Scaled-up from the demonstration unit. Assumed 15% discount for multiple reactors) **Cost of Gas Handling Equipment for 4 Reactors: \$4.6 MM (Assumes one gas handling unit per two reactors, cost increase of only 20% assumed from single reactor gas cleaning system)
8 Reactors	\$ 37.3 MM
Hot Gas Treatment	\$ 9.2 MM
Miscellaneous Costs (Piping, Electrical, Construction, Instrumentation, Civil Work, etc.)	\$ 24.7 MM
Ancillary Equipment (Cranes, Lining Towers, Utilities, Spares, etc.)	\$ 4.6 MM
Engineering, Procurement, Construction Services @ 4%	\$ 2.3 MM
Contingency @ 10%	\$ 7.8 MM
Royalty Fees @ 5%	\$ 4.3 MM
Total Estimated Capital	\$ 90.2 MM

Operating Cost Comparison: Calderon vs. RHF

Operating Cost Estimate	Unit/Unit DRI	Cost/Unit	Cost/Ton DRI	Total
Calderon Process				
Raw Materials				
Ore Concentrate, Ton	1.50	\$25.90	\$ 38.85	
Coal, Ton	0.50	\$40	\$ 20.00	
Total RM Cost				\$ 58.85
Conversion Cost				\$ 10.24
Total Cost				\$ 63.24
RHF Based Process				
Raw Materials				
Ore Concentrate, Ton	1.33	\$25.90	\$34.45	
Coal, Ton	0.38	\$48.18	\$18.30	
Binder, \$			\$ 4.00	
Total RM Cost				\$56.75
Natural Gas, MMBtu	2.5	\$3.0	\$ 7.50	
Electricity, kWh	80	0.035	\$ 2.80	
Total Utilities				\$10.30
Maintenance & Spares				\$ 3.85
Labor				\$ 6.80
GS&A				\$ 3.00
Total				\$80.70

- ... Conversion cost details of Calderon not available
- ... Consumption and cost data mostly from Direct Reduced Iron (Feinman and Mac Rae)
- ... Maintenance and Spares estimate 3% of \$/installed annual ton
- ... Labor 0.2-0.4 mh/mt @ \$25/mh
- ... Overhead costs (GS&A) \$3-5/mt
- ... Steam credits not included in RHF analysis. Estimated at \$10/ton in Chicago area.

Photograph 1

Photograph 2

Photograph 3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

JUL 27 2000

REPLY TO THE ATTENTION OF:
(AR-18J)

Albert Calderon, President
Calderon Energy Company of Bowling Green
P.O. Box 126
Bowling Green, Ohio 43402

Dear Mr. Calderon:

We have received your letter and enclosure dated June 8, 2000, regarding your request for a separate source determination for your proposed research and development facility, Calderon Coke LLC (Calderon). You propose to construct and operate Calderon on property leased from LTV Steel (LTV). Calderon, which will be researching and developing a novel cokemaking process, shares the same Standard Industrial Classification (SIC) code with LTV.

40 C.F.R. § 52.21(b) (5) and (6) defines a stationary source as "all of the pollutant emitting activities which belong to the same industrial grouping, are located on one or more contiguous or adjacent properties, and are under the control of the same person (or persons under common control)...." Pollutant-emitting activities are part of the same industrial grouping if the first two digits of their SIC codes are the same. 40 C.F.R. § 52.21(b) (6).

From our review of your June 8, 2000, correspondence, it appears that there is no evidence of common control between Calderon and LTV. As noted above, common control is necessary to a finding that adjacent facilities with the same SIC code constitute a single source. Therefore, it does not appear, based on the information presented, that Calderon and LTV are a single source for purposes of applicability of new source review requirements. However, because we have only limited information, this document constitutes guidance rather than a formal applicability determination.

We look forward to working with the Ohio Environmental Protection Agency to ensure that Calderon receives any necessary permits and anticipate environmentally beneficial results from Calderon's

novel cokemaking process. If we can answer any questions regarding this matter, please contact Steve Gorg, of my staff, at (312) 353-4145.

Sincerely yours,

A handwritten signature in cursive script that reads "Pamela Blakley". The signature is written in dark ink and is positioned above the typed name and title.

Pamela Blakley, Chief
Permits and Grants Section (IL/IN/OH)

cc: Mike Hopkins, OEPA