LRC-J-4

CARBONTEC CORPORATION
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March 1, 1988

Chairman
North Dakota Industrial Commission
State Capitol Building
Bismarck, ND 58505

Mr. John Dwyer, President
North Dakota Lignite Council
400 N Bdwy
Bismarck, ND 58501

Gentlemen:

Enclosed is our application for research and development plans for proposed work which the objective is to enhance the utilization of North Dakota lignite. Our proposal "Utilization of the Carbondry Coal Drying Process for the Production of Enriched High BTU, 2 x 0 Inch Shippable Coal from North Dakota Lignite" is enclosed. The total amount of the project is $100,000, and the amount of our request is $50,000.

This letter will advise you that Carbontec Corporation is the submitting organization, and hereby commits the organization to the execution and completion of the project providing approval is obtained by the Industrial Commission, State of North Dakota, pursuant to recommemdations submitted by the North Dakota Lignite Research Council.

Yours very truly,

CARBONTEC CORPORATION

John J. Simmons
President

A F F I D A V I T

State of North Dakota)
) ss
County of Burleigh)

The undersigned, being first duly sworn on his oath deposes and says:

That he is the President of Carbontec Corporation, and that Carbontec Corporation has no outstanding tax liability owed to the State of North Dakota or any other government entity within the State of North Dakota.

Further affient sayeth not.

Dated at Bismarck, North Dakota, this 1st day of March, 1988.

John J. Simmons, President
Carbontec Corporation

Subscribed and sworn to before me this 1st day of March, 1988.

Debbie Kasowski
Notary

My commission expires: 4/22/89

Utilization of The Carbondry Coal Drying Process For the Production of Enriched High BTU 2 x 0 inch Shippable Coal From North Dakota Lignite

by

John J. Simmons
Carbontec Corporation
Bismarck, North Dakota

March 1, 1988

Amount of Project - $100,000
Amount of Request - $ 50,000

SUMMARY

A. PROJECT OBJECTIVE

Carbontec Corporation shall investigate the potential to produce 2 x 0 inch, high BTU, shippable coal from mine-run North Dakota lignite coal, using a unique chemical drying process, called the Carbondry Process. This effort will be directed towards obtaining a dried lignite coal, containing more than 10,000 BTU/lb., from mine-run 6,000-6,500 BTU/lb. raw lignite coal. This dried coal could be shipped in open top railroad cars to utilities and industrial users without the severe penalties incurred when shipping high moisture coal. The availability of high BTU coal prepared from low cost North Dakota lignite could provide a competitive fuel, thereby increasing employment opportunities, and providing a broader North Dakota state tax base.

Considerable research has been previously carried out to develop a shippable, dried North Dakota lignite coal, with little success to date. Major problems difficult to overcome have been prevention of spontaneous combustion and reabsorption of moisture. The Carbondry Process shows considerable promise in overcoming these problems. Preliminary tests on North Dakota lignite by Carbontec produced a high 10,000+ BTU dried product. The project objective will be to study process variables, provide additional data, and define optimal conditions to facilitate a full scale continuous pilot plant test program.

Previous test work by the company also indicates a potential to reduce sodium, a detrimental element in the ash of lignite. The removal of even a small amount of sodium would be beneficial. This program will investigate and test this sodium reduction potential from several North Dakota lignite mines.

B. EXPECTED RESULTS:

The program is expected to produce lignite coal with BTU content in excess of 10,000 BTU's and a moisture content of less than 15% at a competitive cost. A reduction of 10% or more in sodium content is expected.

C. TIME PERIOD:

The program will start within 30 days of the notification to proceed and will be completed within 12 months.

D. TOTAL PROJECT COST: $100,000 **Amount of Request:** $50,000

E. MAJOR PARTICIPANTS:

1. John J. Simmons
2. Donald Samples
3. Daniel Urich
4. Steve Simmons

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OBJECTIVES

Carbontec Corporation shall investigate the production of high BTU 2 x 0 inch shippable coal from crushed mine-run North Dakota raw lignite coal, using a unique chemical drying process, called the Carbondry process. The effort is directed towards defining optimal conditions for obtaining a dried lignite coal, containing more than 10,000 BTU/lb., utilizing mine-run 6,000-6,500 BTU/lb. raw lignite coal. The objective is to obtain a high BTU, low moisture, relatively coarse coal which can be shipped in open top rail cars to utilities and industrial users without the severe penalties incurred by shipping high moisture coal. The availability of high BTU coal prepared from low cost North Dakota lignite could provide a competitive fuel with increased employment opportunities, larger coal company shipments and profits, and a broader North Dakota state tax base. Although considerable research and development has been carried out in the past to develop a shippable, dried North Dakota lignite coal, little success, to date, has been obtained. This is evident by the fact that there are no commercial lignite coal drying plants in operation. Two major problems in drying lignite have been very difficult to overcome; namely spontaneous combustion and reabsorption of moisture. An inherent feature of the Carbondry Process shows considerable promise in overcoming both of these problems. Coal from several North Dakota lignite mines will be tested in this process, which is described in U.S. Patent No.

4,750,533, dated November 10, 1987, "Utilization of Low Ranked Coal and Peat", granted to John J. Simmons. Improvements in the procedures and process discovered by John J. Simmons and Carbontec Corporation since the April 4, 1986, filing date of the patent will also be investigated.

The objective of this program will be to outline the basic operating parameters to produce dried lignite coal with a minimum energy content of 10,000 BTU/lb. The Carbondry Process involves a liquid to solid heat transfer system, and drying effectiveness and time required for moisture removal is based on a particle size and the time/temperature relationship between solid lignite coal and hot liquid chemicals. The coarser 2 x 1 inch coal fraction requires more drying time than the 1 x 3/8 inch fraction. Drying time can generally be decreased by increasing the temperature of the drying medium; the optimum temperature varying to some degree with the type of coal. This program will define the optimum drying parameters for individual coal types and sizes, based on this drying time/temperature relationship. This data is necessary to provide engineering data to further evaluate the commercial economics of the process and provide information for future pilot plant tests. Previous test work by the company indicates that in addition to obtaining a dried high BTU product, some reduction in the sodium content of the ash in the final dried product might be accomplished. Since sodium is a particular detrimental element present in all North Dakota lignite, the removal of even a small portion of sodium

would be beneficial. This research program will test the potential to reduce sodium in both high and medium sodium bearing North Dakota lignite coals.

BACKGROUND

Vast quantities of low and medium sulfur, low rank lignite coal are located in North Dakota. These large reserves are located near the surface and can be strip mined at a cost of between $.45-$.75/MM BTU, which is an extremely low and favorable cost for the production of fossil fuel.

These low mining costs could provide large tonnages of a very competitive coal fuel to the multi-million ton utility and industrial market if a satisfactory high BTU fuel can be obtained. This fuel would be substantially lower in sulfur content than the medium and high sulfur midwestern coals currently being burned.

The activities of Carbontec's personnel to develop a viable process to dry lignite coal to produce shippable products goes back about 12 years. This earlier work was not successful, and paralleled similar coal drying test work by several other firms and governmental agencies, including Commonwealth Edison, American Machine & Foundry, Allis Chalmers, The US Bureau of Mines, Texas A & M, and the University of North Dakota. The combined lack of success is evident by the fact that there are no commercial drying plants in North Dakota or any of the other

western states, even though more than 240 million tons of high moisture, low sulfur coal are currently being mined and shipped from the states of North Dakota, Wyoming, Montana, Colorado, New Mexico, and Texas. Only a small portion of the total tonnage of the lignite coal produced in North Dakota is shipped to out-of-state utilities (Ottertail, Fergus Falls, Minnesota, and Big Stone Lake, South Dakota), with the majority being consumed at mine mouth power plants. The high moisture and low BTU content of lignite precludes shipment to distant markets. The sugar beet plants located in North Dakota and Minnesota, from Drayton to Moorhead to Wahpeton, previously were substantial users of North Dakota lignite coal. Much of this market is now being served by coal producers from Montana and Wyoming, who can offer a higher BTU, low moisture coal, assaying from 8,300-9,400 BTU and from 24-28% moisture. A dried North Dakota lignite coal containing 10,000+ BTU and less than 15% moisture could be in a position to recapture this market, as well as to serve additional markets further to the east in Minnesota, Michigan, and Wisconsin.

Large and small utilities and industrial furnaces currently consume tens of millions of tons of low sulfur Western coal which they blend with high sulfur Midwestern coal. If a suitable high BTU, low cost, shippable fuel can be produced from North Dakota lignite at costs lower than is now available with the present technology, the benefits to the producers, users, and the State of North Dakota, could be substantial.

The unique Carbondry chemical drying process, developed by John J. Simmons and Carbontec Corporation, provides a fast, economical, and safe method of drying lignite coal. This hot chemical drying process is carried out in mild steel drying vessels, at moderate temperatures (300-325 Degrees Fahrenheit) and atmospheric pressure; therefore, the system does not require complicated, expensive, high temperature, high-pressure units, which usually result in substantially higher capital and operating costs. Preliminary results obtained by the Company indicate that North Dakota coal can provide a high energy, useable fuel at reasonable capital and operating costs. The results obtained in the research and development program suggested under this proposal will add to the base information necessary to the successful operation of a larger scale drying program in a continuous pilot plant.

RESEARCH PROGRAM GOALS

The proposal will conduct research to study the process variables and provide additional data that will help to determine the potential of producing high energy, stable, coal fuel from North Dakota lignite.

Previous testing of lignite with the "Carbondry Coal Drying Process," has produced low moisture (2.0-15%), high energy, dried coal fuel products containing from 9,500-11,000 BTU/lb. from crushed, mine-run lignite coal. This program will add to

the base of information now available, and zero in on such operating parameters as the time/temperature requirements for specific coal sizes; information that is essential for the next phase - the drying of large tonnages of lignite in a pilot plant. Previous test work has also indicated the potential to reduce the sodium content of lignite ash. This program will further study this potential product improvement, since a lower sodium lignite would be more acceptable to the utilities and easier to market. Several electric utilities and industrial plants, including Northern States Power Company, Ottertail Power Company, and Blandin Paper Company have expressed an interest in testing this fuel once it becomes available.

THE CARBONDRY COAL DRYING PROCESS

Essentially, the process consists of crushing the lignite coal to a size of 2 x 0 inches, screening the crushed coal into three sizes, 2 x 1 inch, 1 x 3/8 inch, and 3/8 x 0 inch, and conveying each size to a separate, specifically designed, dryer units. A blend of oil-based chemicals, the liquid oil-chemical medium, is pumped to the drying units at a temperature that can be varied between 300-350 Degrees Fahrenheit. The moisture is released from the coal and discharged as steam. In a commercial unit, the coal will move continuously through the drying unit with the process time controlled to produce a dried product of uniformly low moisture content. The dried product is discharged

to a shaking screen, which removes the surface chemical, and then proceeds to a secondary drying unit, where additional heat is added. The secondary drying unit removes a portion of the drying chemical, plus some additional moisture. The drying chemical released is recovered and recycled. The process is controlled to retain a small amount of the drying chemical on, and within, the coal. This provides protection, both to the surface and within the coal, to prevent moisture reabsorption and spontaneous combustion. The dried coal product is a 2 x 0 inch product that could be shipped in open-top rail cars.

PREVIOUS WORK

Lignite coal samples have been submitted to Carbontec by mine operators, utility users, or in some instances, obtained by Carbontec's personnel. Lignite from mines in the Beulah, Center, and Gascoyne Districts has been tested and dried on a preliminary basis with encouraging results. A summary of the test results conducted on three of these coals are as follows:

Table 1.

North Dakota Lignite

Carbondry Test Results

	Raw Coal		Carbondry Coal	
Mine	Moist	BTU/lb.	Moist	BTU/lb.
Beulah District	34.00	7270	11.50	10490
Gascoyne District	42.00	6110	10.20	10060
Center District	35.50	6620	9.10	10155

Table 2.

Sodium Reduction Tests - North Dakota Lignite Coal

Coal Source: Beulah

Coal Type: Lignite

Test Sample: 2 x 3/8, CD 5/0

Product	Moist	BTU/lb	MM BTU/ Ton	% Ash	% Na_2O	lbs/MM BTU Ash	lbs/MM BTU Na_2O
Raw Coal	35.98	7424	14.8	4.50	13.6	6.1	0.83
Carbondry Coal	13.54	10370	20.7	6.16	11.8	6.0	0.70

Moisture Reduction: -72.2%
BTU Increase: +39.7%
Sodium Decrease: -15.7%

PRELIMINARY ENGINEERING AND DESIGN WORK

An evaluation had been prepared on coal from another state to show that the Carbondry Process can produce dried coal on a continuous basis at reasonable costs. As a part of this study, former engineers of Davy McKee Company prepared general arrangement drawings and cost estimates for a 1 million TPY coal drying plant. A similar plant could be designed for North Dakota lignite, once more definitive data from both additional research and pilot plant operation is available. Since the process operates at atmospheric pressure and moderate temperatures, expensive drying apparatus and costly materials are not required. With the exception of a specially designed Carbondry Coal Drying unit, a typical plant, as mentioned above, would use off-the-

shelf items such as conveyors, screens, pumps, centrifuges, and coolers. Carbontec has performed its own energy balances, but as a matter of providing an outside source for confirmation, the M. A. Hanna Research Company was hired to prepare an energy balance of the Carbondry Coal Drying Process. Their report was satisfactory, and confirmed the high efficiency of this liquid solid heat transfer system. The Hanna reports concluded that only 1,760 BTU of energy per lb. water removed was required. Heat for a commercial plant would be supplied by burning screen fines, -1/4 x 0 inch coal. Since the drying plant would be located at the mine, this coal represents a cheap source of drying fuel.

METHODS - SCOPE OF WORK

1.1 Obtain large bulk samples of North Dakota lignite from three open pit mines located in the Beulah, Center, and Gascoyne mining districts. Crushing, screening, and sampling of the raw coal products, preparation of sized feed for the drying process.

1.2 Dry each size and each lignite mine type separately in a chemical at several controlled temperatures ranging from 250-350 Degrees Fahrenheit. Adjust the chemical medium according to Carbontec's proprietary data base to arrive at three separate drying mediums. Vary the residence time of each size product at each temperature to obtain the optimum

time/temperature relationship. After a preliminary review and screening program, determine on the basis of product results, which test series should be subjected to the Stage II drying process. Conduct Stage II drying on a pre-selected group for each mine source. Analyze the products to determine the moisture and BTU content of the general test series, with ash, sodium, and sulfur assayed from certain selected group series. Based on information obtained, prepare selected dried coal samples for wet scrubbing tests to determine if additional sodium can be removed.

1.3 Preliminary engineering and economic analyses based on the results of 1 and 2.

1.4 Final report preparation.

TIMETABLE - PERFORMANCE SCHEDULE

Task 1.1 Completed 1 1/2 months after start of program.

Task 1.2 Completed 10 months after start of program.

Task 1.3 Completed 11 months after start of program.

Task 1.4 Completed 12 months after start of program.

DELIVERY OF PRODUCTS

Carbontec shall provide a final report containing data from the experiments performed according to the Task 1.2, along with

preliminary engineering, economic analysis, and conclusions based on this data, according to Task 1.3.

PERSONNEL

1. John J. Simmons - Mr. Simmons (age 56), President of Carbontec Corporation, has more than 20 years of high level managerial experience, much of which has been in coal and energy related business. He has worked directly with Lurgi Gesellschaft, Frankfurt, Germany, in earlier low temperature lignite coal carbonization developments, and more recently, was responsible for the "Carbondry Process", a proprietary lignite and sub-bituminous coal drying process. PReviously managerial responsibilities included direct supervision over some 300 engineers, superintendents, and other employees of major projects. His management, financial, and technical experience is of importance not only in the direct operation of the Carbondry process, but also in implementing new developments that could increase total overall value of future production.

2. Donald Samples - Mr. Samples (age 50) is a former Vice President of Operations Support and Engineering of Peabody Coal Mining Company, the largest coal mining company in the United States, with coal sales in excess of 80 million tons annually, and annual revenues of $1.4 billion. Mr. Samples, a recognized leader in the coal industry, had been with the

Peabody organization for more than 20 years. His executive responsibilities included all aspects of developing new mines and plants for Peabody Coal Company. He routinely handled several projects, many with budgets of from $82,000,000 to $120,000,000 per year. His responsibilities also included financial evaluation of projects and acquisitions, contract negotiations and administration, as well as both short range and strategic planning of operations.

3. Daniel Urich - Mr. Urich (age 56) has developed successful hands-on experience with several major US corporations. He is the former General Manager of Eveleth Taconite Company, a Minnesota iron ore pellet production company, owned in part by the Ford Motor Company. Mr. Urich was responsible for the entire operation sales and profitability of the plant, which had annual sales in excess of $300,000,000. As former Vice President of A. Matthews Engineering Company, he brings considerable direct upper management engineering expertise to the company. Mr. Urich's career has involved him at various middle and upper management levels of the iron and steel industry. He was involved in the early development of Carbontec's proprietary coal drying process. Mr. Urich is in charge of Carbontec's Research and Development laboratory and pilot plant construction at Bismarck.

4. Steve Simmons - Mr. Simmons (age 27), attended Bismarck State College for one year. Mr. Simmons has worked on

engineering field projects and in the process and analytic laboratories of both Minnesota Valley Testing Laboratory and Carbontec Corporation. Previous experience includes work as a field technician for Western Geophysical Company in Wyoming, Utah, and Mexico. Previous experience includes laboratory reearch and development on the initial development on the initial development and testing parameters of the Carbondry Coal Drying Process, the coal-water slurry process, and the Carbontec coal-oil slurry process. He has also served as project coordinator on the Carbontec/Boise Cascade wood chip drying project, at Carbontec's Crosby, Minnesota laboratory.

QUALIFICATION OF APPLICANT

Carbontec Corporation, a North Dakota corporation headquartered at 400 N Broadway, Bismarck, has performed coal drying tests on North Dakota lignite coal and other high moisture sub-bituminous coal, for more than two years. Prior to work by Carbontec Corporation, similar coal drying research and development was carried on by personnel currently working for Carbontec Corporation.

Carbontec Corporation operates a coal drying plant located at 26th Street South and Airway Road, Bismarck, North Dakota, and is currently constructing a Carbondry coal drying pilot/demonstration plant at that location.

MATCHING FUNDS

Carbontec Corporation will furnish matching funds as heretofor described. Carbontec reserves the right to furnish the funds from its own account or from the account of other interested parties. In any event, Carbontec Corporation will be responsible for furnishing matching funds as described above.

FUNDING LEVEL NECESSARY FOR EFFECT.

In the event that less funding is available than requested, the above test program will be reduced in scope and the reduced data obtained will have a negative effect on the total anticipated results.

BUDGET

DIRECT MATERIAL

Laboratory Chemicals, Disposables and Supplies	$ 3,250.00	$ 3,250.00

DIRECT LABOR (Rates incl. payroll taxes and ins.)	Est. Hours	Rate/Hour	Est. Cost	
Senior Personnel				
John Simmons	320			
Donald Samples	60			
Daniel Urich	180			
TOTAL	560	42.00	$23,520.00	
Senior Lab Technicians	1100	18.50	$20,350.00	
Lab Technicians	450	12.50	5,625.00	
Equipment Operator (Sample Program)	80	14.50	1,160.00	
DIRECT LABOR SUB-TOTAL			$50,655.00	
Fringe, overtime, vacation pay @ 15% direct labor			7,600.00	
TOTAL LABOR			$58,255.00	$58,255.00

OUTSIDE SERVICES

Laboratory testing, analytical	$ 6,000.00	
Consultants, other outside services	$ 2,000.00	
TOTAL OUTSIDE SERVICES	$ 8,000.00	$ 8,000.00

EQUIPMENT
(Company owned, leased and rental)

Pickup trucks, 1 ton sample trucks, front-end loader	$ 5,500.00	$ 5,500.00

TRAVEL		
Transportation, air, automobile	$ 3,500.00	
Per Diem	3,500.00	
TOTAL TRAVEL	$ 7,000.00	$ 7,000.00
SUB TOTAL		$82,005.00
General Overhead, Laboratory Rental, Office Rental, Laboratory Equipment and Accounting @ 22%	$17,995.00	
TOTAL PROJECT COST		$100,000.00
AMOUNT OF REQUEST		$ 50,000.00