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A REVIEW OF ERL GASIFICATION RESEARCH AND DEVELOPMENT CONTRACTS

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A REVIEW OF ERL GASIFICATION RESEARCH AND DEVELOPMENT CONTRACTS

by

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ABSTRACT

The performance of five Departmental contracts on the research and development work of coal gasification technology was reviewed. In general, the quality of all these works was satisfactory and they have met most of the objectives set forth in their work statements. All contracts, except the one on small gasifier applications, were given an extension of one or more years for their completion.

The contract on the spouted bed design by the University of British Columbia has potential of becoming a new technology for the gasification of Western Canadian caking coals. The first phase of the Shaunavon coal utilization study by the Saskatchewan Power Corporation was completed, and its future work could lead to the construction of a 300 megawatt power generation plant in the Shaunavon area. In the small gasifier application study, four gasifiers were identified suitable for producing industrial fuel gas from Saskatchewan lignites in small dedicated plants.

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INTRODUCTION

The coal gasification program was started in 1978 with a five year plan to improve the gasification performance of Canadian coals. It was proposed in this plan that this program be carried out in two efforts, which were the in-house effort by the CANMET staff and the external contract effort by the private sector.

The objectives of this program are to provide sufficient background information of the gasification characteristics of Canadian coals. This information is essential for the provision of advice on the selection of advanced gasification technologies for the conversion of coal to electricity in all areas of Canada. Other areas of major importance are the utilization of low or medium BTU gas for process heat, conversion of the product gas into liquid hydrocarbons, and possible application of the gasification process for the extraction and processing of heavy oils.

An outline of the in-house effort has been previously reported (1). The external contract effort has been carried out by both the universities and the private industry with respectively 100% and 50% funding from the Department of Energy, Mines and Resources.

This report summarizes the progress of five contracts in the past two years on the research and development of coal gasification technology. All except one of these contracts have been extended for an additional year. A technical evaluation of each contract is given in this report. It is intended that its publication will provide a quick reference of the CANMET contract work within the Department of Energy, Mines and Resources on the technology of coal gasification.

CONTRACT SUMMARY AND EVALUATION

1. Gasification and Petrographic Studies of Saskatchewan Lignites - Saskatchewan Power Corporation

In 1978 a research contract at a total cost of $58,186.84 was awarded to Saskatchewan Power Corporation by our Department to conduct a study on the reactivity of Saskatchewan lignites as it pertains to their usefulness for gasification. Petrographic study was subcontracted to the University of Regina for a sum of $6,639.29. This work was completed in April 1979 and a final

report was submitted by Saskatchewan Power Corporation with their findings and recommendations.

The objectives of this study were to evaluate the reactivity of Saskatchewan lignite coals as to their usefulness in gasification and to investigate the feasibility of using petrological techniques to assess the suitability of lignites for coal gasification (Appendix 1).

There are two parts in this report. The first part summarizes the gasification study of the Estevan lignite at high and low pressure in the presence of air and steam. The second part reports the microscopical analyses of the Estevan and Shaunavon lignites and compares these findings with the Estevan char residues from the gasification study. This report suggests that petrological analysis and the ratio of its maceral contents, (structured huminite + liptinite) / (unstructured huminite + inert materials), can be used for this assessment. Petrological analysis can also be used for monitoring the reactivity of coal constituents under different gasification conditions.

In general, the quality of this work is above average and is appreciated by investigators in this area. The equipment was well designed and the experiments were carefully planned. Although all the objectives of this study have not been met entirely, it has provided useful information on coal gasification which contributes to our in-house research program. The experimental work is continuing towards a stage where some meaningful numerical correlations can be made between the reactivity and the maceral content of the lignite coal as planned.

It is felt that the results in this report are preliminary and additional work is needed before any conclusions can be made. In order to assess the reactivity of the coal by petrological analysis, one must establish a relationship between the amount of volatile matter evolved from the reactive maceral material (liptinite, structured huminite) and the gasification temperature. Temperature is an important factor because it controls the extent of the gasification and hence the amount of volatiles from the starting material. However, it must be cautioned that although the maceral content and rank can be of value in predicting the reactivity of a new coal, one should not expect much accuracy in this prediction, since the correlations are only approximate, coals are far from uniform even within a given seam.

In summary, the results are well presented, but presentation can be improved with minor editorial changes in the text.

2. Spouted Bed Gasification of Western Canadian Caking Coals - University of British Columbia

In April 1978 a research contract was given to the University of British Columbia by our Department to initiate a program on the investigation of spouted bed as a novel coal gasifier for the treatment of Western Canadian caking coals. This contract was awarded based on development work with a 0.15-m spouted bed gasifier by the staff of the Department of Chemical Engineering of that University. It has been suggested by these workers that the spouted bed has an advantage over the fluidized bed because the former breaks up the agglomerates continuously in the high velocity spout in the absence of a gas-distribution plate where sintering of coal may occur. The duration of this program was 36 months and the work was to be carried out in two phases with the following objectives to:

(1) build a spouted bed gasifier unit of 0.3-m diameter

(2) determine optimum operating conditions for gasification

(3) demonstrate technical feasibility by extended experimental runs

(4) gather data on effects of operating variables necessary for scale up

The first phase was contracted for an amount of $103,928.86 with an objective of designing, constructing, commissioning and debugging a pilot scale spouted bed gasifier as mentioned above. Six preliminary gasification tests on this gasifier were included. A final report was submitted by the University to the Department in June 1979 at the completion of the first phase. The second phase of the work is in progress and will be completed by March 1981.

This report is well written and the figures are self-explanatory. The money is well spent on such a demonstration unit which has a capacity of gasifying coal at a rate of 50 kg per hour. Except for the experimental work specified in Task No. 7, all the tasks identified in the statement of work (Appendix II) have been met and the construction work of the gasifier as a whole is entirely satisfactory. Technical difficulties, such as the feeding problems and insufficient cooling of the gas and the tar, occurred during the initial gasification runs. These problems can be corrected readily with slight modification of the existing system.

At present it is difficult to predict the performance of this type

of gasifier for the utilization of caking coals based on two one-hour experimental runs reported in Table 7. However, it appears that, from the high carbon content (36.1%) in the ash of Run No. 1, the gasification is not fully completed although the average bed temperature is relatively high at 973°C.

It has been suggested by the UBC workers in their original program proposal, that a gasification process depends on several variables such as the bed depth, coal feed rate, proportion of inert solids in the bed, bed temperature, steam/coal ratio, air/coal ratio and coal particle size. All these variables will be investigated in the second phase of the program and optimum operating conditions can be obtained from experimental work in the coming year.

3. Development of a Bench Scale Fluidized Bed Coal Gasifier and Gas Burner System - Carleton University

In April 1978, the Department of Energy, Mines and Resources awarded a research contract to the Mechanical and Aeronautical Engineering Department of Carleton University (Ottawa) for the development and construction of a laboratory scale fluidized bed gasifier. The original contract was for one year but was extended to two years during the course of the program. The cost of the first year contract was $37,148.00 for the development of a bench scale, fluidized bed facility to gasify coal, clean the gases of ash and burn the gaseous products in a gas turbine type combustor. The cost for the second year contract was $45,090.55 for the optimization of the operating conditions for this facility using Canadian sub-bituminous and lignite coals. At the completion of the work for the first year, a final report was submitted by the University to the Department in September 1979. The work for the second year is in progress and will be completed by March 31, 1980.

The report describes the construction and the performance of the laboratory fluidized bed gasifier and gas turbine type combustor for the coal gas. The gasifier comprises a 7 cm internal diameter, 70 cm long fluidizing zone and a 14 cm diameter free board section which is 28 cm in length. This gasifier was designed to have an operating temperature of 900°C and has facilities for the injection of oxygen and steam into the gasification system. Auxiliaries for the gasifier include a coal feeder, two steam heaters, a heat exchanger and a cyclone ash separator. A detailed description of the factors influencing the design of a gasifier of this dimension is given. Preliminary results from the gasification of sub-bituminous coal (Sundance Mine, Alberta)

at 450°C, 500°C, 570°C, 650°C, 700°C, 745°C and 800°C are reported. For gasification conditions near the design specifications (0.25 kg/hr coal, 0.0113 std m^3/hr oxygen, 0.625 std m^3/hr steam) at a bed temperature of 800°C, the gas produced had a composition of 24% CO, 34.8% H_2, 37% CO_2 1% N_2 and 3.2% CH_4 with a heating value of 2000 kcal/std m^3 (~225 BUT/scf). This represents a cold gas efficiency of 67.7%.

The gas turbine type combustor successfully burned simulated coal gas mixture with complete combustion at air/fuel ratios ranging from 2.35 to 7.25 achieving temperatures ranging from 810 to 270°C.

Basically, this project has met most of the objectives outlined in the statement of work (Appendix III). It has provided detailed information on the design parameters for a laboratory fluidized bed gasifier. Although most of the design parameters were obtained from standard textbooks (2), this kind of information should be useful to those workers who are new in this area.

Results of the gas analysis from gasification runs at different bed temperatures in the presence of a mixture of steam and oxygen are also reported. It has been found that at 800°C the gas product has a composition of 24% CO, 34.8% H_2, 37% CO_2, 1% N_2 and 3.2% CH_4 with a heating value of 2000 kcal/standard m^3. This composition seems to be in general agreement with that of a typical gas product from a fluidized bed gasifier (3). However, one must be cautioned that the methods used for gas analysis in this report are not sensitive to hydrogen detection and the results can only be considered as approximate. It is suggested that the major components (CO_2, H_2) of the product gas should be quantified before any meaningful conclusion can be drawn from this study.

4. Small Gasifier Application - Saskatchewan Power Corporation

A contract work entitled "Small Gasifier Application" was commissioned to Saskatchewan Power Corporation by CANMET to perform the following tasks (Appendix IV):

(1) Technical and economical evaluation of four small gasifiers which are under the trade name, Wellman-Galusha, Riley-Morgan, Wilputte and Woodall-Duckham.

(2) Identification and site selection for the installation of the gasifier.

(3) Case studies for two sites.

(4) Environmental and Health considerations.

The contract was financed jointly by the Saskatchewan Power Corporation and

the Department of Energy, Mines and Resources of Canada at a cost of $61,835.63. At the completion of the contract, a final report was submitted by the Saskatchewan Power Corporation to the Department in February, 1979. The site selection work was carried out by Saskatchewan Power Corporation. All other work relating to the technical and economic assessment was performed by the Lummus Company Canada Limited under a contract with the Saskatchewan Power Corporation.

It is concluded in this report that all four gasifiers under investigation are suitable for the production of low or medium heat value industrial fuel gas in the range of 2.11 to 31.65 x 10^{12} J/day using Estevan or Coronach coal as feedstock. Special design is required for the Shaunavon coal because of its high ash and moisture content. The lowest cost industrial fuel gas is hot raw gas obtained with the air-blown Wellman-Galusha gasifiers. Interprovincial Steel and Pipe Corporation Limited (IPSCO) and Inland Cement Industries Limited (ICIL) are the two sites selected as appropriate for utilizing the coal gas at an estimated cost of $\$1.98/_{10^9}J$ and $\$2.10/_{10^9}J$ respectively. The cost estimates are based on established factors used by the Saskatchewan Power Corporation. However, it is found that a significant retrofit cost is required for burning the low heating value gas as opposed to existing natural gas burners.

The hot raw gas systems proposed for the two case studies will meet or exceed the current and projected environmental requirements at the plant locations.

The evaluation work performed by the Lummus Company is quite thorough and provides most of the information as specified in the statement of work. The Wellman-Galusha gasifier is a proper choice since it is both economically and technically superior to the other three gasifiers under consideration. According to the report, the McDowell-Wellman Company is the only North American vendor of small gasifiers that has been able to maintain manufacturing facilities in the last 20 to 25 years. Several of the Wellman-Galusha units are currently operating in the U.S.

It is unfortunate that the Lummus Company made their evaluation based solely on the technical information supplied by the vendor. A 91% hot raw gas efficiency claimed by the company seems to be high and this can be verified by conducting a survey on the performance of the Wellman-Galusha gasifiers at various plants. Other technical information such as the interruption period, operating cost, maintenance requirement, caking and chanelling in the bed, tar condensation in the gas distribution system and the feeding

mechanism can be obtained by visiting the gasification plants. Environmental requirements and safety features can also be investigated during these visits.

After visiting 10 industries, Saskatchewan Power Corporation recommended that the IPSCO and ICIL as suitable sites for the installation of the Wellman-Galusha gasifiers. However, the problems associated with burning low heating value hot raw gas from small fixed bed gasifiers as opposed to natural gas are:

(1) 30 to 35% increase in the volume of the flue gas,

(2) 500 to 600% increase in the volume of fuel gas to the burner,

(3) new type of burner tips are required,

(4) contamination of the direct-fired products.

These problems have been identified and solutions have been recommended by the Lummus Company.

As far as the environmental and health aspects are concerned, this report reiterates that utilization of the low sulfur Estevan and Coronach coal does not seem to present any problems in meeting the current or projected environmental regulations in the province of Saskatchewan.

In summary, this report is well organized with Figures and Tables, and presents all the relevant information except on the item of "overall cycle and plant efficiency" as specified in the case study.

5. The Shaunavon Coal Utilization Study - Saskatchewan Power Corporation

The Shaunavon Coal Utilization Study was initiated by the Saskatchewan Power Corporation (SPC) in 1977 with an objective of constructing a commercial prototype electricity generating plant based on new coal processing technology near the town of Shaunavon. This demonstration plant could have a gross capacity of generating 150 or 300 MW electricity depending on the demand of the area residents by 1988. Commissioning date of the plant is expected to be in 1988/89.

This study consists of five phases with the following commitments by the SPC:

Phase	Description	Date
I	Preliminary Techno-economic assessment of 15 process schemes	Completed March 25, 1978
II	Detailed coal and water survey followed by the detailed techno-economic assessment of the 2 contending process schemes in comparison with the base PF case	Completed March, 1980

Phase	Description	Date
III	Conceptual design or optimization of the One process scheme selected for demonstration and including the detailed environmental impact study	Completed March, 1981
IV	Detailed design and construction of the 150 MWe commercial prototype including the mining operation	Start construction 1982/83
V	Electricity generation - 150 MWe/300 MWe	1988/89

Phase 1 was started in September 1977 and completed in a 3-volume report in March 1978. The cost of this project was $186,343 and shared equally by the SPC and the Department of Energy, Mines and Resources (EMR). Contractors for this Phase of work were Intercontinental Engineering Limited ($98,300), Saskatchewan Research Council ($35,000) and SPC ($53,043).

Volume 2 of the report was a preliminary techno-economic assessment of 15 advanced coal to electricity processes using a conventional pulverized fuel (PF) power plant as a base case for the study. It was concluded that both the Lurgi-Combined Cycle and the Atmospheric Fluidized Bed Combustor (AFBC) technologies were mature enough to be considered for a plant operating in 1988/89, and could provide an alternative to the base case. However, the AFBC process was recommended for further study because it provided a good combination of advanced technology and conventional power generation technology.

Volume 1 compared the AFBC with the base case (PF with SO_2 scrubber) and concluded that the former had an advantage over the latter based on the production cost of energy. The cost of energy in terms of 1988 dollars was 4.65¢/kWh and 4.89¢/kWh for AFBC and the base case respectively.

Volume 3 contained an environmental study conducted for both the AFBC and the base case and a water survey for surface and ground water availability in the plant area. The environmental study showed a net positive socio-economic impact associated with both the plant construction and operation. Gaseous and particulate emissions were estimated to be satisfactory for both the technologies if suitable gas cleaning equipment were used for the base case. There were no adverse effects on ecology. The water survey indicated that surface water was not available in the area. A shallow aquifer was established with a strong possibility of a deeper aquifer of unknown capability.

At its conclusion, the Phase 1 Study recommended to carry out a detailed techno-economic assessment of both the Lurgi and the AFBC technologies,

along with a comprehensive coal drilling, analysis and field water survey. This recommendation will form the work of Phase II of the Shaunavon Coal Utilization Study. In general, the quality of the Phase I work is good and it has met most of its objectives. The work is presented in a 3-volume report, of which volume 2 is the most important. It provides up-to-date information on the development of coal gasification and fluidized bed combustion technologies for power generation. Fifteen advanced power generation cycles are carefully analyzed according to the available data on their process description, development aspect of proposed plant, potential process improvements and performance summary. All these generation cycles are compared in a Table (Table 1-1, Volume 2) as to their efficiency, capital cost, cost of electricity, operating cost and water consumption. Other detailed studies are also provided on the available cooling systems for various generation processes, temperature variations over a period of time in the Shaunavon area and capital and operating costs estimate of a pulverized lignite-fired, air cooled, 300 megawatt unit.

Specifically the 3-volume report of the Phase 1 work is too long and repetitious in some cases. Most of the review materials in section 2 of volume 2 can be found in ordinary textbooks (4) and in the "Studies of Advanced Electric Power Generation Techniques and Coal Gasification" by B.C. Hydro and Power Authority and EMR (5). Hence this section can be shortened considerably and incorporated into section 4 of the same volume without losing much of its effectiveness.

It is however surprising to see that power generation plant with the atmospheric fluidized bed combustion (AFBC) has been recommended in volume I of this report for further study. The AFBC is not a good recommendation since this technology is still at its developmental stage as stated in a letter by one of its manufacturers. At present a 50-megawatt electrical plant retrofited with an atmospheric fluidized bed unit at the Rivesville, West Virginia, station of the Monongahela Power Co. is experiencing serious technical difficulties (6).

Based on those figures in Table 1-1, volume 2, the Lurgi combined cycle scheme appears to be economically attractive when compared to the others. Unless the SPC is dedicated to the application of new technology, the conventional pulverized fuel process should be a logical choice because it can meet the required commissioning date of 1988/89.

Both the Woodall Duckham simple cycle and Koppers-Totzek simple cycle can be eliminated because of their high capital and operating costs. All other second generation technologies such as the General Electric/AFB, Westinghouse/u-Gas and United Technologies can be excluded as they are still at the developmental stage and may not be ready by the scheduled construction date of 1982/83.

CONCLUSIONS

The performance of five departmental contracts on the research and development work of coal gasification technology was reviewed. In general, the quality of all the work reviewed was satisfactory, and met most of the objectives set forth in the work statements.

Contracts on the spouted bed gasification, Shaunavon coal utilization study and small gasifier application may lead to commercial realization of the gasification process identified in these studies.

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5. "Studies of advanced electric power generation techniques and coal gasification based on the use of Hat Creek coal"; A Consultant Report by B.C. Hydro and Power Authority and Department of Energy, Mines and Resources, Volumes 1 to 3; 1976.

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APPENDIX I

Work Statement of Contract "Gasification and Petrographic Studies of Saskatchewan Lignites"

For the year 1978-79 we will guarantee completion of gasification reactions of (i) coal and air, and (ii) coal-air and steam. Modelling of these reactions will also be guaranteed within this time frame. Other reactions mentioned under objective will be looked at only if time is available, if not, then will be studies in 1979-80.

The coal to be studied will be one sample from Coronach for this contract. If time permits, a second sample from Estevan will be studied. For this the data only will be supplied without any modelling.

TASK 1 - Test Runs

The apparatus will undergo test runs to smoothen the operation to identify and eliminate the problem areas in the equipment assembled.

TASK 2 - Coal Analysis

Here the two coal samples will be analyzed for Ultimate and Proximate analysis along with the ash analysis according to ASTM procedures.

TASK 3 - Gasification of Coronach Coal with Air and Air-Steam Mixtures

Here the coals will undergo gasification at five different pressures ranging from 103 kPa to 7 MPa and various temperature and reactant compositions. Pyrolysis of coals will also be done only at 103 kPa at various temperatures. For each run, reaction and product gas analysis will be conducted on a continuing basis from initiation to the end of the run. Analysis of the remaining ash and the condensable liquid products will be done for each run. Infra-red and Nuclear Magnetic Resonance Spectra will be obtained from condensable liquid products in an attempt to identify these products. The quantitative analysis will be by gas chromatography. This work will be conducted at the University of Regina.

If during the course of this work a change in the direction of the work seems necessary, it will take place in consultation and in agreement with the Scientific Authority.

TASK 4 - Modelling

Models for gasification will be developed using the data collected under Task 3.

TASK 5 - Petrographic Studies

1. Conduct a literature search and study regarding lignite petrographical classification and use of petrography in lignite assessment.
2. Consult with prominent workers in lignite petrology and assessment including those at Ottawa, Calgary, Pennsylvania State University, and the University of West Virginia.
3. Prepare and examine samples of lignite with known gasification characteristics and samples of residue from the same gasification tests. It is understood that this is a preliminary study and it is not anticipated that all the tested samples will be examined during this phase of the petrographic studies.

TASK 6 - Report Writing

Presentation of final report - EMR will be supplied with 25 copies plus 15 microfiches. The final report will contain a summary of all the work done, together with the appropriate data, graphs, interpretations and conclusions.

TASK 7 - Presentation

Presentation of a technical paper at the one-day Coal Conversion Seminar.

APPENDIX II

Work statement of Contract "Spouted Bed Gasification of Western Canadian Caking Coals".

Major Tasks:

1. Detailed design of the spouted bed coal gasifier, coal feeding system, cyclones and off-gas cooler-washer.
2. Specification of off-gas incinerator, propane burner, safety controls, instrumention and piping. Procurement of these items.
3. Construction of equipment and supporting structure.
4. Assembly of equipment, instrumentation panel, piping.
5. Initial testing of individual items of equipment, viz. the spouted bed, propane burner, voal feeding system, off-gas cooler-washer and off gas incinerator.

   Calibration of flow meters, coal feeder and control instruments.
6. Commissioning runs including initial cold runs followed by hot runs to test operation of the assembled plant. Making adjustments and modifications where necessary.

   Formulating start-up and shut-down procedures.
7. Six preliminary gasification runs of 12 hours duration to demonstrate operation of the plant, (two runs using Forestburg coal, two runs using Sukunka coal and two runs using Coleman coal). Operating conditions established in the 6 inch diameter unit will be used.
8. Preparation of final report (25 typewritten copies and 15 microfiche copies) to be received by EMR by 31 March 1979. The report will include an account of the work carried out during 1978-79 plus detailed programmed of further work planned for the following year.
9. a) Presentation of technical paper at one day a Coal Conversion Seminar in Ottawa. (allowance $1000.).
   b) To attend a conference on coal (Allowance $1000.).
10. Monthly progress reports will be sent by 10th of each month together with invoices for the previous month. Final invoice will be submitted by March 20, 1979.
11. Equipment details as per attached sheets.

APPENDIX III

Work Statement of Contract "Development of a Bench Scale Fluidized Bed Coal Gasifier and Gas Burner System" - Carleton University.

The overall bench scale system to be developed consists of a fluidized bed gasifier, a gas cleaning apparatus, and a combustor. The system is intended to use coal to generate clean, high temperature exhaust gases suitable for driving a turbine for electrical power generation.

Task 1 Development of the Fluidized Bed Gasifier

The design of the bench scale fluidized bed gasifier is complete and fabrication of the basic unit is proceeding. In this task, construction of the basic unit is completed. Operating conditions will be:

Coal feed rate 0.6 to 1.5 lb/hr.; Oxygen/coal ration .58 lb O_2/lb coal; Steam/coal = 1.5 lb steam/lb coal; Outlet temperature 750-850°C; Operating pressure up to 10 atm.

Task 2 Development of apparatus for the control and metering of coal input

Task 3 Development of apparatus for the control and metering of the air or oxygen as well as steam input

Task 4 Apparatus development for the measurement and monitoring of temperatures at various points in the fluidized bed

Task 5 Development of the gas sampling apparatus for sampling gas at selected points in the fluidized bed

Task 6 Development of apparatus for taking solid samples at selected points in the bed, quenching their reactivity and removing them for analysis

Task 7 Development of apparatus to allow removal of klinker ash during operation

Task 8 Development of apparatus for interfacing with the fly ash separator including char recycling capability

Task 9 Design and fabrication of the fly ash separator

A device will be developed to separate the fly ash before the gas goes on to the combustor. The main component will be a cyclone type separator

Task 10 Test operation of fly ash separator

If the gas leaving the cyclone still contains too much solid matter to be tolerated by a gas turbine, the apparatus will be modified or additional cleaning steps will be built into the system.

Task 11 Design and fabrication of a controlled combustor

Design and fabrication of a combustor using a low heating value gas as fuel will be carried out. The fuel will be introduced at the center of one end of the combustor and combustion air will be added from the sides. The resulting combustor will allow individual metering and control of the relative amounts of air entering at various sections along the combustion zone.

Task 12 Combustor Testing

The combustor will be tested with simulated and actual coal gas to select optimum fuel/air distrubution

Task 13 Design of conventional combustor

A second burner will be disigned and built which will use conventional induced air mixing to accomplish the same optimum burning conditions

Task 14 Assemble Facility

The components developed and tested individually as outlined in the previous tasks will be assembled.

Task 15 Operation of Facility

After assembly of the system is completed, testing as a system will begin using Canadian sub-bituminous and/or lignite coal.

(a) overall performance will be measured

(b) probing of local conditions will be done

This task will be pursued in as much detail as time and funds permit

Task 16 Preparation of a Final Report

The final report will summarize all the work done with appropriate data, calculations and conclusions. EMR will be supplied with 25 copies plus 15 microfische copies of the report.

Task 17 Presentation of a technical paper at the one-day coal conversion seminar. Included in this task will be attendance at Technical meetings.

APPENDIX IV

Work Statement of Contract "Small Gasifier Application".

A. You shall:

1. Evaluate the following gasifiers:
   (i) Wellman Galusha
   (ii) Riley Morgan
   (iii) Wilputte
   (iv) Woodall-Duckham

   The gasifiers will be evaluated for suitability in 2 to 30 x 10^9 BTU/day range utilizing Saskatchewan coals. The coals to be considered would be from Estevan, Coronach and Shaunavon coal fields in Saskatchewan.

2. Carry out technical and economical evaluation of various gasifiers for one specific plant capacity with both air and oxygen injection. The most suitable gasifier will then be dealt with in detail, as outlined below, and project plant capital costs, operating costs, and gas costs will be projected over the entire range of 2 to 30 x 10^9 BTU/day plants. Evaluation will be done for both the oxygen blown and the air blown gasifier. Costs will be given again for both "hot raw gas" as well as "clean cold gas" from this gasifier.

   One of the aims of this study is to compare the medium BTU gas cost from a 30 x 10^9 BTU/day plant with the previous Coronach study.

B. You Shall:

Identify various suitable sites in Saskatchewan for self-supported plants (such as, for example, a 30 x 10^9 BTU/day plant in Coronach) as well as sites where a dedicated small plant can be installed; e.g., the cement plant in Regina. Minimum present consumption of natural gas at the latter sites should not fall below 2 x 10^9 BTU/day.

From the sites identified as above, five most likely ones will be selected on the basis of space abailable for gasification plant installation, nearness to the coal availability, water availability, and waste disposal facilities. At least one of the five sites will be an SPC facility.

Of the five sites selected, two sites will be recommended for further work under case studies. One site again would be an SPC facility.

C. You shall:

1. Carry out case studies for the two sites recommended previously. Plant capacities and load factors will also be specified. It will also be specified at the time whether hot raw gas or cold clean gas is required at these sites as well as whether air and/or oxygen injection is to be considered. The coal at both sites will be identified. For each case, the following details will be calculated.

   - plant size
   - overall cycle and plant efficiency
   - capital and operating costs of the plant
   - main process diagrams
   - energy and material balances
   - equipment, material flowsheets, specifications of equipment
   - technical modifications required for utilizing coal gas and retrofitting costs if at the selected site natural gas is currently used
   - gas costs
   - data supporting the selection of recommended gasifier
   - statement regarding the degree of development and viability of the selected gasification technology

2. Carry out an environmental study for both the sites recommended and previously studied under this contract

   The study will identify pollutant streams from the plant including quantities and flow rates; current and projected legislation will be considered and present day technology to combat the pollution will be discussed along with capital and operating costs. The areas to be covered by the study will include air, land and water.

   In addition to the above, safety aspects and occupational health aspects for workers in the gasification plant and additional safety requirements at the user end will also be discussed and solutions arrived at.