LMFS-6 (RFP-92-6)
LIGNITE ENERGY CONVERSION
TECHNOLOGY STUDY

CONTRACTOR: Bechtel Corporation

PRINCIPAL INVESTIGATOR: Horst Huettenhain
(415) 768-5912

CONTRACT AMOUNT: $90,000

Project Schedule – 3 Months

Contract Date – 8/27/92
Start Date – 8/27/92
Completed – 7/30/93

Project Deliverables

Status Report – 9/30/92 ✔
Monthly Progress Reports ✔
Draft Final Report – 1/93 ✔
Final Report – 7/30/93 ✔

OBJECTIVE / STATEMENT OF WORK

The objective of this study is to evaluate current and emerging national and international lignite coal combustion technologies and determine which technologies could be economically utilized to take advantage of the unique properties of North Dakota lignite and offer a high probability for rapid commercialization. This evaluation:

1) lists the most promising advanced combustion process under development
2) indicates which processes are capable of utilizing lignite,
3) notes any improvements under study,
4) assesses probability of commercialization in five years,
5) makes a preliminary estimate of relative costs with lignite and other coals, and
6) identifies potential improvements.

The contractor obtained process information from developers and determined which technologies were considered viable by the regional (MAPP) utilities. The study produces specific recommendations for testing. Technologies examined included:

- Pulverized coal fired boilers
- Fluidized bed combustion steam cycles
- Coal gasification combined cycles
- Mild Gasification/Topping Cycles
- Fuel Cells
- Novel Combustion Turbine Cycles
- Magnetohydrodynamics Systems

STATUS

Performance and cost analyses were performed for ten coal conversion processes in power generation systems. The results showed the cost of producing electricity, an important measure of utility acceptance, is dominated by the burden of installed capital cost. It was concluded that efforts to improve the cost effective use of North Dakota lignite for power generation should concentrate on capital cost reductions. The cost analyses assumptions included non-site-specific mine mouth plants, no transportation cost, no specific electricity market, and no electricity transmission costs. The ranking of the technologies considered, from lowest to highest electricity production costs, is:[1]

1. Integrated Gasification Compressed Air Storage with Humidification (38.78). IGCASH
2. Integrated Gasification Kalina Cycle (44.52). IG Kalina
3. Integrated Gasification Molten Carbonate Fuel Cell (45.31). IG Fuel Cell
4. Integrated Gasification Magnetohydrodynamic Cycle (46.16). IGMHD
5. Mild Gasification/Pressurized Fluidized Combustion Steam Plant (46.92). MG/PFB
6. Pressurized Fluidized Bed Combustion Steam Plant (49.07). PFB
7. Atmospheric Fluidized Bed Combustion Steam Plant (50.75). AFB
8. Integrated Gasification Combined Cycle (51.17). IGCC
9. Pulverized Coal Steam Plant (51.20). PC
10. Integrated Gasification Steam Injected Gas Turbine (80.08). IG Steam

The first five listed above are emerging technologies. Therefore, uncertainties exist in their project cost estimates.

The reported status of technology development for the power generation systems was:

Pulverized Coal Steam Plants – (rank 9, estimated costs 51.20 mills/kWh) No further developments are necessary to achieve commercial status. Developments of primary concern are reliability and performance improvement, cost reduction and simplification of subsystems for control of emissions.

Integrated Gasification Combined Cycles – (rank 8, estimated costs 51.17 mills/kWh) No further developments are needed to achieve commercial status. Activities dealing with low-cost, high temperature "getting" of sodium will affect the usage of North Dakota lignite.

Fluidized Bed Combustion – (Pressurized Fluidized Bed Combustion Steam Plant – rank 6, estimated costs 49.07 mills/kWh and Atmospheric Fluidized Bed Combustion Steam Plant – rank 7, estimated costs 50.75) AFB and PFB are considered to be commercial. The largest AFB plant is 160 MW. Large PFB plants must be built with parallel 80MW modules which are limited in size by the availability of the gas turbine. The main thrust in development for AFB systems is reduction in erosion and calcium usage. For PFB

[1] Values in parenthesis are estimated lower limit electricity generation costs for North Dakota lignite in mills/kWh.

systems the main development thrust is full-scale demonstration, development of cost effective hot gas cleanup technology, and design modifications to achieve capital cost reductions.

Mild Gasification/Topping Cycles – (Integrated Gasification Molten Carbonate Fuel Cell – rank 3, estimated costs 45.81 mills/kWh) Molten carbonate fuel cells and solid oxide fuel cells are viable with North Dakota lignite. Technological uncertainties are a hydrogen and carbon rich gasifier, electrode sensitivity to sodium, and hot sodium gettering.

Novel Combustion Turbine Systems – (Integrated Gasification Kalina Cycle – rank 2, estimated costs 44.52/kWh and Integrated Gasification Compressed Air Storage with Humidification – rank 1, estimated costs 37.78 mills/kWh) The economics of the novel combustion systems of Kalina cycle and IGCASH look very attractive. Both systems are currently under development and several years from commercialization. Technical uncertainties exist with use of the gas turbine in both systems. Two areas of concern are NO_x emissions and blade materials of construction.

Magnetohydrodynamic Cycles – (Integrated Gasification Magnetohydrodynamic Cycle – rank 4, estimated costs 46.16 mills/kWh) Many basic problems need solutions before commercialization of the technology is possible. Technological uncertainties include cost effective seed recovery and recycle, high temperature heat exchange and power channel materials of construction.

Testing in the following areas was recommended:

- hot gas cleanup
- akali gettering
- syngas reforming for fuel cells
- small circulating bed AFB
- mild Gasification/PFB combustion
- hot ceramic filters
- molten carbonate fuel cells
- fuel cell electrodes