FY00-XXXIV-94
LIGNITE TESTING IN AN ADVANCED HIGH-TEMPERATURE, HIGH-PRESSURE TRANSPORT REACTOR GASIFIER

CONTRACTOR: Energy & Environmental Research Center

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PARTICIPANTS

Sponsor	Cost Share
Energy & Environmental Research Center / DOE	$249,970
Ottertail Power Company	$30,000
Northern States Power	$30,000
Great River Energy	$50,000
Minnesota Power	$30,000
Southern Company Service	$30,000
Dakota Gasification Company	$20,000
Montana-Dakota Utilities	$20,000
ND Industrial Commission	$249,970
Total Project Costs	$709,970

Project Schedule – 24 Months
Contract Date – 12/3/99
Start Date – 12/3/99
Completion Date – 12/31/01

Project Deliverables
Contract Execution – 12/3/99 ✓
First Task Report – 3/31/00 ✓
Second Task Report – 11/30/01 ✓
Final Report – 12/30/01 ✓

OBJECTIVE / STATEMENT OF WORK

The objective of this project is to demonstrate the two-stage/adiabatic/dense-phase mixing concept of the transport reactor at a pilot plant scale. Determinations are to be made on carbon equilibrium content of bed material and the overall and mixing zone performance. Hydrodynamic and integrated data are to be obtained as well as material and elemental balances. Product gas yields with respect to temperature, riser velocity/residence time, and air: coal and steam: coal ratios are to be determined. The viability of a high reactivity North Dakota lignite in an advanced low capital cost two-stage/adiabatic/dense-phase mixing concept of the transport reactor will be demonstrated as well as the successful operation of a hot-gas filtration system. The economics of a lignite-fired transport reactor combined cycle to a natural gas-fired combined cycle will be compared in this study.

EQUIPMENT DESCRIPTION

The TRDU system can be divided into three sections: the coal feed section, the TRDU, and the product recovery section. The TRDU consists of a riser reactor with an expanded mixing zone at the bottom, a disengager, and a primary cyclone and standpipe. The standpipe is connected to the mixing section by a J-leg transfer line. All of the components in the system are refractory-lined and designed mechanically for 150 psig and an internal temperature of 2000°F. The bulk of entrained solids leaving the riser is separated from the gas stream in the disengager and circulated back to the riser via the standpipe. A solids stream is withdrawn from the standpipe via an auger to maintain the system's solids inventory. Gas exiting the disengager enters a primary cyclone. Solids from the primary cyclone are recirculated back to the standpipe through the dip leg crossover. Gas exiting this cyclone enters a jacketed-pipe heat exchanger before entering the HGFV. The cleaned gases leaving the HGFV enter a quench system before being depressurized and vented to a flare.

STATUS

The project has been completed. The pilot-scale TRDU located at the EERC was successfully operated under both air-blown and oxygen-blown operating conditions on three different North Dakota lignite fuels. Significantly higher product gas heating values were achieved under oxygen-blown conditions when compared on a dry basis. However, when compared on a wet basis, the air-blown and oxygen-blown operation both provided a fuel gas of comparable heating value considering the significantly higher steam flows which must be injected to keep the process temperatures below ash melting temperatures. For strictly power production, air-blown operation makes more economic sense since the high capital and operating costs associated with an air separation unit (ASU) is not needed. If the plant also wants to consider chemicals and fuels production, oxygen-blown operation is required in order to reduce the size of the subsequent unit operations. No problems with sodium-based bed material agglomeration and deposition were detected with these fuels even though some lignites were considered to be high-sodium fuels. Hot-gas filter operation and performance was excellent with no operating problems encountered with these fuels.

Before the construction of a commercial transport reactor should begin, a longer-duration proof-of-concept test on the selected lignite feedstock should be conducted on the larger-scale Power Systems Development Facility (PSDF) located at the Southern Company Services (SCS) facility in Wilsonville, Alabama. The economics of a transport reactor need to be determined especially in light of a potential requirement to install a selective catalytic reduction (SCR) unit in the heat recovery steam generator (HRSG) of the combined cycle for NO_x best available control technology.