Slag Characterization and Removal Using Pulse Detonation for Coal Gasification

**Quarterly Report
October 1 - December 31, 1996**

**By:
Ziaul Huque; Daniel Mei
Paul O. Biney; Jianren Zhou**

RECEIVED

APR 10 1998

Work Performed Under Contract No.: DE-FG22-95MT95010

For
U.S. Department of Energy
Office of Fossil Energy
Federal Energy Technology Center
P.O. Box 880
Morgantown, West Virginia 26507-0880

By
Prairie View A&M University
Department of Mechanical Engineering
P. O. Box 397
Prairie View, Texas 77446

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Disclaimer

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owed rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

**Portions of this document may be illegible
electronic image products. Images are
produced from the best available original
document.**

**ECONOMIC FEASIBILITY STUDY FOR PULSE DETONATION
ENGINE installed in a mid large size boiler (400-600 MW boiler) are as
follows:**

The economic feasibility study report was written and submitted to Document Control Center and Anthony E. Mayne (Contracting Officer's Representative) in a previous quarterly (reporting period: 10/01/96-12/31/96). Later, we were told to rewrite the report based on the design and unit cost. Also, we were asked to provide the background information based on which we had written the report. So, we contacted the North States Power (NSP) Company and those personnel who provided the necessary information.

**ECONOMIC ANALYSIS OF PULSE DETONATION ENGINE SOOT
BLOWER INSTALLION**

This report is a preliminary economic analysis of the Sherburne Co. plant North State Power. This analysis is made with the cooperation of Joe Brojberg (senior analysis engineer of NSP) and Steve Bension (Slag and ash specialist, President of Microbeam Technologies Incorporated (MTI) of North Dakota) and Paul Johnson of Diamond Power Speciality.

According to Paul Johnston, "Effective control of ash accumulation through the boiler tubes costs big money by limiting the output of steam to the turbine and by requiring more fuel to make a pound of steam. Typical savings on a mid to large size boiler can be as much as \$3,000,000 a year from steam output and \$500,000 for fuel". If we assume the size of the plant to be 600MW, then 5833 \$/MW are lost due to heat exchanger blockage.

The Sherburne Co. plant consists of 3 units, a 800MW and two 750MW units (Total 2300MW). The 800MW unit was recently taken off line for excessive ash build up in the heat exchanger unit in the convective pass. Evidently, the lead heat exchanger in the convective pass takes the burnt of the ash accumulation. In addition, the king unit of NSP, but not a part of Sherburne plant, had to be taken off line to clean the fouled heat exchangers which had "one foot accumulation of ash" according to Mr. Brojberg.

The 800MW unit was taken down for 4 days at \$100,000 per day, plus the cost of cleaning the unit which we estimate at \$80,000 for a total of \$480,000 ($4 \times 100,000 + 80,000$). Assuming that the king unit downtime cost the same amount so that costs incurred at NSP due to fouling before the annual cleaning costs approximately \$1,000,000.

For this amount of money, 33 pulse detonation unit could be purchased ($1,000,000 / 30,000 = 33$) where \$25,000 is the estimated cost for each PDE soot blower (which resembles the steam units currently in use at NSP), and \$5,000 for installation. The PDE units will be retractable and will work about the same frequency as the current steam blowers now in use.

COSTS

The primary costs of the ash build up are as follows:

- (1) downtime to clean unit before annual maintenance
- (2) downtime cycles may be extended to 15 months instead of 12 months with detonation equipment
- (3) loss of output of steam
- (4) additional fuel to make a pound of steam

These costs will be estimated for the Sherburne plant of NSP only and will based on experience where possible.

For Sherburne units, we will assume annual costs for taking down units for annual maintenance

Cost for 2, 750MW units	$1500\text{MW} \times 600 \text{ \$/MW} = \$900,000$
Cost per month	75,000
Maintenance cost per month of the 800MW unit required every 7 months	69,000
Annual maintenance for 3 plants/year $(69,000 \times 12 + 900,000)$	1,728,000

If this cycle can be extended to 15 months for all units due to PDE soot blowers, the following savings occur

without PDE for 15 months	$(75,000 \times 15 + 69,000 \times 15)$	= \$2,160,000
with PDE for 15 months	$(2300\text{MW} \times 600\text{\$/MW})$	= 1,380,000
Savings for 15 months		780,000
Savings per month		52,000

This savings will allow to be purchased 21 PDE soot blowers $(780,000/30,000 = 21)$ per year.

If we book keep the lost efficiency in terms of dollar amounts due to slag and ash fouling, for the Sherburne plant at $5800 \text{ \$/MW} \times 2300\text{MW} = \$ 13,340\text{K}$. The Sherburne plant consumes 7,500K tons of coal per year at a cost of \$130,000K in its present status. On an environmental basis, if 1-2% of the coal was saved to produce the same amount of power, 150K tons of coal produces approximately 500K tons of carbon dioxide, which could be prevented from entering the atmosphere. Taken world wide, the environmental savings will be enormous.