

DEMONSTRATION OF A HYBRID CLEAN COAL COMBUSTION SYSTEM

Project History

PROJECT PARTNERS

**South Carolina Institute
for Energy Studies**
Clemson University
Clemson, SC

PROJECT SPONSOR

**Department of Energy
National Energy Technology
Laboratory**
Morgantown, WV

PROJECT SITE

Central Energy Facility
Clemson University
Clemson, SC

The technology of interest is the Pulsed Atmospheric Fluidized Bed Combustor (PAFBC) developed by Manufacturing and Technology Conversion International, Inc. (MTCI) and marketed by ThermoChem, Inc., both located in Baltimore, MD. The PAFBC combines the performance of a pulse combustor operating on fine coal with an atmospheric fluidized bed operating on coarse coal. ThermoChem, Inc. provided the design and construction of the PAFBC unit and Clemson provided the site and associated laboratory research.

The cooperation between MTCI, ThermoChem, Inc., and the South Carolina Institute for Energy Studies at Clemson University, (formerly the South Carolina Energy Research and Development Center) began in 1991. In the subsequent years, cooperative agreements for the demonstration project were developed and laboratory research on PAFBC technology was initiated. The laboratory research was conducted by faculty and graduate students in academic departments of Clemson University.

The PAFBC was physically located directly behind the Central Energy Facility in the center of the Clemson campus. The PAFBC, at maximum capacity, was sized to produce 50,000 pounds of saturated steam per hour for use in the Clemson University steam distribution system.

Project Status

ThermoChem, Inc. was responsible for on-site construction and assembly of the PAFBC unit. The initial testing and operation of the facility was conducted during the summer of 1996. All phases of the testing and demonstration program were completed in 1997.

CLEAN COAL COMBUSTION

The Pulsed Atmospheric Fluidized Bed Combustor (PAFBC) is a bubbling fluidized bed coal combustor combined with a pulse combustor. Fluidized bed combustors allow the use of high sulfur coal, performing extremely well environmentally with particularly low NO_x and Sox emissions, however, they have the disadvantage of requiring coarse coal with no fines. Adding the pulse combustor to the fluidized bed allows the use of very fine coal. The pulsing stabilizes the hydrodynamic and thermodynamic characteristics while minimizing particulate carry over.

The pulse combustor is a combustion chamber with no moving parts operating on either gas or fine coal. The chamber and exit tube are designed in a manner which results in a self sustaining, periodic combustion process. The frequency of the resonance varies with chamber size and exit tube length. The exit tube of the pulse combustor is immersed in the fluidized bed. The raw coal is pneumatically separated with the coal fines carried to the pulse combustor and the coarse coal to the fluidized bed combustor via a screw feeder.

CONTACT POINTS

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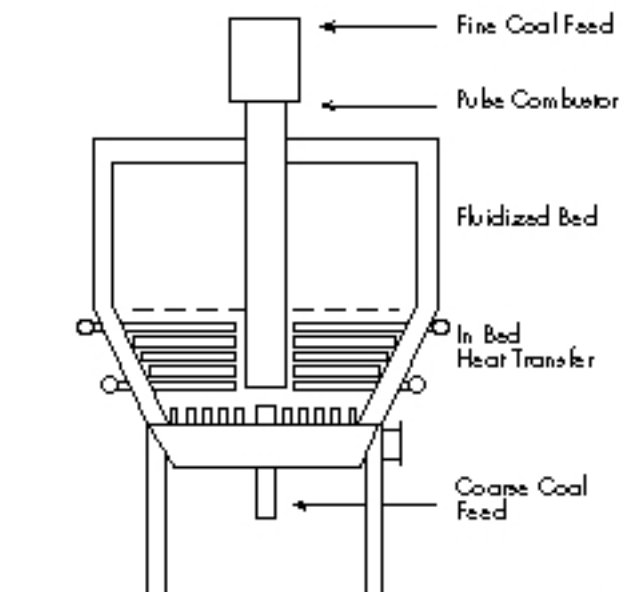
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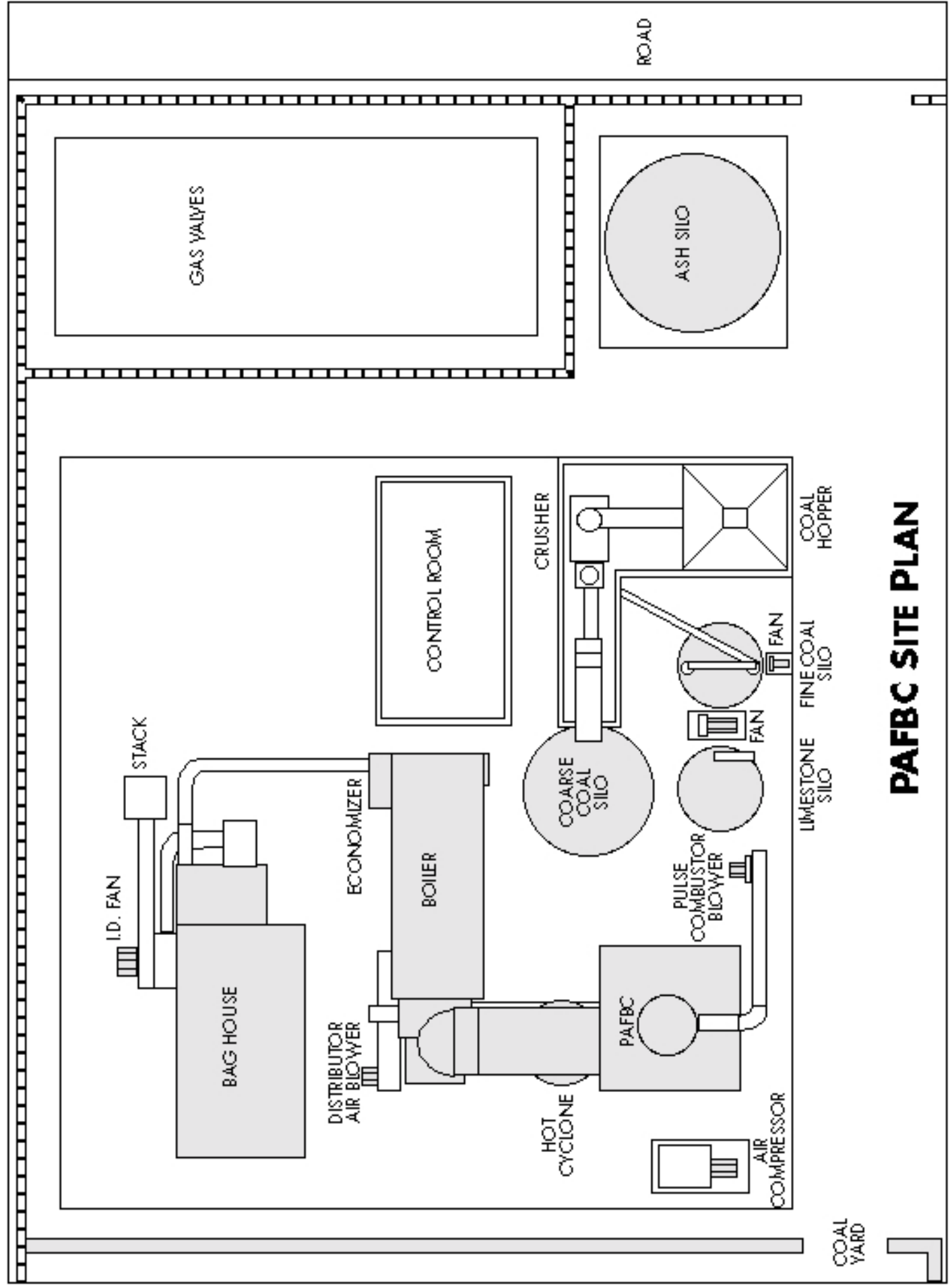
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PAFBC Elevation View





PAFBC SITE PLAN

REFEREED JOURNAL AND CONFERENCE PAPERS

Pence, D.V., Beasley, D.E. and R.S. Figliola, "Heat Transfer and Surface Renewal Dynamics in Gas-Fluidized Beds," Fundamental Experimental Techniques in Heat Transfer, ASME/ AICHE National Heat Transfer Conference, Paper 93-HT-32, August, 1993, Atlanta, GA.

Pence, D.V., Beasley, D.E. and R.S. Figliola, "Heat Transfer and Surface Renewal Dynamics in Gas-Fluidized Beds," J. Heat Transfer, Vol 116, No. 4, Nov. 1994. 929.

Pence, D.V., Beasley, D.E. and J.B. Riester, "Deterministic Chaotic Behavior of Heat Transfer in Gas-Fluidized Beds," General Papers in Heat and Mass Transfer, Insulation, and Turbomachinery, HTD - Vol. 271, Sixth AIAA/ASME Thermophysics and Heat Transfer Conference, Colorado Springs, CO, June, 1994.

Pence, D.V., Beasley, D.E. and J.B. Riester, "Deterministic Chaotic Behavior of Heat Transfer in Gas-Fluidized Beds," J. Heat Transfer, Accepted for publication, 1994.

Lorenzo, E.C., Beasley, D.E., Mueller, B.T. and J.B. Riester, "Numerical Model for Convective Heat Transfer in a Tailpipe of a Pulse Combustor," Accepted for presentation, 4th ASME/JSME Thermal Engineering Joint Conference, Maui, Hawaii, March 19-24, 1995.

Mueller, B.T., Pence, D.V., and Beasley, D.E., "Emulsion Phase Contact Dynamics and Heat Transfer in Large and Small Particle Gas-Fluidized Beds," Accepted for presentation, 4th ASME/JSME Thermal Engineering Joint Conference, Maui, Hawaii, March 19-24, 1995.

Pence, D.V., and Beasley, D.E., "Multi-Fractal Signal Simulation of Local Instantaneous Heat Transfer in a Bubbling Gas-Fluidized Bed," In review, 1995 National Heat Transfer Conference, Portland, OR, August, 1995.

Pence, D.V., and Beasley, D.E., "Multi-Fractal Signal Simulation of Pressure Fluctuations in a Bubbling Gas-Fluidized Bed," Sixth International Symposium on Gas-Solid Flows, Hilton Head, August, 1995.

Muller, B.T., "Update-Pulse Enhanced Fluidized Bed Combustion," 13th Annual Pittsburgh Coal Conference, Pittsburgh, PA, September, 1996.

Muller, B.T., "Preliminary Data Pulse Enhanced Fluidized Bed Combustion," CIBO Fluid Bed XII, Pittsburgh, PA, November, 1996.

MASTERS AND DOCTORAL THESIS

Mueller, Brian, "Characteristics of Emulsion and Bubble Phase Contact Dynamics in Three-Dimensional Gas-Fluidized Beds," May, 1994, M.S.

Lorenzo, Elias, "Development of One-Dimensional Quasi-Steady State Model for Convective Heat Transfer in the Tail Pipe of a Pulse Combustor," August 1994, M.S.

Allen, John, "Effect of an Opposing Secondary Pulsed Flow on Heat Transfer and Hydrodynamics in Two-Dimensional Gas-Fluidized Beds," December, 1994, M.S.

Postle, Michael Cory, "The Effects of an Opposing Oscillatory Flow on Heat Transfer and Pressure Fluctuations in Gas-Fluidized Beds," May, 1995, M.S.

Pence, Deborah Valerie, "Experimental and Chaos Analysis of Heat Transfer in a Gas-Fluidized Bed with Opposing Oscillatory Flow," August, 1995, Ph.D.