PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Advanced Research Combustion Technologies

12/2008

ESTABLISHMENT OF AN ENVIRONMENTAL CONTROL TECHNOLOGY LABORATORY WITH A CIRCULATING FLUIDIZED-BED COMBUSTION SYSTEM

CONTACTS

Robert R. Romanosky
Technology Manager
Advanced Research
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4721
robert.romanosky@netl.doe.gov

Robert M. Kornosky
Project Manager
National Energy Technology Laboratory
626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4521
robert.kornosky@netl.doe.gov

Wei-Ping Pan
Director
Institute for Combustion Science and Environmental Technology
Western Kentucky University
2413 Nashville Road
Bowling Green, KY 42101
270-745-2272
wei-ping.pan@wku.edu

Description

In response to President Bush's Clear Skies Initiative in 2002—a legislative proposal to control the emissions of nitrogen oxides (NO_x), sulfur dioxide (SO_2), and mercury (Hg) from power plants—the National Energy Technology Laboratory (NETL) organized a Combustion Technology University Alliance and hosted a Solid Fuel Combustion Technology Alliance Workshop. The workshop identified four high-priority research needs for controlling emissions from fossil-fueled power plants: multipollutant control, improved sorbents and catalysts, mercury monitoring and capture, and an improved understanding of the underlying combustion chemistry. The Environmental Control Technology Laboratory was established at Western Kentucky University's Institute for Combustion Science and Environmental Technology to help meet these challenges.

Goals and Objectives

To develop the capability and technology database needed to support municipal, regional, and national electric power generating facilities in improving efficiency of operation and in solving operational and environmental problems.

Technological Approach

Researchers designed and built a bench-scale (0.6 MW_{th}) circulating fluidized-bed combustion (CFBC) system and used it to perform combustion experiments to study coal firing, co-firing with coal and biomass, fuel switching, load-tuning performance, heat transfer, and air pollutant emission monitoring. Major air pollutant concentrations, including NO_x, SO_2, carbon monoxide (CO), Hg, volatile organic compounds (VOCs), halogens, and trace metals were measured. Variables such as oxygen concentration and system temperature profiles were studied. Limestone additives were investigated for their effects on SO_2 concentration, reducing agents for NO_x concentrations, and chlorine-containing fuels for Hg concentrations. The investigators also tried the novel concept of adding hydrogen bromide (HBr) to oxidize Hg and promote its adsorption on fly ash.

PROJECT DURATION

Start Date
09/15/03
End Date
05/31/08

COST

Total Project Value
$2,543,410
DOE/Non-DOE Share
$1,946,458 / $596,952

ADDRESS

National Energy Technology Laboratory
1450 Queen Avenue SW
Albany, OR 97321-2198
541-967-5892

2175 University Avenue South
Suite 201
Fairbanks, AK 99709
907-452-2559

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4764

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-386-4687

One West Third Street,
Suite 1400
Tulsa, OK 74103-3519
918-699-2000

CUSTOMER SERVICE

1-800-553-7681

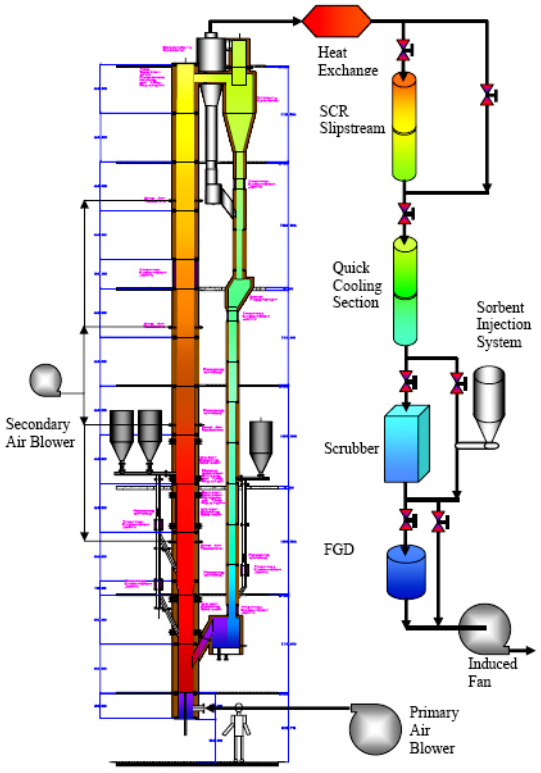
WEBSITE

www.netl.doe.gov

Accomplishments

The studies have shown that:

- Limestone can effectively control SO_2 emissions.
- Oxygen concentration, reducing agents, and system temperature profiles can have major impacts on NO_x emission concentrations.
- Good combustion performance inside the CFBC system can largely abate emissions of CO, VOCs, and semi-VOCs during co-firing of coal and biomass.
- Co-firing high-chlorine fuel, such as chicken waste, can reduce Hg emissions by over 80 percent.
- The addition of HBr can be very effective for Hg oxidation, which can lead to subsequent adsorption of oxidized Hg on fly ash, thereby reducing Hg emissions.
- Combustion performance control was stable when switching between air firing and oxygen firing, and Hg speciation and emission rates did not change as a result of this switching.



Schematic of circulating fluidized-bed combustion (CFBC) systems.

Benefits

The Environmental Control Technology Laboratory's CFBC system can perform a variety of combustion tests using a wide range of fuels (high-sulfur coals, low-rank coals, municipal solid waste, agricultural waste, and refuse-derived fuel) under varying co-firing conditions to analyze and monitor air pollutant emissions. It can also be used for multipollutant control studies to discover the synergistic effects of control methods. The CFBC system ultimately provides scientific data for atmospheric pollutants and the methodologies required to reduce pollutant emissions.