PROJECT facts

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

Advanced Research

12/2008

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

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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 only, co-firing with coal and biomass, fuel switching, load tuning performance, heat transfer, and air pollutant emission monitoring. They measured major air pollutant concentrations, including NO_x, SO_2, carbon monoxide (CO), Hg, volatile organic compounds (VOCs), halogens, and trace metals. 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

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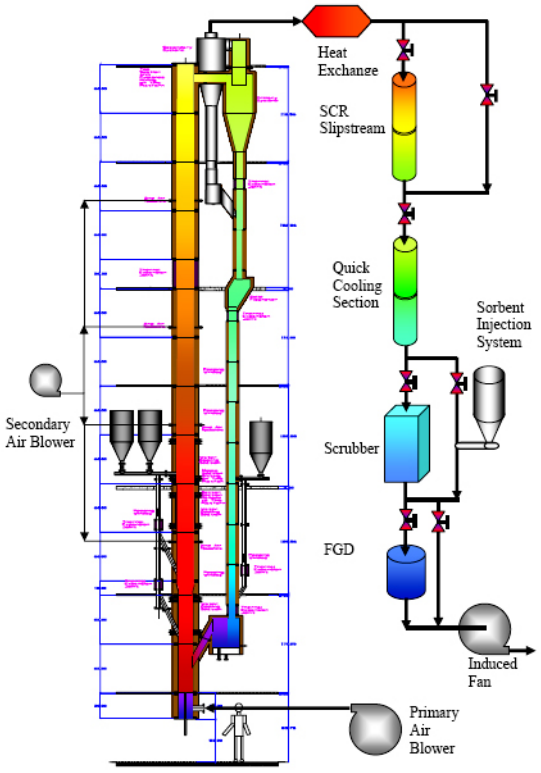
Accomplishments

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.