

# Pilot- & Laboratory-Scale Stationary Combustion Facilities

## General Description

The EMS Energy Institute, a leader in stationary combustion research since 1949, has some of the best facilities in the country for both fundamental and applied research on the nature of fossil fuels and biofuels and the impact of their utilization on the environment. The pilot-scale facilities create industrially relevant flame and temperature conditions and yet have the advantage of producing samples under controlled conditions to assist in understanding the processes at a fundamental level. The facilities are typically used for:

- conducting research to understand the fundamentals of energy conversion processes;
- conducting applied research and providing solutions to industrial problems;
- providing specialized test services such as proof-of-concepts, performance evaluations, demonstrations of new burner designs, emissions characterization and remediation; &
- promoting transfer of technology to industrial groups.

## Key Equipment

### **2 Million Btu/h Research Boiler**

The multifuel capable package boiler is of A-Frame watertube construction and was designed and built by Cleaver Brooks. To accommodate fuels with various degrees of ignitability, a ceramic quarl extends the combustion zone to provide flame stability. The boiler is equipped with ports for gaseous and particulate sampling in the radiative and convective sections of the boiler.

### **1 Million Btu/h Fluidized Bed Combustor (FBC)/ 2 Million Btu/h Circulating Fluidized Bed Gasifier**

The fluidized bed combustion/ gasification system can be operated as a circulating or bubbling FBC or circulating fluidized bed gasifier. Fuel and limestone are fed into the combustor using screw feeders or pumps, depending on the fuel type. Numerous ports are provided in the main bed and freeboard for the measurement of pressures and temperatures and for particulate or gas sampling. The unit also has overfire air capabilities.

### **500,000 Btu/h Down-Fired Combustor (DFC)**

The DFC is designed to evaluate the combustion performance and pollutant emissions from various fuels. The combustor is constructed of modular sections to vary

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the height and thereby the residence time and is fitted with a multifuel burner. The flue gases pass through a modular heat exchanger before entering the fabric filter and either the wet flue gas desulfurization unit or stack. Ports are located along the combustor for extraction of gaseous or particulate samples.

### ***Pilot-Scale Forced Oxidation Wet Flue Gas Desulfurization (WFGD) Facility***

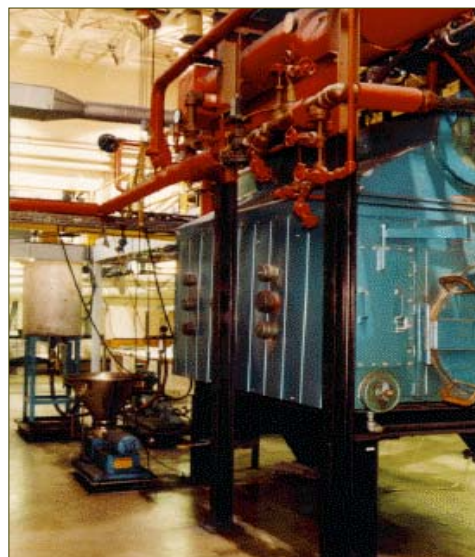
A pilot-scale WFGD test facility can be connected to the DFC. The scrubber is equipped with a demister at the top and access ports are located along the column to allow for changes in the location of the slurry nozzle and for inspecting the unit. The unit can be run in batch or continuous mode.

### ***Laboratory-Scale Traveling Grate Stoker Simulator***

The stoker simulator is a batch system designed to simulate the combustion process on a traveling grate stoker. The simulator is equipped with an array of thermocouples and gas sampling ports in the bed to follow the rate of ignition plane travel and reactions occurring in the bed.

### ***Drop-Tube Reactor (DTR)***

The DTR is a vertically fed, electrically heated apparatus that can simulate fuel heating rates, temperature profiles, and particle residence time of a utility boiler. The DTR system consists of four main components: a fuel feeder, a preheater, a furnace and a sample collection probe.



Research Boiler

# Equipment Capabilities

## **2 Million Btu/h Research Boiler**

Examples of activities performed using the research boiler include:

- Evaluating the combustion performance and determining emissions from a range of fuels including coals, Synfuels, fuel oils, orimulsions, and biofuels such as animal fats;
- Evaluating the effect of operating parameters and hardware components on combustion and boiler performance;
- Developing automated firing systems (e.g., for coal-water slurry fuel firing);
- Providing research support and operator training;
- Characterizing emissions such as NO<sub>x</sub>, SO<sub>2</sub>, inorganic and organic hazardous air pollutants; and
- Developing emissions factors and stack testing methodologies.

## **1 Million Btu/h Fluidized Bed Combustor/ 2 Million Btu/h Circulating Fluidized Bed Gasifier**

The fluidized bed system, which can be operated in either a circulating or bubbling bed mode and as a gasifier or combustor, is routinely used to:

- Evaluate fuels such as coals, coal-water slurry fuel, coal cleaning refuse, biomass materials such as animal fats and manures/litter, and refuse-derived fuels;
- Evaluate sorbents for SO<sub>2</sub> removal; and
- perform fundamental studies on sorbent sulfation, bed modeling, and particle attrition.

## **500,000 Btu/h Down-Fired Combustor/ Forced Oxidation Wet Flue Gas Desulfurization (WFGD) Facility**

The down-fired combustor is a multifuel capable test unit that is primarily used for fundamental studies on mineral matter transformations, sulfur capture, and NO<sub>x</sub> reduction mechanisms. When integrated with the forced oxidation WFGD facility, the following activities are performed:

- characterize limestones for potential as reagents for SO<sub>2</sub> removal;
- study the effect of limestone chemistry and physical characteristics, slurry chemistry, and operating parameters on sulfur capture performance; and
- study the use of scrubbers as a removal technique for mercury.



Fluidized Bed Combustor

## **Laboratory-Scale Traveling Grate Stoker Simulator**

The purpose of the fixed-bed, self-sustained stoker simulator is to mimic the combustion process on a traveling grate stoker. The simulator is used to:

- evaluate the relative combustion efficiency of various coals and coal blends;
- determine the clinkering propensity of ash under stoker combustion conditions; and
- characterize emissions from coals and blends of coal and waste materials, e.g., plastics.

## **Drop-Tube Reactor**

The drop-tube reactor is an electrically heated furnace that is used to perform fundamental studies to:

- determine pyrolysis and overall kinetic parameters of coals, coal blends, biofuels, and petroleum coke;
- compare emissions and combustion performance of fuels;
- generate char/ fly ash samples for study; and
- measure relative ash deposition characteristics of fuels.

## **Key Contact**

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