

PROJECT facts

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

Advanced Research

09/2005



CHAR-NO_x FORMATION IN PULVERIZED COAL COMBUSTION

Description

CONTACTS

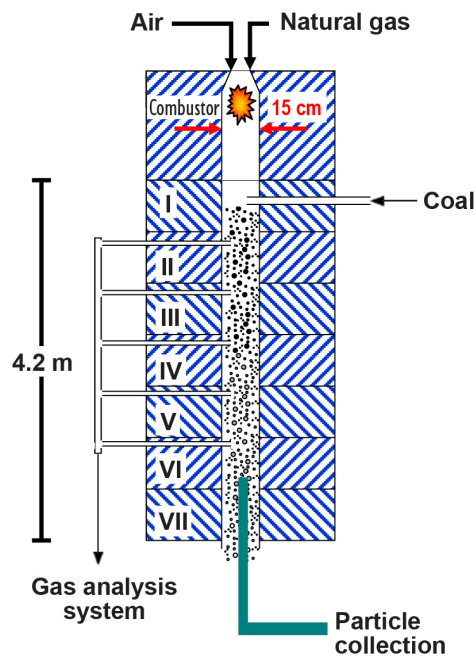
Robert R. Romanosky
Advanced Research Technology
Manager
National Energy Technology
Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-4721
robert.romanosky@netl.doe.gov

Susan Maley
Project Manager
National Energy Technology
Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507
304-285-1321
susan.maley@netl.doe.gov

Dr. Linda G. Blevins
Principal Investigator
Sandia National Laboratories
7011 East Avenue
Livermore, CA 94551
925-294-3840
lgblevin@sandia.gov

Oxides of nitrogen (NO_x) form in pulverized coal boilers in two general ways: the combustion of volatiles and the combustion of char. Current combustion control technologies, such as low-NO_x burners and staged combustion, minimize NO_x formed from volatiles combustion, but have limited influence on char-derived NO_x. Little is known about minimizing NO_x that forms from char combustion downstream of the main combustion zone. A competing mix of homogeneous and heterogeneous chemical reactions occurs, some of which consume NO, which has complicated previous efforts to understand the relevant chemical steps. Furthermore, most previous laboratory investigations have explored char-NO_x formation under fluidized-bed conditions with large particles, low heating rates, and low temperatures relative to pulverized coal combustion conditions.

This project used both the Multifuel Combustor (MFC) and Char Combustion Laboratory (CCL) at Sandia National Laboratories to improve understanding of NO_x formation and destruction during pulverized coal char combustion. In this study, pulverized coal char was produced with hot combustion products with very little oxygen in the MFC. To uncouple heterogeneous reaction influences on NO_x formation and destruction from gas-phase radical reaction pathways, radical scavenging agents were added to the bulk gas flow. In addition, bulk flow chemistry modeling and single-particle chemistry modeling was performed and compared to the experimental results.



Schematic of the Multifuel Combustor (MFC) with newly installed multiport sampling system. For this investigation, char was produced in the MFC and then fed in place of coal.



CONTACTS (cont.)

Dr. Christopher R. Shaddix

Principal Investigator
Sandia National Laboratories
7011 East Avenue
Livermore, CA 94551
925-294-3840
crshadd@sandia.gov

ADDRESS

National Energy Technology Laboratory

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

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

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

539 Duckering Bldg./UAF Campus
P.O. Box 750172
Fairbanks, AK 99775-0172
907-452-2559

PROJECT DURATION

October 1, 2001 –
September 30, 2004

PROJECT COST

\$500,000

CUSTOMER SERVICE

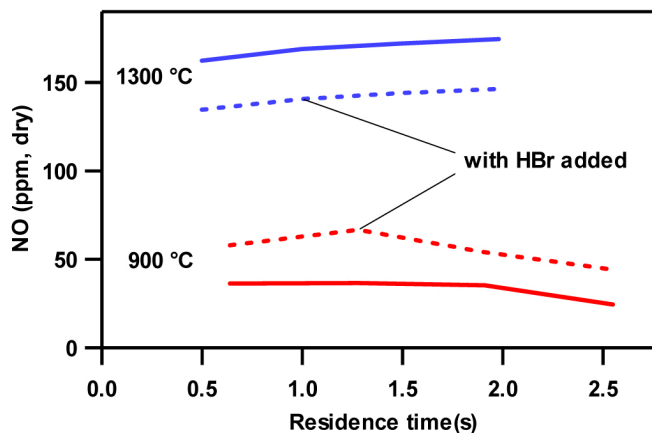
1-800-553-7681

WEBSITE

www.netl.doe.gov

Accomplishments

An effective technique was developed for generating high-quality pulverized coal char using the MFC and a large cyclone collector. The char was shown to have the same combustion rate in the CCL as char generated *in situ* from direct injection of coal particles into the CCL. Experiments co-fed solid potassium bromide (KBr) and solid sodium carbonate (Na_2CO_3) with coal and char particles to scavenge gas-phase radicals. Both agents were found to inhibit CO oxidation, and to affect the NO production, but the use of KBr introduced a liquid coating on the reacting char particles, and the inhibition chemistry of Na_2CO_3 is not well established. Consequently, gas-phase hydrobromic acid (HBr) was adopted as the best available scavenging radical. Experiments with the addition of HBr showed the inhibition of CO oxidation without affecting char oxidation, or the rate of NO reduction on the char. The addition of HBr increased NO concentrations during char oxidation at lower temperatures (900 °C) and decreased NO concentrations at higher temperatures (1,300 °C). Preliminary modeling results suggest that the reburn of NO in the reacting char boundary layer (via an H atom route) may be important at lower temperatures.



Measured profiles of NO in the MFC as a function of residence time after char injection, with and without the addition of 920 ppm HBr for 900 °C and 1,300 °C.