Research on Potential Environmental Impacts of Oxy-fuel Combustion at EPA

Chun Wai Lee[a]*, Christopher K. Winterrowd[b], Myrrha Andersen[c], William Linak[a]

[a]*National Risk Management Research Laboratory, U.S. Environmental protection Agency, Research Triangle Park, NC 27711, USA*
[b]*ARCADIS U.S. Inc. Durham, NC 27713, USA*
[b]*Department of Mechanical and Aerospcae Engineering, North Carolina University, Raleigh, NC 27608, USA*

There are a number of environmental issues which must be addressed before oxy-fuel combustion can be adopted commercially. These include effects of oxy-fuel combustion on pollutant formation, and how changes in pollutant behavior, characteristics of the various process effluents, and the behavior of existing pollution control devices in an oxy-fuel environment. Further, it is unknown how pollutant species will partition within compression and purification units (CPUs) designed to produce a supercritical CO_2 effluent for transportation and sequestration. Research to evaluate the potential environmental impacts of oxy-fuel combustion has been initiated at the U.S. EPA. Initial efforts will examine pollutant behavior and partitioning in oxy-fuel combustion, and provide exhaust effluent to a new compression purification unit (CPU) currently being built through a Cooperative Research and Development Agreement (CRADA) with American Air Liquide Inc. An existing 35kW laboratory-scale combustor located at the U.S. EPA's National Risk Management Research Laboratory, Research Triangle Park, North Carolina, has been modified for performing oxy-natural gas and oxy-coal experiments by adding O_2 operation and flue gas recycling capabilities. The combustor has previously been used in research studies to characterize air pollutants similar to those produced in utility boilers. A New burner, moisture condenser, flue gas reheater, recycle blower, and flow controls have been installed as part of the modifications. The vertical furnace (4 meters in length, 0.2 m inside diameter) is refractory lined with evenly spaced sampling ports that span the full length to facilitate gas and aerosol sampling as well as temperature measurements. The exhaust exits the furnace into an insulated stainless steel pipe (0.2 m ID) with additional sampling ports. After heat removal, fly ash can be removed by a new electrostatic precipitator. The combustor operates with ~0.8 m^3/min total flue gas flow in air combustion mode. Oxy-coal operation will reduce the flow to ~0.16 m^3/min. The combustor has existing air pollution control equipment including a fabric filter, wet flue gas desulfurization , and selective catalytic reduction, and is equipped with continuous emission monitors for O_2, CO, CO_2, NO, NO_x, SO_2, and PM. A new supervisory control and data acquisition (SCADA) system for monitoring and controlling all process streams has been installed. The combustor is currently operational on oxy-natural gas, and modifications for oxy-coal operation are close to complete. Experiments have been conducted to characterize the formation of trace hazardous air pollutants (HAPs) such as volatile organic compounds (VOCs) and soot from oxy-natural gas combustion. The potentials for organic HAP formation as a result of recyling major combustion products including CO_2 and H_2O back to the burner as part of the oxy-fuel combustion process are being evaluated.