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THE FATE OF ARSENIC IN WASTE-TO-ENERGY FACILITIES

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Project Description

Trace levels of arsenic contained in coal and liberated during combustion typically react with fly ash and are removed during flue gas treatment for particulate control in baghouses, electrostatic precipitators, and scrubbers (1, 2). If 100% copper chromium arsenic (CCA)-treated wood, which can contain up to 30% arsenic, is fired in an industrial stoker or waste-to-energy facility (WTE), the existing flue gas treatment system may or may not remove all of the arsenic required to meet emission standards. In addition, elevated levels of CCA are expected to be present in the ash and can present ash management concerns. The project will determine the fate of arsenic by conducting a bench-scale combustion experiment in which arsenic removal efficiency from combustion flue gas will be measured across a baghouse, and scrubber, in the EERC's conversion and environmental process simulator (CEPS) (Figure 1), and CCA levels and speciation will be determined in the bottom ash and fly ash. The publication of results will provide crucial data for utilities, WTE facilities, and other industrial stoker furnace operations that may consider firing treated wood. The data will also be useful to regulators and solid waste officials looking for alternative disposal methods for treated wood.

Goal

The project goal is to determine the potential fate of arsenic from the combustion of CCA-treated wood and the impacts relative to emissions and ash management. Objectives are as follows:

1. Conduct a treated-wood combustion experiment and measure arsenic capture efficiency across pollution control equipment.

2. Analyze bottom ash and fly ash to determine the speciation and quantity of copper, chromium, and arsenic.

3. Publish the experimental data for utilization by other research institutions, electric power utilities, industrial cogeneration facilities, WTE facilities, regulators, and solid waste officials.

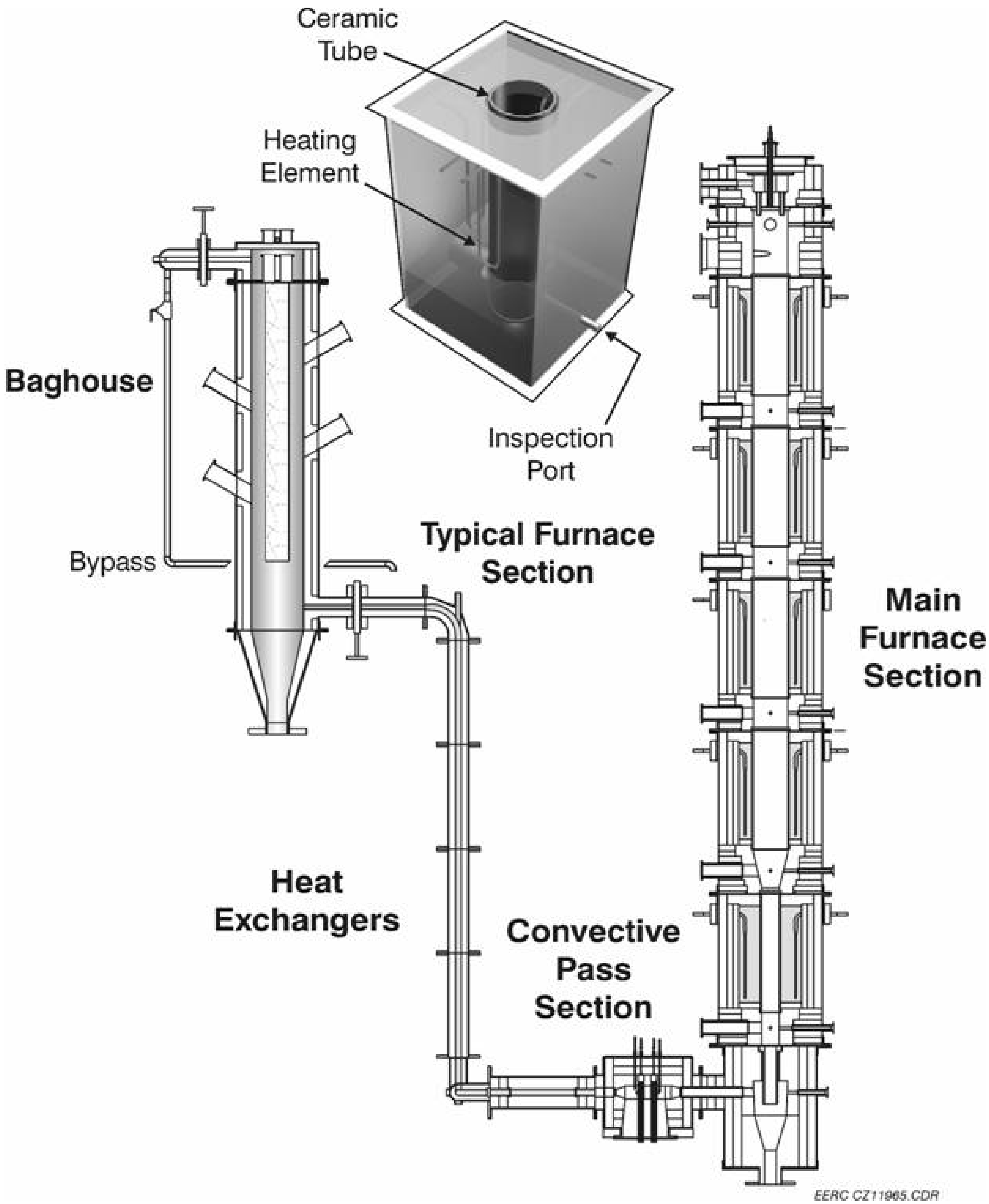

Figure 1. Conversion and environmental process simulator.

Rationale

The project will determine the fate of arsenic in combustion systems when firing relatively high concentrations of treated wood. The project is intended to find alternatives for treated-wood diposal.

Approach

Experimental Apparatus

Arsenic removal efficiency from combustion flue gas will be measured across a baghouse and scrubber in the CEPS (Figure 1), and CCA levels and speciation will be determined in the flue gas by EPA Method 29 and analyzed in bottom ash and fly ash.

Test Plan

The CEPS will be utilized in its present configuration to fire treated wood. CCA-treated wood with retention of 0.4 pcf will be obtained and prepared for the experiment as shown in Figure 1. Test runs will be conducted utilizing an EPA Method 29 trace element sampling train located at the inlet and outlet of the baghouse and scrubber. Test runs will be completed until a satisfactory and repeatable mass balance for arsenic is obtained. Bottom ash will be collected from the CEPS, and fly ash will be collected from the baghouse. Samples will be submitted for analysis to determine the quantity and speciation of arsenic, copper, and chrome.

Progress

1. Treated wood was acquired for testing.
2. The fuel has been sized appropriately for experimentation.
3. Fuel analysis is scheduled to determine arsenic concentration.

Quality Assurance/Quality Control

Based on previous work, it has been determined that the detection and quantification of arsenic is extremely difficult. The experiments to be performed have been designed such that the highest likelihood of a good mass balance closure is achieved.

Measurement/Data Acquisition

EPA Method 29 sampling will be utilized for the quantification of particulate and arsenic, while data acquisition will be used to gather information on feed rate, gas composition, and other operational conditions.

Assessment and Validation

Based on the analysis of the Method 29 and the data taken by the data acquisition, an arsenic balance will be performed. If good closure cannot be achieved, additional balances will be utilized to determine the final location of the contaminants.

Status

The project began in April 2005 with initial work to set up contracts with other partners including the Electric Power Research Institute and the EERC's Jointly Sponsored Research Program with the U.S. Department of Energy. Actual work started in July. Methods for sampling arsenic are being reviewed to ensure accuracy. Test runs are planned for December 2005 – January 2006.

Potential Applications and Benefits

Potential Users and Real-Life Applications

The most likely benefactors are WTE plants or cement kilns.

Technology Transfer

Technology will be transferred through publication.

Technical and Economic Benefits

Arsenic is a common compound widely dispersed across the globe found in water and sediment as a trace composition. The toxic effects of arsenic have been known for centuries. Arsine (AsH_3) and arsenic(III) halogenides are more toxic than other inorganic arsenic compounds. Arsenic has not been produced in the United States since the closure of the last remaining copper smelter plant in 1985, due to the high cost for compliance to sulfur and to a lesser extent arsenic emission regulations. The historic demand for arsenic grew between 1910 and 1920. Since that time, the U.S. demand has remained between 10,000 and 25,000 metric tons per year (3). In recent years (1998 – 2003), domestic consumption has been slightly decreasing. Between 1970 and 1980 the utilization of arsenic shifted from agricultural uses to wood preservatives. Today, wood preservatives are the primary use for arsenic, and all production is imported. Arsenic trioxide is produced from roasting arsenopyrite and from the by-products of copper, lead, and gold smelters. Imports are mostly supplied by China. The global reserve base is expected to be 20 to 30 times current annual production (4). Global demand for arsenic is expected to decrease by about 30% as the wood-preserving industry has voluntarily eliminated arsenic from residential treated wood; however, nonresidential arsenic treatments remain in use.

Environmental and/or Health Benefits

Treated wood is a significant solid waste issue and a challenge for recovery and toxic emission control. The use of CCA has increased by a factor of 7 since 1970 in the United States. Once representing 16% of the wood preservative market in 1970, CCA represented about 80% of the market in 1996 (5). The volume of wood treated with CCA by 1970 was 36 million cubic feet and by 1996 increased to 470 million cubic feet. Since CCA-treated wood has a life span of about 25 years, it is projected that the wood waste stream will mirror the production statistics of CCA-treated wood and amounts of CCA-treated wood being disposed of will multiply. Based on these numbers, about 1.2 million tons/yr could be going into our nation's landfills. Nonarsenic alternatives to CCA are being provided for residential wood; however, plywood, utility poles, and marine applications are continuing to use arsenic treatments. The alternatives typically contain high compositions of copper and may provide for attractive recycling. Treated wood containing arsenic and nonarsenic wood remain difficult to separate. Residential arsenic-treated wood will be a disposal issue for the next 25 to 50 years, and arsenic from treated wood will continue to be a disposal issue beyond 50 years for utility, industrial, and marine applications.

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