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ADA TECHNOLOGIES, INC
AN ENVIRONMENTAL SCIENCE & ENGINEERING COMPANY

Novel Process for Removal and Recovery of Vapor-Phase Mercury

Monthly Technical Progress Report
Covering November 1 through November 30, 1995

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Novel Process for Removal and Recovery of Vapor-Phase Mercury

The purpose of this project is to investigate the application of a sorbent-based process for removing and recovering mercury in the flue gas of coal-fired power plants. The process is based on the sorption of mercury by noble metals and the regeneration of the sorbent by thermal means, recovering the desorbed mercury as liquid, elemental mercury. ADA Technologies holds a patent on this process (US 5,409,522, April 25, 1995) and has tested it under conditions typical of municipal waste incinerators. In this process, the noble metal sorbent is regenerated thermally, and the mercury is recovered for commercial recycle. Consequently, ADA has adopted the name "Mercu-RE" to describe its process.

In the current project, ADA will test its process under conditions typical of coal-fired power plants where the mercury concentration is low (below 10 $\mu g/m^3$) and little pressure drop can be tolerated. Methods of accommodating the Mercu-RE process to the circumstances and conditions of coal-fired power plants will comprise the core of the planned program.

Overview of Progress

We began to assemble the sorbent configurations to be tested. Orders were placed for the substrate materials for three of the four configurations: ceramic monoliths, metallic monoliths, and the bag filter.

Task I-1: Screen Sorbent Configurations

Ceramic Monoliths

We ordered wash-coated ceramic monoliths from Advanced Catalyst System, Inc. (Knoxville, TN). The monoliths themselves are the Corning "Celcor" product (Corning Inc., Corning, NY) and are made of cordierite. This product is available in pieces that are 5.66" by 5.66" square and 6" long. Advanced Catalyst Systems (ACS) cut some of this material for us into blocks that are 1" square to accommodate our laboratory test needs. ACS applied a thin layer of alumina particles, approximately 50 microns thick, to the inside wall of each channel. We intend to soak gold into these alumina particles to prepare the monolith to sorb mercury.

The monoliths have 200 cells per square inch (cpsi). We thought that 50 cells per square inch would be more ideal, but there would have been a significant time delay for ACS to obtain monoliths with that cell density. The 200 cpsi monoliths were readily available. The volume occupied by each monolith is six cubic inches (98.3 cm^3). Therefore with typical laboratory flow rates of one to 10 standard liters per minute (slpm), our space velocity will be 610 hr^{-1} to 6100 hr^{-1}. Space velocity is defined as the volumetric flow rate (0°C, 1 atm.) divided by the volume of the monolith and is a measure of throughput common to the catalysis industry.

Each monolith has 57.3% open area on the front face (the wall thickness for each cell is 0.017 inches, and therefore the walls block off 42.7% of the cross-sectional area). Consequently, the cross-section open to flow is 4.08 cm^2 (0.0208 cm^2 each, 196 cells). At typical test conditions of 300°F, 12 psia pressure, and one slpm of flow, the average linear velocity in each channel will be 7.7 cm/sec, and the residence time will be 1.97 sec. The flow in each channel will be laminar (Reynolds number approximately equal to 3.3). The washcoat layer adds less than 0.1% to the wall thickness and can therefore be ignored in calculations of residence time and flow velocities.

Metallic Monoliths

We ordered five metallic monoliths from Metal Methods, Inc. (Frankfort, KY). These monoliths also will have 200 cells per square inch. The samples will have a circular cross-section, 1" diameter, and a length of six inches. The volume of these monoliths will be 77.2 cm^3. At the flow rates between one and 10 slpm, the space velocities will vary from 777 hr^{-1} to 7770 hr^{-1}.

These monoliths are made by laying a corrugated metal foil on top of a flat metal foil and rolling or winding the foils into the desired diameter. In the case of a 1" diameter piece, the length of the corrugated metal foil is 12", and the length of the flat foil is 18". The excess flat foil allows for overlap and welding to hold the piece together. The cross-section of each flow path is bell-shaped. Each foil is 0.002 inches thick. Hence, the cross-sectional area of the metal foils perpendicular to the direction of flow is 0.387 cm^2. Therefore each metal monolith has 92.3% open area for flow (4.68 cm^2). We will block the flow to the innermost cell since, as part of the winding process, this cell is about four times as large as the rest. We have yet to calculate the remaining open cross-sectional area, and calculations of flow velocity, residence time, and Reynolds number will depend on the remaining cross-sectional area. All things considered, these quantities will likely turn out to be very similar to those in the ceramic monoliths.

Task I-2: Design and Fabricate Bench-Scale Equipment

Work on this task begins in April, 1996.

Task I-3: Test Bench-Scale Equipment on Pilot Combustor

Work on this task begins in July, 1996.

Task I-4: Evaluate Economics

Work on this task begins in July, 1997.

Task I-5: Reporting

We prepared and submitted the monthly reports for October (technical, status, cost management, milestone schedule, summary).

Project Plan for Next Month

In December, we expect to determine the flow resistance of the ceramic and metal monoliths and imbibe gold into the wash coats.