Multi-Pollutant Control Using Membrane –Based Up-flow Wet Electrostatic Precipitation

SECOND QUARTERLY REPORT

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ABSTRACT

This is the second quarterly report of the “Multi-Pollutant Control Using Membrane –Based Up-flow Wet Electrostatic Precipitation” project funded by the US Department of Energy’s National Energy Technology Laboratory under DOE Award No. DE-FC26-02NT41592 to Croll-Reynolds Clean Air Technologies (CRCAT). In this 18 month project, CRCAT and its team members will conduct detailed emission tests of metallic and new membrane collection material within a wet electrostatic precipitator (WESP) at First Energy’s Penn Power’s Bruce Mansfield (BMP) plant in Shippingport, Pa. Test results performed on the existing metallic WESP during November of 2002 showed consistent results with previous test results. Average collection efficiency of 89% on SO₃ mist was achieved. Additionally, removal efficiencies of 62% were achieved at very high velocity, greater than 15 ft./sec. During the first quarter of 2003 final design and start of fabrication of the membrane wet ESP was undertaken.

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1. List of Graphical materials

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2. Introduction

This is the second quarterly report of the “Multi-Pollutant Control Using Membrane –Based Up-flow Wet Electrostatic Precipitation” project funded by the US Department of Energy’s National Energy Technology Laboratory under DOE Award No. DE-FC26-02NT41592. Croll-Reynolds Clean Air Technologies (CRCAT) is the project leader and First Energy’s Penn Power’s Bruce Mansfield Plant (BMP) located in Shippingport, Pa. is the host site. Ohio University and Southern Environmental are participating team members. In this 18 month project, CRCAT and its team members will conduct detailed tests of metallic and new membrane collection material within a wet electrostatic precipitator (WESP). The project’s overall objectives are:

- To compare the performance of metallic collecting surfaces to the performance of membrane (fabric) collecting surfaces in a wet electrostatic precipitator (ESP), in terms of their efficiency in removing fine particles, acid aerosols, and mercury from an actual power plant flue gas stream.
- To determine the relative durability and overall cost-effectiveness of the membrane collectors versus metallic collectors.

Croll-Reynolds installed at BMP in 2001 a 316L stainless steel metallic pilot WESP, which uses a slipstream of flue gas from the exhaust of the venturi scrubbing system on BMP Units Nos. 2. BMP installed the WESP to test for PM_{2.5} and SO₃ mist removal as a potential control technology to reduce visible emissions. This project will utilize the existing WESP infrastructure installed at BMP as a baseline to compare the membrane technology. A new membrane WESP similar in design to the metallic WESP will be installed alongside the existing metallic WESP during May of 2003.

BMP is planning on starting up new Selective Catalytic Reduction (SCR) with ammonia injection equipment in the spring of 2003. Additionally, the plant is going to start up a SO₃ mitigation injection technology. Because it is expected that these new control systems will significantly change the composition of the flue gas, testing of the metallic WESP will be repeated during the summer of 2003 to gain a new baseline to compare the membrane WESP technology against.

3. Executive Summary

During the first quarter of 2003, final design of the pilot membrane and start of fabrication was begun. Design parameters for the membrane wet ESP were based upon design parameters of the metallic wet ESP already installed at BMO. The goal was to match as closely as possible collection surface area, velocity and electrical power between the existing metallic wet ESP and new membrane wet ESP. No major design issues were encountered and the membrane wet ESP pilot unit is on schedule for completion by end of April.

4. Experimental

Design Parameters

Parameter	Metal Wet ESP	Membrane Wet ESP
Configuration	Round	Square
# of tubes	28	16
Tube diameter	10" dia.	11 1/2" sq.
Tube Length	10' long	10' long
Collection area	724 sq. ft.	613 sq. ft.
Designed air-flow	5000 acfm	5000 acfm
Designed velocity	6 ft./sec.	6 ft./sec.
# of electrical fields	2	2
Residence Time	2 seconds	2 seconds
Specific Collection Area	145 ft. ² /1000 acfm	123 ft. ² /1000 acfm
Specific Power	2000 watts/1000 acfm	2000 watts/1000 acfm

Progress

Task one, testing of the metallic WESP, was partially completed during the 4th quarter of 2002. Task two, design and installation of the membrane WESP, was begun with design finalized and fabrication started. Task three, testing of the membrane WESP could not be performed, as Task two is not complete. Task four, reporting, was continued with the submission of this report. The project is on schedule.

Problems Encountered

Matching design parameters of the existing metallic wet ESP and the new membrane wet ESP created design issues that had to be analyzed and decided upon. The metallic wet ESP consists of 28 -10" diameter round tubes, 10' in length. Due to membrane construction configuration limitations, the membrane wet ESP must be rectangular with 16-11-1/2" square tubes. There will be 5 continuous horizontal hung sheets of membrane collection material with 12 cross sheets providing a square tubular configuration.

A drainage gutter system had to be designed to prevent splashing at the bottom of the membrane sheets. A method to hang and stabilize the membrane material had to be finalized.

Membrane collection material had to be decided upon. Based upon Ohio University tests, polypro material was selected because of its wicking properties.

Future Plans

Ohio University is developing a complete test plan for testing the metallic and membrane WESP and for longevity of the membrane material. These plans will be discussed with all interested parties and be detailed in the next quarterly report.

Ohio University is continuing to test various membrane materials.

Prospects

WESP technology is an established control technology for abatement of PM_{2.5}, SO₃ acid mist, and metals. The membrane technology promises to be a low cost alternative to expensive corrosion resistant alloys required in saturated flue gas conditions. Continued testing of various membrane materials is being conducted to select the most appropriate material. A membrane WESP would offer lower cost, continuous wetting and potentially enhanced performance than that metallic unit if reliability and longevity of the membrane material can be demonstrated.

The membrane material combined with a high velocity designed WESP that can still achieve high levels of control could substantially reduce the cost of WESP technology.

5. Results and Discussion

No testing was performed this quarter.

6. Conclusion

The membrane wet ESP pilot project is on schedule with design complete and fabrication started. Completion is expected by end of April 2003 with installation during May 2003. No major design issues were encountered.

7. References

8. Bibliography

9. List of Acronyms and Abbreviations

BMP- Bruce Mansfield Plant
CEMS – Continuous Emissions Monitors
CRCAT- Croll-Reynolds Clean Air Technologies
FE- First Energy
OU- Ohio University
PPM- parts per million
SEI- Southern Environmental, Inc.
WESP- wet electrostatic precipitator

FIGURE 1
GENERAL ARRANGMENT ELEVATION

FIGURE 2
GENERAL ARRANGMENT PLAN VIEW

FIGURE 3
PICTURES OF MEMBRANE WET ESP

FIGURE 4
PICTURE OF INSIDE MEMBRANE UNIT