Test Report

for the

Determination of Wet Scrubber Emissions

for

Johnson Controls APS Production, Inc.

Meadowbrook Plant
70 West 48th Street
Holland, Michigan

Test Date – October 30, 2013
Report Date – November 15, 2013

Prepared by:

Environmental Partners, Inc.
305 Hoover Boulevard, Suite 200
Holland, Michigan 49423

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1. *INTRODUCTION & BACKGROUND*

The Johnson Controls APS Production, Inc. (JCI) Meadowbrook Plant in Holland, Michigan manufactures lithium ion batteries predominantly for the automotive industry. The lithium ion batteries are manufactured by applying special coatings on copper and aluminum substrates to create an anode and cathode, winding the anode and cathode substrates together into a cell, and combining multiple cells to create a battery pack.

The anode and cathode slurry coatings are applied to copper and aluminum substrates, respectively, and each are dried in separate natural gas fired dryers, and wound into rolls. Deionized water (DI water) and n-methyl-2-pyrrolidone (NMP) are used as carrier solvents for the anode and cathode slurry coatings to facilitate their application to the metal substrates. The DI water and NMP carrier solvents are evolved in the dryers.

Most of the NMP is recovered and recycled within the process using a chilled condenser. A portion of the recirculated air stream from the chilled condenser is exhausted through a wet scrubber control device located in a separate building from the production process. The purpose of the scrubber is to remove residual NMP from the exhaust prior to its discharge to the atmosphere.

An emissions test was conducted to determine the NMP emissions from the wet scrubber control device by measuring the scrubber exhaust NMP concentration and air flow rate under conditions that were representative of normal production and operation.

All testing was conducted in accordance with the procedures and requirements of the Code of Federal Regulations, Title 40, Part 60 Appendix A, and Part 63 Appendix A, as applicable.

2. *PURPOSE OF THE TEST PROGRAM*

The purpose of the emissions test program was to determine the NMP emissions from the wet scrubber control device under conditions that were representative of normal production and operation. Measurements of NMP concentration and exhaust air flow rate were made in accordance with applicable EPA test methodologies. Operating parameters for the coating process (including condenser) and scrubber were monitored during the test.

3. *DESCRIPTION OF THE TEST PROGRAM*

The volumetric flow rate of the scrubber exhaust gas stream was determined using EPA Methods 1 – 4. Concentrations of NMP were measured in the wet scrubber exhaust using EPA Method 320.

The mass emission rate of NMP at the control device exhaust was determined as the product of the corresponding volumetric flow rate and NMP concentration for that test run, as follows:

$MER\ NMP_n = Volumetric\ Flow\ Rate\ Q_n \times Concentration\ NMP_n \times 1.5437 \times 10^{-5}$

Where: $MER\ NMP_n$ = Mass Emission Rate of NMP for Test Run n (lbs/hr)
Q_n = Volumetric Flow Rate for Test Run n (scfm)
$Concentration\ NMP_n$ = Average NMP concentration during Test Run n (ppmv)
1.5437×10^{-5} = Conversion Factor
n = Test Run Number (1 – 3)

Three 1-hour test runs were performed. For each test run, the mass emission rate of NMP at the scrubber exhaust was determined as the product of the respective volumetric flow rate and average NMP concentration as described above. The final emission result of the test is the 3-run average of the NMP emission rates as shown in Section 5 of this test report.

Throughout the duration of the test program the coating process (including condenser), and scrubber operating parameters were monitored.

4. *TEST METHODOLOGIES AND SCHEDULE*

NMP concentrations and exhaust flow rates were measured on the exhaust from the wet scrubber control device. All testing was conducted in accordance with the procedures and requirements of the *Code of Federal Regulations, Title 40 Part 60 Appendix A, and Title 40 Part 63 Appendix A* as follows:

Method	Method Description and Parameters
USEPA Method 1	Sample and Velocity Traverses for Stationary Sources
USEPA Method 2	Determination of Stack Gas Velocity and Volumetric Flow Rate
USEPA Method 3A	Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)
USEPA Method 4	Determination of Moisture Content in Stack Gases
USEPA Method 320	Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared (FTIR) Spectroscopy

All QA/QC procedures and methodologies of the above test methods were followed in accordance with the respective methods. A description of the test methodologies is contained in the test plan, included as Attachment A.

5. *TEST RESULTS*

The results of the test program are summarized in the table below:

Run	NMP Concentration (ppm)	Volume Flow Rate (scfm)	NMP Mass Emission Rate (lbs/hr)
1	< 1	2431	< 0.038
2	< 1	2378	< 0.037
3	< 1	2375	< 0.037
Average	< 1	2394	< 0.037

As shown above, concentrations of NMP in the wet scrubber exhaust were below the detection limit of the method. The three run average NMP mass emission rate from the wet scrubber exhaust controlling the coating operation was < 0.037 lbs/hour.

Included in Attachments B and C are the process and control device parametric values observed during the test program. For the process, the Condenser Chilled Water Supply Temperature was less than 10°C, the Condenser SLA Post Demister Temperature was less than 20°C, the Cathode Coating Line Speed was approximately 25 meters/minute, and the NMP application rate was approximately 2,200 grams/minute. For the control device, the scrubber pressure drop was approximately 1 inch of H_2O, and the total scrubber water flow rate (sum of the recycle rate and make-up rate) was approximately 470 liters/minute.

Included in Attachment D is a complete test report including the measured NMP concentrations, exhaust flow measurement data, calculation tables, and equipment calibration data sheets.

LIST OF ATTACHMENTS

A Test Plan
B Operational Parameter Field Data Sheets
C Table of Operational Parameters
D Test Report – Stack Test Group and Prism Analytical