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DTE Energy

VIA CERTIFIED MAIL

September 22, 2014

Mr. Brian Carley, Environmental Quality Specialist
Air Quality Division
Michigan Department of Environmental Quality
301 E. Louis B. Glick Highway
Jackson, MI 49201-1556

Re: DTE Electric Company – Monroe Power Plant's Response to the MDEQ-AQD Violation Notice of August 25, 2014 for Compliance Stack Testing of Monroe Power Plant – Unit 1 & Unit 3

Dear Mr. Carley:

This letter is DTE Electric Company's response to the Michigan Department of Environmental Quality, Air Quality Division (MDEQ-AQD) Violation Notice dated August 25, 2014 (VN) sent to Monroe Power Plant. The VN cites the failure of compliance stack emission tests for particulate matter (PM) performed on Monroe Unit 1 on July 8, 2014 and Monroe Unit 3 on July 9, 2014. The results of these tests were documented in the test report sent to MDEQ-AQD on September 8, 2014. The tests performed were required periodic compliance testing per Permit to Install (PTI) 27-13. This response incorporates by reference DTE Electric Company's September 8, 2014 test report submittal. It also incorporates the results of subsequent PM compliance testing performed on Unit 1 (July 29, 2014) and Unit 3 (August 19, 2014) which show compliance with the permit limit. The test report for that testing was also submitted on September 8, 2014. A summary of the permit PM emission limit and these stack tests is provided in the following table.

Monroe Power Plant Unit 1 & Unit 3 PM Emissions Summary (lb/mmBtu)

Unit	Date	Permit Limit (lb/mmbtu)	Test Result (lb/mmbtu)
Unit 1	July 8, 2014	0.011	0.014
Unit 3	July 9, 2014	0.011	0.013
Unit 1	July 29, 2014	0.011	0.007
Unit 3	August 19, 2014	0.011	0.005

During Unit operation, DTE Electric Company monitors many operational parameters for each of their pollution control processes. This data includes but is not limited to electrostatic precipitator performance, opacity, sulfur trioxide feed rate and conversion percentages, selective catalytic reduction (SCR) nitrogen oxides reduction efficiency and ammonia slip, flue gas desulfurization (FGD) system liquid and gas stream flow rates, reaction chemistries and sulfur dioxide (SO_2) removal efficiencies, as-fired fuel analysis, boiler load and heat rates as well as emissions monitoring of carbon monoxide, carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury. At the times of all emissions testing referenced, all of these parameters were within normal operating ranges.

PM emissions are controlled primarily by the ESP & FGD systems. The FGD provides for the plant's ability to meet the stringent PM emission limits set forth in PTI 27-13, which are among the lowest PM emissions in the country. Furthermore, the testing performed on Unit 1 was done shortly after initial startup of FGD systems on that unit. All FGD equipment is new and any equipment upgrades made and lessons learned from equipment installed previously on Units 3 & 4 were incorporated into the Unit 1 installation. As you know, many parameters are monitored during operation. The investigation into these test results showed no issues with any equipment. The included boiler, ESP, FGD & other equipment in operation at the time of the testing and showed no evidence related to the excess emissions.

After the initial investigation into plant and equipment operation found no issues, the investigation turned to the stack testing process. A thorough investigation was done to identify any potential issues with anything related to the stack testing process. DTE Energy contracted RMB Consulting to further investigate issues associated with the testing. RMB provided DTE with two documents related to these issues. The findings of this investigation are outlined below and the documents are attached to this submittal.

Stack Test Methods for Particulate Matter

There are two typical test methods used for testing PM emissions; EPA Reference Method (RM) 5 and Method 5B. The following provides a summary of the attached RMB analysis *Applicability of Reference Method 5B to Measure Filterable Particulate Matter* which is attached for reference.

All coal-fired electric generating units (EGUs) constructed since the 1970s are subject to filterable PM emission standards specified in either Subpart D or Da of 40 CFR Part 60. Both Subparts specify the use of RM 5 unless the unit is equipped with wet FGD to control SO2 emissions which are utilized on the Monroe units. Both Subparts specify using RM 5B when the sampling location is downstream of a wet FGD system which is the case on the Monroe units. This difference in test method specification is due to potentially significant sulfuric acid biases and the limitations of RM 5 at sample locations downstream of wet FGD equipment.

RM 5B is used at test locations downstream of wet FGD as the stack temperatures in those locations is well below the dew point for sulfuric acid and near the dew point for nitric and hydrochloric acids. Collection of these acids using RM 5 can lead to positive biases due to reactions of the acids with other components in the sample effluent (i.e. SO2). RM 5B deviates from RM 5 in two key areas to minimize the effect of these acid gases on filterable PM measurement. The first is the increase in sample probe & filter temperature (248°F to 320°F). This allows for the effluent sample temperature to be above the acid dew point to minimize collection of acids on the filter. In addition RM 5B requires the sample filters to be baked in order to drive off any acids collected on the sample filter.

RM 5 was developed prior to the commercial use of wet FGD technology and was not designed for use in that type of sampling environment. Effluent downstream of a wet FGD tends to be super-saturated and RM5 is not equipped to handle these conditions. Water droplets are present in these conditions. The sample filter in effect becomes a small scrubber for SO2 and other acid gases when these water droplets reach the filter.

Particulate Matter Testing Filter Types

As emission standards for filterable PM from EGUs has gotten tighter over time, some limitations and potential biases with the reference method have been revealed. Any bias encountered in testing can impact compliance with such stringent limits. One potential bias is that found due to filter type. The following provides a summary of the attached RMB analysis *Bias Associated with Glass-Fiber Filters for Filterable PM Testing* which is attached for reference.

The two main types of filters used in PM testing are borosilicate glass fiber and quartz. In RM 5 EPA cites a report which shows a clear positive bias in PM measurements in the presence of sulfur oxides for some glass-fiber media. Impurities in borosilicate glass are measured in percent while impurities in quartz are measured in parts per million.

The PM emission limit for the Monroe units (0.011 lb/mmBtu) correlates to a collected mass of about 10 mg or less on the filter. Any bias associated with the filter can have a significant impact in relation to that small mass collection. In a paper referenced by EPA in RM 5 it indicates that there could be a 30% error in measurement due to SO2 reacting on glass fiber. Studies have found that quartz-fiber filters are non-reactive to SO2. Enthalpay Analytical, a lab company that provides filters to stack testing companies stated to RMB that over 95% of the filters they now sell are quartz-fiber due to inorganic salts found in borosilicate glass-fiber filters. Several testing companies also indicated to RMB that they use quartz filters for all of their testing. In addition, the filterable PM emission limit for coal-fired EGUs under the Mercury and Air Toxics Standards was set based on data collected using quartz-fiber filters.

Previous PM Testing at Monroe Power Plant

Emissions compliance testing performed at Monroe Power Plant since 2011 has been done with FGD systems in operation. The following table summarizes the results of compliance testing done for PM since the FGD system was installed.

Date	Unit	Test Method	Filter Type	PM (lb/mmBtu)
May 10, 2011	Unit 3	5	Glass	0.004
May 13, 2011	Unit 4	5	Glass	0.008
August 30, 2011	Unit 4	5B	Quartz	0.005
September 1, 2011	Unit 3	5B	Quartz	0.002
December 1, 2011	Unit 4	5B	Quartz	0.005
December 5, 2011	Unit 3	5B	Quartz	0.004
March 19, 2012	Unit 3	5B	Quartz	<0.0008
May 24, 2012	Unit 4	5B	Quartz	0.005
August 14, 2012	Unit 3	5B	Quartz	0.004
March 20, 2013	Unit 4	5B	Quartz	0.005
June 12, 2013	Unit 3	5B	Glass	0.003
August 16, 2013	Unit 4	5B	Glass	0.004
September 10, 2013	Unit 4	5B	Glass	0.014
September 12, 2013	Unit 3	5B	Glass	0.011
October 29, 2013	Unit 3	5B	Quartz	0.005
October 31, 2013	Unit 4	5B	Quartz	0.007

March 4, 2014	Unit 4	5B	Quartz	0.002
March 25, 2014	Unit 3	5B	Quartz	0.008
April 3, 2014	Unit 1	5	Glass	0.007
May 8, 2014	Unit 3	5	Glass	0.011
May 9, 2014	Unit 4	5	Glass	0.010
July 8, 2014	Unit 1	5	Glass	0.014
July 9, 2014	Unit 3	5	Glass	0.013
July 10, 2014	Unit 4	5	Glass	0.009
July 29, 2014	Unit 1	5	Glass	0.013
July 29, 2014	Unit 1	5	Quartz	0.007
July 30, 2014	Unit 1	5	Glass	0.014
July 30, 2014	Unit 1	5B	Glass	0.011
August 19, 2014	Unit 3	5B	Quartz	0.005

As you can see from the table, different test methods and filter types have been used since 2011. The initial investigation into the July 2014 testing showed no operational or equipment issues as described previously. In light of the apparent increased emissions seen in 2014, extensive analysis of our testing procedures and data was also done. This included intricate analysis of the material collected on the filter media during testing. The lab analysis conducted indicated a high level of sulfates in addition to filterable PM such as fly ash. This finding led us to concur with the RMB analyses that were outlined above and attached to this response. Subsequent testing comparing methods and filters at similar conditions done in July and August 2014 proved that there was indeed bias associated with RM 5 and glass-fiber filters.

Analyzing the data in the table shows several key items that substantiate the scientific background provided by the RMB papers. First, the average emission rate shown by the testing when using quartz filters was 0.0046 lb/mmBtu while the average for glass-fiber filters was 0.0097 lb/mmBtu. Of the 29 tests completed on all of the units, there were ten tests which showed emissions of greater than 0.008 lb/mmBtu. All ten of these tests were done with glass-fiber filters. The highest emissions found when using quartz filters was 0.008 lb/mmBtu. When looking at the impact of the test method on the results, the average emissions when using RM 5B was 0.0056 lb/mmBtu versus 0.010 lb/mmBtu on average using RM 5.

Additionally, during a 2011 Electric Power Research Institute (EPRI) PM CEMS demonstration project at Monroe Power Plant, a clear bias was shown in the filterable PM concentration using glass-fiber versus quartz filters. PM concentrations observed when using glass-fiber filters was approximately 37% higher than when using quartz filters while the most reliable PM CEMS in use at the time showed only a 14% increase.

Status of the Particulate Matter Monitoring

Per PTI 27-13 SC VI.3, DTE Electric Company must implement a method to continuously monitoring particulate emissions from all of its FGD controlled units by January 1, 2015. The current plan is to install PM CEMS on all four units at Monroe Power Plant. We have performed engineering and planning on the monitors. We also recently purchased monitors which are being fabricated currently. It is expected that installation work will begin early in the 4^{th} quarter of 2014. The PM emissions monitors will provide real-time data to assess emissions limit compliance as well as signal possible operational or equipment issues. The monitors will be a significant upgrade in our capability to continuously monitor emissions compared to the current periodic stack testing.

Quarterly PM emissions stack testing will continue until the continuous PM monitors are installed, certified and in operation. DEQ will be notified of all planned testing as required. Operation of the FGD and associated equipment will continue to be monitored as well as has been committed to in the past.

Summary & Conclusions

It is clear from the documents and data provided that there are inherent issues with PM testing under certain conditions. Literature cited by EPA in RM 5 points to a clear bias in filterable PM measurement when using glass-fiber filters at sample locations where SO2 is present in the effluent and the bias is more prevalent in high or saturated moisture environments. The literature cited clearly shows that glass-fiber filters have the potential to show significant positive bias in the presence of sulfur oxides due to a chemical reaction in the filter substrate to form sulfates. Quartz filters provide the best media for performing PM emissions testing as they have the lowest levels of background contaminants and low potential for biases. RM 5B is the preferred test method due to the stack temperature at the sample locations downstream of wet FGD systems being at or below the dew point of certain acids. If these acids are collected on the sample filter, they can react with other components in the stack effluent to yield an erroneously high bias in the filterable PM mass. Testing for emissions using RM 5B with quartz filters is the best way to get accurate, unbiased results for filterable PM emissions.

In light of the evidence provided above, DTE Energy believes that the emissions shown in the testing for which the Violation Notice dated August 25, 2014 was issued in fact were not an actual emissions limit violation. Rather, interference related to the test method &/or filter type caused the results to be biased high based on contaminants and reactions on the filter. The actual filterable PM emissions, in reality are more in line with testing done using RM 5B and quartz filters. Since discovering the issues related to glass-fiber filters and RM 5, we have used RM 5B and quartz filters only and plan to do so for any future testing on units equipped with wet FGD systems. Due to the interference encountered during the testing and the supporting information provided herein, we are requesting that the August 25, 2014 Violation Notice be rescinded.

If you have any questions on the information contained herein or would like further information, please contact Mr. Barry Marietta at (313) 235-5611 or mariettab@dteenergy.com.

Sincerely,

Inderpal Deol
Plant Manager – Monroe Power Plant

Cc (electronic): S. Miller – MDEQ Jackson
S. Boyd – DTE Energy
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APPLICABILITY OF REFERENCE METHOD 5B TO MEASURE FILTERABLE PARTICULATE MATTER

Measurement at Sample Locations Downstream of
Wet Flue-Gas Desulfurization System

AUGUST 1, 2014

DTE ENERGY

Prepared by: Russell Berry & Jack Martin of RMB Consulting & Research, Inc.

Applicability of Filterable PM Reference Method 5B

As filterable particulate matter (PM) emission limits approach the abilities of "better-performing" PM control equipment installed on coal-fired electric generating units (EGU), the accuracy and limitations associated with each PM reference method becomes increasingly significant. All coal-fired EGU's constructed since the 1970s and capable of generating more than 73 megawatts (MW) or combusting greater than 250 million British thermal units per hour (mmBtu/hr) are subject to filterable PM emission standards specified in either Subpart D or Da of 40 CFR Part 60. Both Subpart D and Da specify that the test method to be used to determine compliance with the filterable PM emission standard is Reference Method (RM) 5, unless the affected unit is equipped with wet flue gas desulfurization (WFGD) system to control sulfur dioxide (SO_2) emissions. Both Subpart D and Da specify using RM 5B when the sampling location is downstream of a WFGD. In addition, both Subpart D and Da allow for the sample probe and sample filter temperature to be increased to no greater than 320 °F (±25 °F), regardless of the reference method selected. EPA clearly recognizes the potentially significant sulfuric acid biases and the limitations of RM 5 at sample locations downstream of WFGD to provide an accurate filterable PM measurement, thus specifies the use of RM 5B for those locations. Although DTE Energy's Monroe Station is not subject to the filterable PM emission standards in Subparts D or Da, the requirement for using RM 5B as the filterable PM method should be applicable to the sample locations downstream of the WFGD at the Monroe Station.

Technical Discussion

RM 5B is used at test locations downstream of a WFGD because the stack temperatures (~125 °F) at those sites are well below the dew point for sulfuric acid and right at the dew point for nitric and hydrochloric acid. The collection of these acids on the sample filter at the lower RM 5 sample filter temperature of 248 °F can lead to positive biases in the mass gain due to chemical reactions of these acids with other components in the sample effluent (i.e., SO_2). RM 5B deviates from RM 5 in two key areas to minimize the effect of these acid gases on the filterable PM measurement. The first and readily apparent deviation is the increase of the sample probe and filter temperature from 248 °F to 320 °F. This is designed to get the effluent sample temperature above the acid dew point to minimize the collection of acids on the filter substrate. In addition, RM 5B requires the tester to bake the sample filters for 2-3 hours at 320 °F (±10 °F) prior to getting a tare weight for each sample filter, and to bake the recovered sample filter for 6-hours at 320 °F (±10 °F) prior to getting the final filter weight. The post-test baking of the sample filters is used to drive-off any acids that may have collected on the sample filter. The pre-test baking of the filters is to ensure that the initial sample filter tare weights are accurate compared to the baked, post-test sample filters.

RM 5 was developed prior to the commercial use of WFGD technology and not designed for use in that type of sampling environment. The effluent downstream of a WFGD tends to be super-saturated which often leads to water droplets in the effluent stream. RM 5 is not equipped to handle super-saturated test conditions. The sample probe temperatures (i.e., ~250 °F) are frequently not high enough and the sample rates are too fast to volatize the droplets prior to them reaching the sample filter. When water droplets reach the sample filter, the sample filter in affect becomes a small scrubber for SO_2 and other acid gases (i.e., SO_3, NO_2 etc.) that are soluble in water. RM 5B was designed to operate at the higher temperature which:

1. Is above the acid dew point,
2. Results in a high temperature driving force,
3. Increases the rate of heat transfer to the sample, and
4. Keeps the sample contact surfaces and filter dry, minimizing the "scrubbing effect" impacts, and other potentials of positive biases associated with sampling downstream of a WFGD.

Extended Sample Times

The extension of sample times can reduce the percent error associated with filterable PM sampling. The extension of the sample time does two things to improve the precision of the data by 1) increasing the sample mass collected and 2) increasing the sample volume. Almost all the error associated with measuring filterable PM is static and is independent of the sample time. Therefore, by increasing the sample time, thus increasing the collected sample mass and sample volume, the percent error associated with the measurement will decrease. For example, the uncertainty in the measurement of PM mass is ±1.0 mg (i.e., ±0.5 mg for both sample filter and probe rinse mass determinations). The units at DTE Energy's Monroe Station have a filterable

PM emission limit of 0.011 lb/mmBtu, which is equivalent to ~12 mg/scm. For a 60-minute sample time, the sample volume will be a little over 1.0 scm[1] for a typical test run, with an expected collected mass of ~12 mg at the emission standard. The uncertainty in the measured sample mass would be ~8 % just based on the error associated with weighing the sample filter and probe rinse residue. This does not include any uncertainty associated with the handling of the sample filter and performing the test method. By simply increasing the sample time to 120-minutes[2], the uncertainty in measuring the sample mass is reduced to ~4%, assuming the collected sample mass on the filter also doubles.

Summary

The regulatory precedence for measuring filterable PM at sample locations downstream of a WFGD system is the use of RM 5B. RM 5B is the preferred test method because:

- The stack temperature at sample locations downstream of WFGD systems are below or at the dew point certain acids that are common in the effluent of coal-fired boilers. These acids, if collected on the sample filter, will react with other components in the stack effluent to yield an erroneously high bias in the filterable PM mass.

- RM 5 was designed prior to the widespread use of WFGD systems and was not designed to handle the super-saturated moisture conditions often found at sample locations downstream of a WFGD. RM 5B requires operating the sample probe and filter temperatures at a higher set point (i.e., 320 °F instead of 248 °F) to minimize the potential of water droplets collecting on the sample filter.

The uncertainty associated with the filterable PM measurement is improved with an increase in the collected sample mass and sample volume. Both the sample mass and sample volume can be increased by extending the test run time of the reference method. This is based on the fact that a majority of the errors associated with the filterable PM reference method are static and independent of the sample run length.

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[1] The sample volume during a test run is a function of the sample nozzle diameter. As the sample nozzle diameter increases, the collected sample volume will increase.

[2] The required sample time for Subpart Da units.

Conclusions

It is uncertain how extended sampling times would affect the positive bias associated with acid gases reacting on the sample filter. Extended sample times may allow for an increase in the chemical reactions that take place on a sample filter, but RMB believes that using RM 5B with quartz filters for compliance testing at units equipped with WFGD systems will provide the most accurate filterable PM results currently possible.

BIAS ASSOCIATED WITH GLASS-FIBER FILTERS FOR FILTERABLE PM TESTING

Glass-Fiber vs. Quartz for Reference Method 5 Sampling

AUGUST 1, 2014

DTE ENERGY

Prepared by: Russell Berry & Jack Martin of RMB Consulting & Research, Inc.

Introduction

Since the initial development and implementation of EPA's Reference Method (RM) 5 in the 1970's, the emission standard for filterable particulate matter (PM) from coal-fired boilers has become progressively tighter. This tightening or lowering of the filterable PM emission standard over the years has revealed some limitations and potential biases associated with the Reference Method. Section 7.1.1 of RM 5 specifies the use of "glass fiber filters, without organic binders." For years, testers used borosilicate glass filters to perform RM5 testing; however, over the last 10 to 15 years, in the presence of acid gases, EPA has also allowed the use of other types of glass fiber filters. Section 7.1.1 of RM 5 also references a report titled "Inertial Cascade Impactor Substrate Media for Flue Gas Sampling," which shows a clear positive bias in PM measurements in the presence of sulfur oxides for some glass-fiber filter media. This is not a new issues but has become increasingly significant as source emissions of PM have been reduced. For years, some testing companies have been using exclusively quartz filters for EPA Reference Method testing. There are many differences between borosilicate glass and quartz, either pure- or synthetic-fused silica types. The main difference is the percentage of silica or SiO_2 relative to other compounds in the glass. Borosilicate is usually in the 80% silica range, while quartz is over 99%. Quartz is also capable of handling much higher temperatures up to 1,100° C. Impurities in borosilicate glass are measured in percent; impurities in quartz are measured in parts per million (ppm).

As part of the emissions testing performed for EPA's 2010 oil- and coal-fired electric generating unit (EGU) "Information Collection Request" (ICR), PM emissions were pre-dominantly collected as part of the RM 29 sampling trains. RM 29 recommends the use of quartz fiber filters, due to the ability of the quartz filters to meet the blank metals content criteria. Thus, the Mercury and Air Toxics Standard (MATS) filterable PM emission limit for coal-fired EGU's was based on data collected using quartz fiber filters.

In 2011, DTE Energy's Monroe Station hosted an Electric Power Research Institute (EPRI) demonstration project for PM continuous emission monitoring systems (CEMS). As part of this study, a correlation test was conducted using RM 5 for 12 of the correlation test runs and RM 29 for the final three (3) correlation test runs[1]. For the correlation testing, the RM 5 sample trains used glass fiber filters and the RM 29 sample trains used the quartz fiber filters. A review of the data showed a noticeable difference between the RM 5 filterable PM results and the RM 29 filterable PM results.

Reported Biases Associated with Glass-Fiber Filters

The coal-fired boilers at DTE Energy's Monroe Station are equipped with electrostatic precipitators (ESP), selective catalytic reduction (SCR), and wet flue-gas desulfurization scrubbers (WFGD) to control emissions of PM, nitrogen oxides (NO_x) and sulfur dioxide (SO_2), respectively. In addition, sulfur trioxide (SO_3) is added to the boiler exhaust to improve the capture efficiency of the ESP. The WFGD also serves as a secondary PM removal device.

The PM emission limit at the Monroe Station is 0.011 pounds per million British thermal units (lb/mmBtu), which is equivalent to a PM concentration of ~10.5 milligrams per standard cubic meter (mg/scm). Based on a traditional 60-minute compliance test run, the collected mass would be about 10 mg or less. Thus any biases associated with a filter media could have significant consequences when demonstrating compliance with such a low PM emission standard.

In a paper referenced in Section 7.1.1 of RM 5, it notes that work (Gelman, 1975) performed by Charles Gelman and J.C. Marshall of the Gelman Instrument Company (makers of filter media at the time the paper was published, 1977) confirmed the results of a previous study performed by Forest and Newman (Forrest, 1973) indicating mass gains of glass-fiber filters are possible in the presence of SO_2. The Gelman report stated "…SO_2 reaction on glass fiber could cause 'a 30% error in the measurement of total suspended particulate matter' in an urban atmosphere," and it is suspected the error would be even higher for flue gases that have high moisture contents[2] (e.g., downstream of a wet scrubber). In the Gelman study, both glass-fiber and quartz-fiber filters were tested, and the quartz-fiber filters were found to be non-reactive to SO_2. The paper referenced in Section 7.1.1 of RM 5 was assessing the performance of filter media in impactor substrates and did not conduct any further tests with quartz-fiber filters due the quartz-fiber material being too fragile for use in an impactor. The study noted that mass gains in the glass-

[1] The site was also host to a separate EPRI funded project examining the use of a continuous metals monitoring system. The RM 29 test runs were incorporated into the PM CEMS correlation testing to assess the performance of the continuous metals measurement.

[2] The moisture content downstream of the WFGD at the Monroe Station is ~13% or higher.

fiber filters were due to the formation of sulfates on the filter "due to a gas phase reaction with [sulfur oxides]." The mass collected on impactor substrates for doing particle sizing is on par with the expected filterable PM masses collected today on coal-fired units to demonstrate compliance with the filterable PM emission limit. Note that none of these references directly studied low PM emissions from EGUs but the finding can be directly applied to current testing scenarios.

It is suspected that the bias associated with glass-fiber filters during the promulgation and implementation of RM 5 was not significant enough to affect the compliance status of units at that time (which typically were subject to PM limit over 0.1 lb/mmBtu), thus the less-expensive glass-fiber filters were used and incorporated into the method. In looking at current pricing for PM filters, the quartz-fiber filters are almost three times the cost of the glass-fiber filters.

Enthalpy Analytical, a laboratory company that provides pre-tared filters to stack test companies, stated that over 95% of the filters they now sell are quartz-fiber, because of inorganic salts typically found in the borosilicate glass-fiber filters. This high background of inorganic salts also limits the ability to analyze filters for diagnostic purposes "after-the-fact" when the filterable PM results are suspiciously high. During resent conversations, several prominent testing companies also indicated to RMB that they use quartz filters for all of their testing.

Data Collected at DTE Energy's Monroe Station

In late 2010, DTE Energy's Monroe Station served as host to EPRI's PM Demonstration Project and a separate EPRI project assessing the variability of the multi-metals using Cooper Environmental Services' (CES) XACT™ 640, an automated multi-metal continuous emissions monitoring system (CEMS). As part of both EPRI projects, filterable PM and multi-metals testing were performed in February 2011. The primary purpose of the test program was to conduct correlation testing on the PM CEMS that were installed as part of the PM Demonstration Project, but as part of the correlation testing, the last three PM tests were combined with a RM 29 sampling train to assess the performance of the XACT™ 640. The initial correlation test runs were conducted using RM 5 and glass-fiber filters. The last three correlation test runs were performed using RM 29 and quartz-fiber filters. The correlation test program was performed over the course of four test days starting on January 31, 2011. The RM 29 tests were performed on February 3, 2011. An attempt was made to elevate the PM emissions on the second day of the test program (February 1, 2011) with very little success. For purposes of this paper, RMB looked at the RM 5 filterable PM test results from the tests conducted on February 2nd for comparison to the RM 29 filterable PM test results conducted on February 3rd. Included in the data is the average reading from the PCME PM CEMS during each of the test runs. The PCME PM CEMS was the most consistent instrument during the PM Demonstration Project, and its readings serve as a good indicator of any changes in the PM concentration over the test period. Table 1 provides a summary of the filterable PM concentration test data collected on February 2 and 3, 2011 on Monroe Station's Unit 4.

Table 1
Summary of Filterable PM Test Results - Monroe Station Unit 4

Test ID	Test Date	Test Method (Filter Media)	Reference PM (mg/scm)	PCME (mg/scm)
8	February 2, 2011	RM 5 (Glass-fiber)	6.22	2.64
9			5.23	2.56
10			6.75	3.03
11			5.01	2.73
12			5.66	2.60
		Daily Average:	**5.77**	**2.71**
13	February 3, 2011	RM 29 (Quartz-Fiber)	4.72	2.33
14			3.50	2.25
15			2.73	2.39
		Daily Average:	**3.65**	**2.32**

The average Reference Method filterable PM result on February 2nd was 5.77 mg/scm, and the average PCME reading during the same time period was 2.71 mg/scm. The PCME average PM reading on the following day dropped to 2.32 mg/scm or a change in the filterable PM reading of 14.4%. The average reference method filterable PM result from the RM 29 sampling train on February 3rd was 3.65 mg/scm or a change in the filterable PM measurement of 36.7%.

The difference in filterable PM measurements between the glass- and quartz-fiber filters collected during the correlation test in February 2011 are consistent with the data collected recently (i.e, July 2014) at the Monroe Station and the biases observed in EPA's RM 5 references. Filterable PM measurements made using a glass-fiber filter had an emission rate of 0.013 lb/mmBtu, and the filterable PM emission rate using a quartz-fiber filter had an emission rate of 0.007 lb/mmBtu. That is a difference of ~46% between the glass-fiber and quartz-fiber filters.

Summary

The use of glass-fiber filters to measure low filterable PM concentrations (i.e., <10 mg/scm) can yield a significant positive bias relative to quartz-fiber filters. The use of quartz-fiber filters provide a more accurate measurement of filterable PM. The literature and data presented in this paper are summarized below:

- Literature cited in RM 5 show a clear bias in the filterable PM measurement when using glass-fiber filters at sample locations where sulfur oxides were present in the effluent. Some glass-fiber filters showed a positive bias up to 30%. This bias is expected to be even more prevalent in high or saturated moisture environments.

- The filterable PM standard for existing EGU's specified in 40 CFR Part 63, Subpart UUUUU promulgated in February 2012 was based on filterable PM emissions collected during the 2010 EGU ICR, which a majority were collected as part of a RM 29 sampling train. All the RM 29 sampling trains were performed using quartz-fiber filters to collect the filterable PM.

- Most stack test firms are now using quartz-fiber filters to measure filterable PM due to the high background of inorganic salts found in glass-fiber filters. The high background of inorganic salts prevents useful post-test examination of the filters in the event of questionable test results.

- Data collected as part of a 2011 EPRI PM CEMS Demonstration Project at DTE's Monroe Station showed a clear bias in the filterable PM concentration using glass- versus quartz-fiber filters. The reference method filterable PM concentration measured using glass-fiber filters was ~37% than the filterable PM concentration measured using quartz-fiber filters. The most reliable PM CEMS operating during the test program only showed a ~14% increase in the PM concentration during same time period.

Conclusions

The literature cited in RM 5 clearly show that glass-fiber filters have the potential to show significant positive bias in the presence of sulfur oxides due to a chemical reaction in the filter substrate to form sulfates. Hydrogen chloride and nitrogen oxides may also contribute to this bias. As the filterable PM emission limits have become tighter since development of RM 5, the positive bias due to the presence of acid gases has become significant enough to possibly affect the compliance status of coal-fired units. Over the course of a 1-hour test run, a positive bias of 1-3 mg is significant. The filter media recommended for EGUs and predominantly used by test firms is quartz. The use of quartz-fiber filters has become typical at EGUs for EPAs test methods due to the low-levels of background contaminates and low potential for biases in the results.

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