FLUOROMONOMERS
MANUFACTURING PROCESS
VE SOUTH STACK
EMISSIONS TEST REPORT
TEST DATES: 22-23 MAY 2019

THE CHEMOURS COMPANY
FAYETTEVILLE, NORTH CAROLINA

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W.O. No. 15418.002.014

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1. INTRODUCTION

1.1 FACILITY AND BACKGROUND INFORMATION

The Chemours Fayetteville Works (Chemours) is located in Bladen County, North Carolina, approximately 10 miles south of the city of Fayetteville. The Chemours operating areas on the site include the Fluoromonomers, IXM and Polymer Processing Aid (PPA) manufacturing areas, Wastewater Treatment, and Powerhouse.

Chemours contracted Weston Solutions, Inc. (Weston) to perform HFPO Dimer Acid emission testing on the Vinyl Ethers (VE) South Stack. Testing was performed on 22 and 23 May 2019 and generally followed the "Emissions Test Protocol" reviewed and approved by the North Carolina Department of Environmental Quality (NCDEQ). This report provides the results from the emission test program.

1.2 TEST OBJECTIVES

The specific objectives for this test program were as follows:

- Measure the emissions concentrations and mass emissions rates of HFPO Dimer Acid from the VE South stack which is located in the Fluoromonomers process area.
- Monitor and record process data in conjunction with the test program.
- Provide representative emissions data.

1.3 TEST PROGRAM OVERVIEW

During the emissions test program, the concentrations and mass emissions rates of HFPO Dimer Acid were measured on the VE South Stack.

Table 1-1 provides a summary of the test locations and the parameters that were measured along with the sampling/analytical procedures that were followed. Section 2 provides a summary of test results. A description of the process is provided in Section 3. Section 4 provides a description of the test location. The sampling and analytical procedures are provided in Section 5. Detailed test results and discussion are provided in Section 6.

Appendix C includes the summary reports for the laboratory analytical results. The full laboratory data package is provided in electronic format and on CD with each hard copy.

Table 1-1
Sampling Plan for VE South Stack

Sampling Point & Location	**VE South Stack**				
Number of Tests:	3 (VE South Stack)				
Parameters To Be Tested:	HFPO Dimer Acid (HFPO-DA)	Volumetric Flow Rate and Gas Velocity	Carbon Dioxide	Oxygen	Water Content
Sampling or Monitoring Method	EPA M-0010	EPA M1, M2, M3A, and M4 in conjunction with M-0010 tests	EPA M3/3A		EPA M4 in conjunction with M-0010 tests
Sample Extraction/ Analysis Method(s):	LC/MS/MS	NA[6]	NA		NA
Sample Size	> 1m^3	NA	NA	NA	NA
Total Number of Samples Collected[1]	3	3	3	3	3
Reagent Blanks (Solvents, Resins)[1]	1 set	0	0	0	0
Field Blank Trains[1]	1 per source	0	0	0	0
Proof Blanks[1]	1 per train	0	0	0	0
Trip Blanks[1,2]	1 set	0	0	0	
Lab Blanks	1 per fraction[3]	0	0	0	0
Laboratory or Batch Control Spike Samples (LCS)	1 per fraction[3]	0	0	0	0
Laboratory or Batch Control Spike Sample Duplicate (LCSD)	1 per fraction[3]	0	0	0	0
Media Blanks	1 set[4]	0	0	0	0
Isotope Dilution Internal Standard Spikes	Each sample	0	0	0	0
Total No. of Samples	7[5]	3	3	3	3

Key:

[1] Sample collected in field.

[2] Trip blanks include one XAD-2 resin module and one methanol sample per sample shipment.

[3] Lab blank and LCS/LCSD includes one set per analytical fraction (front half, back half and condensate).

[4] One set of media blank archived at laboratory at media preparation.

[5] Actual number of samples collected in field.

[6] Not applicable.

2. SUMMARY OF TEST RESULTS

Three tests were performed on the VE South stack. Table 2-1 provides a summary of the HFPO Dimer Acid emission test results. Detailed test results summaries are provided in Section 6.

It is important to note that emphasis is being placed on the characterization of the emissions based on the stack test results. Research conducted in developing the protocol for stack testing HFPO Dimer Acid Fluoride, HFPO Dimer Acid Ammonium Salt and HFPO Dimer Acid realized that the resulting testing, including collection of the air samples and extraction of the various fraction of the sampling train, would result in all three compounds being expressed as simply the HFPO Dimer Acid. However, it should be understood that the total HFPO Dimer Acid results provided on Table 2-1 and in this report include a percentage of each of the three compounds.

Table 2-1

Summary of HFPO Dimer Acid Test Results

Source	Run No.	Emission Rates	
		lb/hr	g/sec
VE South Stack	1	3.79E-03	4.78E-04
	2	1.19E-03	1.50E-04
	3	1.56E-03	1.96E-04
	Average	2.18E-03	2.75E-04

3. PROCESS DESCRIPTIONS

The Fluoromonomers area is included in the scope of this test program.

3.1 FLUOROMONOMERS

These facilities produce a family of fluorocarbon compounds used to produce Chemours products such as Teflon® Polymers and Viton®, as well as sales to outside customers.

The VE South Waste Gas Scrubber is vented to the process stack (NEP-Hdr2). In addition, the following building air systems are vented to this stack:

- RV Catch Pots
- Tower HVAC
- Nitrogen Supply to Catch Tanks
- Catalyst Feed Tank Pot Charge Vent

3.2 PROCESS OPERATIONS AND PARAMETERS

Source	Operation/Product	Batch or Continuous
VE South	PMVE/PEVE	Semi-continuous – Condensation is continuous, Two Agitated Bed Reactors are batch for 30-40 mins at end of each run, Refining (ether column) is batch

During the test program, the following parameters were monitored by Chemours and are included in Appendix A.

- Fluoromonomers Processes
    - VE South Waste Gas Scrubber
        - Caustic recirculation flow rate

4. DESCRIPTION OF TEST LOCATIONS

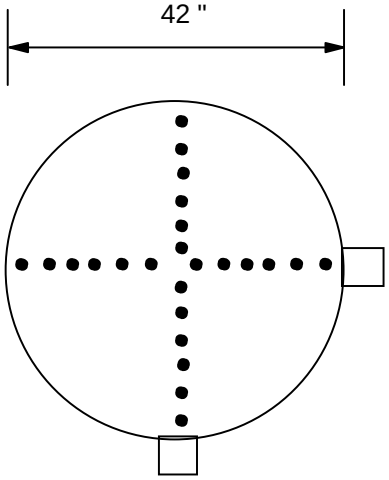
4.1 VE SOUTH STACK

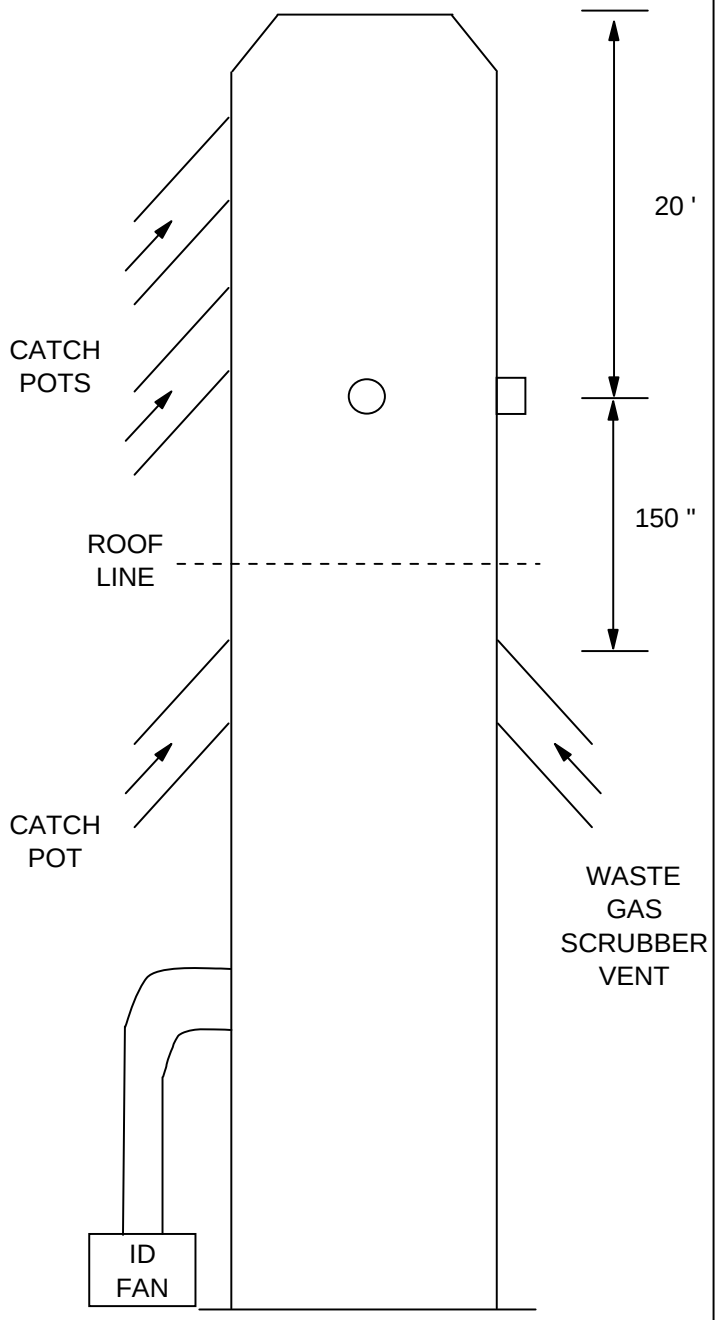
Two 6-inch ID test ports are installed on the 42-inch ID steel stack. The ports are placed 150 inches (3.6 diameters) from the location where the waste gas scrubber vent enters the stack and 20 feet (5.7 diameters) from the stack exit.

Per EPA Method 1, a total of 24 traverse points (12 per axis) were used for M0010 isokinetic sampling. It should be noted that near the port locations are a number of small ducts leading to the stack. These are catch pots which, under normal operation, do not discharge to the stack. They are used to vent process gas to the stack in the event of a process upset. For the purpose of test port location, and given the fact that there is no flow from these catch pots, they are not considered a flow contributor or a disturbance.

See Figure 4-1 for a schematic of the test port and traverse point locations.

Note: All measurements at the test location were confirmed prior to sampling.





TRAVERSE POINT NUMBER	DISTANCE FROM INSIDE NEAR WALL (INCHES)
1	1
2	2 7/8
3	5
4	7 3/8
5	10 1/2
6	15
7	27
8	31 1/2
9	34 5/8
10	37
11	39 1/8
12	41

DRAWING NOT TO SCALE

FIGURE 4-1
VE SOUTH STACK TEST PORT AND
TRAVERSE POINT LOCATION

IASDATA\CHEMOURS\15418.002.014\FIGURE 4-1 VE SOUTH SCRUBBER STACK

5. SAMPLING AND ANALYTICAL METHODS

5.1 STACK GAS SAMPLING PROCEDURES

The purpose of this section is to describe the stack gas emissions sampling train and to provide details of the stack sampling and analytical procedures utilized during the emissions test program.

5.1.1 Pre-Test Determinations

Preliminary test data were obtained at the test location. Stack geometry measurements were measured and recorded, and traverse point distances verified. A preliminary velocity traverse was performed utilizing a calibrated S-type pitot tube and an inclined manometer to determine velocity profiles. Flue gas temperatures were observed with a calibrated direct readout panel meter equipped with a chromel-alumel thermocouple. Preliminary water vapor content was estimated by wet bulb/dry bulb temperature measurements.

A check for the presence or absence of cyclonic flow was previously conducted at the test location. The cyclonic flow check was negative (< 20°) verifying that the source was acceptable for testing.

Preliminary test data was used for nozzle sizing and sampling rate determinations for isokinetic sampling procedures.

Calibration of probe nozzles, pitot tubes, metering systems, and temperature measurement devices was performed as specified in Section 5 of EPA Method 5 test procedures.

5.2 STACK PARAMETERS

5.2.1 EPA Method 0010

The sampling train utilized to perform the HFPO Dimer Acid sampling was an EPA Method 0010 train (see Figure 5-1). The Method 0010 consisted of a borosilicate nozzle that attached directly to a heated borosilicate probe. In order to minimize possible thermal degradation of the HFPO Dimer Acid, the probe and particulate filter were heated above stack temperature to minimize water vapor condensation before the filter. The probe was connected directly to a heated borosilicate filter holder containing a solvent extracted glass fiber filter.

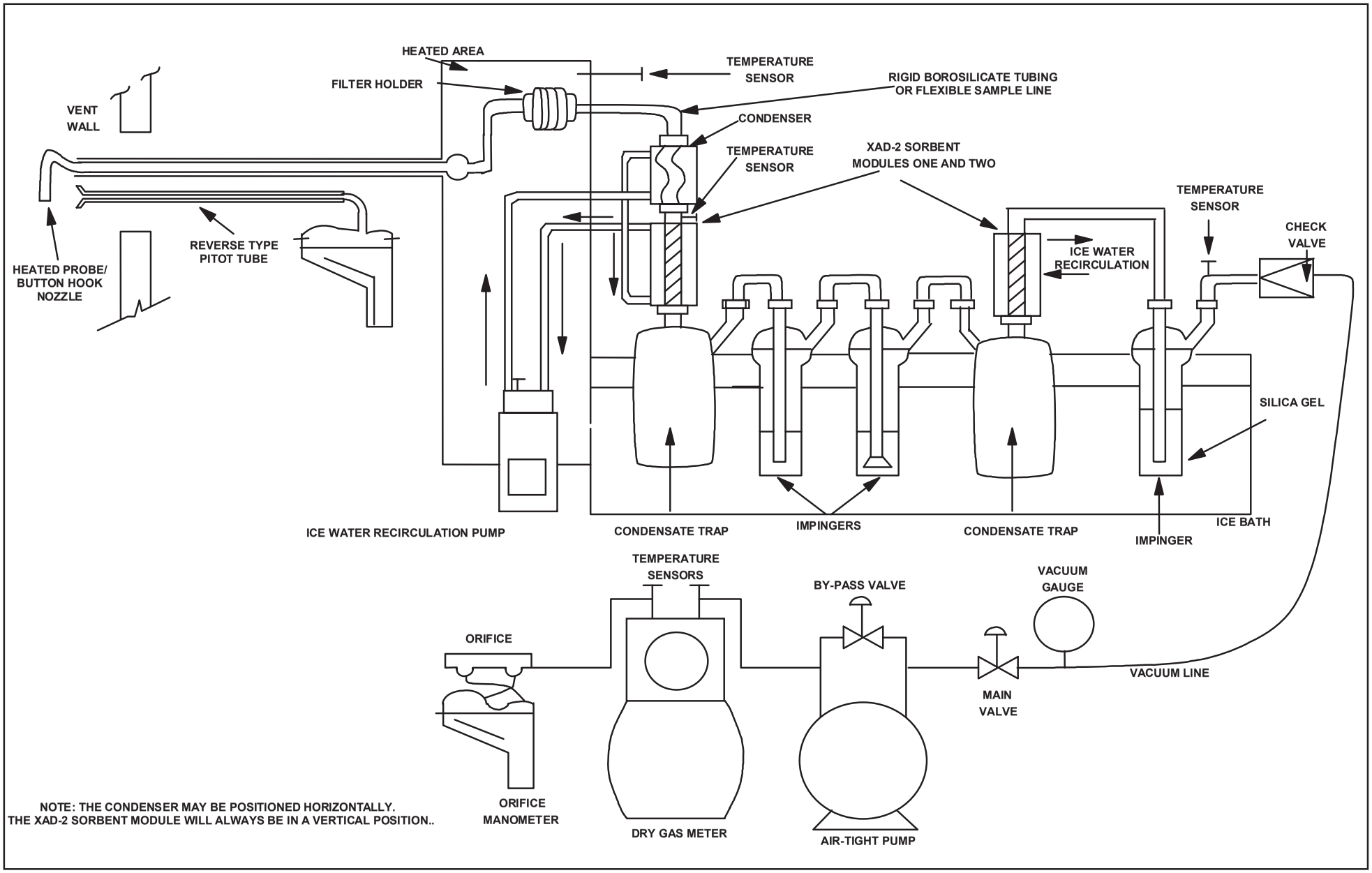


FIGURE 5-1
EPA METHOD 0010 SAMPLING TRAIN

IASDATA\CHEMOURS\15418.002.014\FIGURE 5-1 METHOD 0010

A section of borosilicate glass or flexible polyethylene tubing connected the filter holder exit to a Grahm (spiral) type ice water-cooled condenser, an ice water-jacketed sorbent module containing approximately 40 grams of XAD-2 resin. The XAD-2 resin tube was equipped with an inlet temperature sensor. The XAD-2 resin trap was followed by a condensate knockout impinger and a series of two impingers that contained 100 mL of high-purity distilled water. The train also included a second XAD-2 resin trap behind the impinger section to evaluate possible sampling train breakthrough. Each XAD-2 resin trap was connected to a 1-liter condensate knockout trap. The final impinger contained 300 grams of dry pre-weighed silica gel. All impingers and the condensate traps were maintained in an ice bath. Ice water was continuously circulated in the condenser and the XAD-2 module to maintain method-required temperature. A control console with a leakless vacuum pump, a calibrated orifice, and dual inclined manometers was connected to the final impinger via an umbilical cord to complete the sample train.

HFPO Dimer Acid Fluoride (CAS No. 2062-98-8) that is present in the stack gas is expected to be captured in the sampling train along with HFPO Dimer Acid (CAS No. 13252-13-6). HFPO Dimer Acid Fluoride underwent hydrolysis instantaneously in water in the sampling train and during the sample recovery step, and was converted to HFPO Dimer Acid such that the amount of HFPO Dimer Acid emissions represented a combination of both HFPO Dimer Acid Fluoride and HFPO Dimer Acid.

During sampling, gas stream velocities were measured by attaching a calibrated S-type pitot tube into the gas stream adjacent to the sampling nozzle. The velocity pressure differential was observed immediately after positioning the nozzle at each traverse point, and the sampling rate adjusted to maintain isokineticity at 100% ± 10. Flue gas temperature was monitored at each point with a calibrated panel meter and thermocouple. Isokinetic test data was recorded at each traverse point during all test periods, as appropriate. Leak checks were performed on the sampling apparatus according to reference method instructions, prior to and following each run, component change (if required) or during midpoint port changes.

5.2.2 EPA Method 0010 Sample Recovery

At the conclusion of each test, the sampling train was dismantled, the openings sealed, and the components transported to the field laboratory trailer for recovery.

A consistent procedure was employed for sample recovery:

1. The two XAD-2 covered (to minimize light degradation) sorbent modules (1 and 2) were sealed and labeled.

2. The glass fiber filter(s) were removed from the holder with tweezers and placed in a polyethylene container along with any loose particulate and filter fragments.

3. The particulate adhering to the internal surfaces of the nozzle, probe and front half of the filter holder were rinsed with a solution of methanol and ammonium hydroxide into a polyethylene container while brushing a minimum of three times until no visible particulate remained. Particulate adhering to the brush was rinsed with methanol/ ammonium hydroxide into the same container. The container was sealed.

4. The volume of liquid collected in the first condensate trap was measured, the value recorded, and the contents poured into a polyethylene container.

5. All train components between the filter exit and the first condensate trap were rinsed with methanol/ammonium hydroxide. The solvent rinse was placed in a separate polyethylene container and sealed.

6. The volume of liquid in impingers one and two, and the second condensate trap, were measured, the values recorded, and the sample was placed in the same container as Step 4 above, then sealed.

7. The two impingers, condensate trap, and connectors were rinsed with methanol/ ammonium hydroxide. The solvent sample was placed in a separate polyethylene container and sealed.

8. The silica gel in the final impinger was weighed and the weight gain value recorded.

9. Site (reagent) blank samples of the methanol/ammonium hydroxide, XAD resin, filter and distilled water were retained for analysis.

Each container was labeled to clearly identify its contents. The height of the fluid level was marked on the container of each liquid sample to provide a reference point for a leakage check during transport. All samples were maintained cool.

During the VE South test campaign, a Method 0010 blank train was set up near the test location, leak-checked and recovered along with the respective sample train. Following sample recovery, all samples were transported to TestAmerica Laboratories, Inc. (TestAmerica) for sample extraction and analysis.

See Figure 5-2 for a schematic of the Method 0010 sample recovery process.

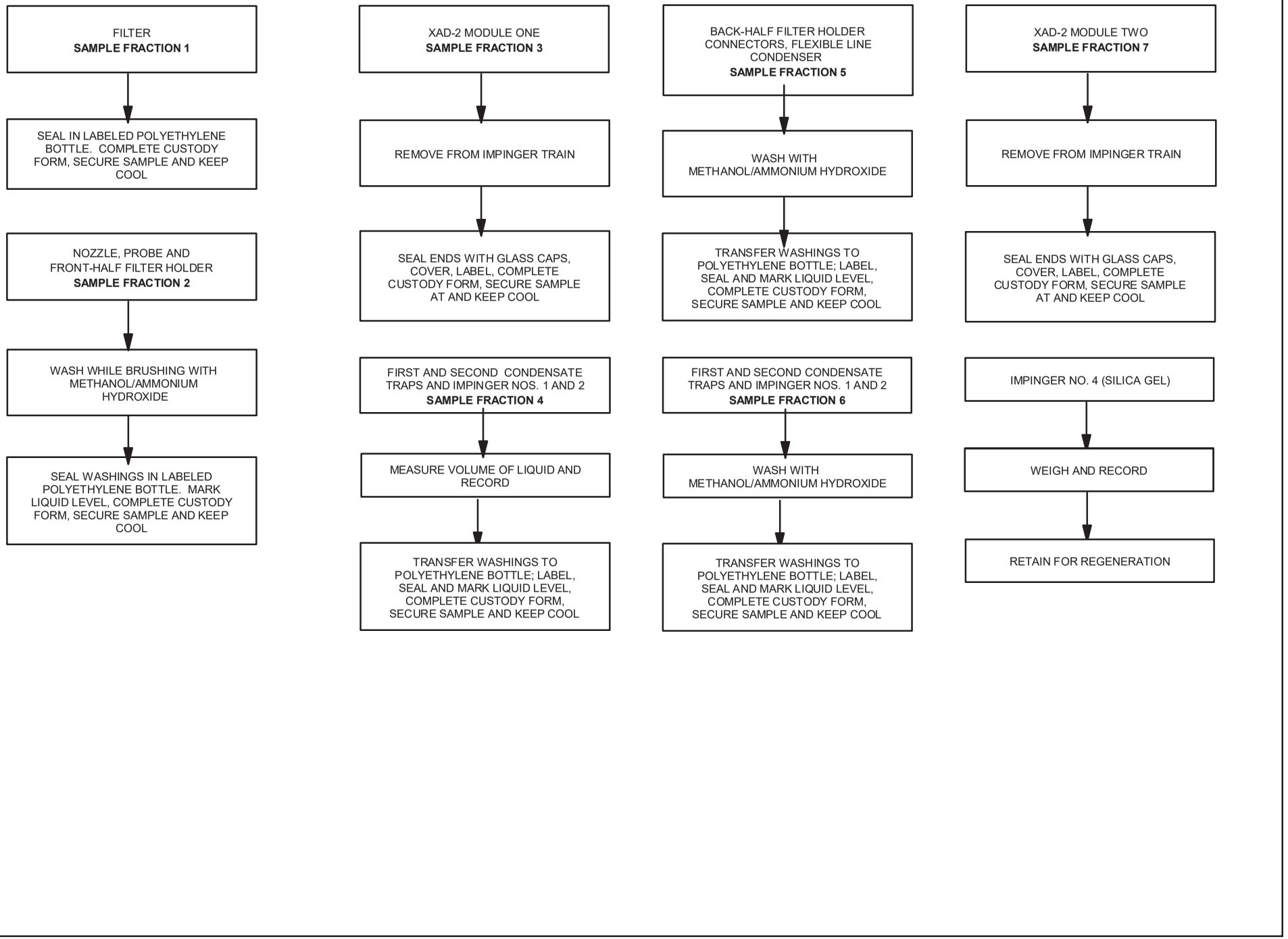


FIGURE 5-2
HFPO DIMER ACID SAMPLE RECOVERY PROCEDURES FOR METHOD 0010

IASDATA\CHEMOURS\15418.002.014\FIGURE 5-2 EPA 0010

5.2.3 EPA Method 0010 – Sample Analysis

Method 0010 sampling trains resulted in four separate analytical fractions for HFPO Dimer Acid analysis according to SW-846 Method 3542:

- Front-half Composite—comprised of the particulate filter, and the probe, nozzle, and front-half of the filter holder solvent rinses;
- Back-half Composite—comprised of the first XAD-2 resin material and the back-half of the filter holder with connecting glassware solvent rinses;
- Condensate Composite—comprised of the aqueous condensates and the contents of impingers one and two with solvent rinses;
- Breakthrough XAD-2 Resin Tube—comprised of the resin tube behind the series of impingers.

The second XAD-2 resin material was analyzed separately to evaluate any possible sampling train HFPO-DA breakthrough.

The front-half and back-half composites and the second XAD-2 resin material were placed in polypropylene wide-mouth bottles and tumbled with methanol containing 5% NH_4OH for 18 hours. Portions of the extracts were processed analytically for the HFPO dimer acid by liquid chromatography and duel mass spectroscopy (HPLC/MS/MS). The condensate composite was concentrated onto a solid phase extraction (SPE) cartridge followed by desorption from the cartridge using methanol. Portions of those extracts were also processed analytically by HPLC/MS/MS.

Samples were spiked with isotope dilution internal standard (IDA) at the commencement of their preparation to provide accurate assessments of the analytical recoveries. Final data was corrected for IDA standard recoveries.

TestAmerica developed detailed procedures for the sample extraction and analysis for HFPO Dimer Acid. These procedures were incorporated into the test protocol.

5.3 GAS COMPOSITION

The Weston mobile laboratory equipped with instrumental analyzers was used to measure carbon dioxide (CO_2) and oxygen (O_2) concentrations. An integrated gas sample was collected from the exhaust of the Method 0010 sample console.

The oxygen and carbon dioxide content of the stack gas was measured according to EPA Method 3/3A procedures. A Servomex Model 4900 analyzer (or equivalent) was used to measure oxygen content. A Servomex Model 4900 analyzer (or equivalent) was used to measure carbon dioxide content of the stack gas. Both analyzers were calibrated with EPA Protocol gases prior to the start of the test program and performance was verified by calibration checks before and after each test run.

6. DETAILED TEST RESULTS AND DISCUSSION

Preliminary testing and the associated analytical results required significant sample dilution to bring the HFPO Dimer Acid concentration within instrument calibration; therefore, sample times and sample volumes were reduced for the formal test program. This was approved by the North Carolina Department of Environmental Quality (NCDEQ).

Each test was a minimum of 96 minutes in duration. A total of three test runs were performed on the VE South stack. During Run 3, a power outage occurred for approximately one minute and then the test run was resumed without further incident.

Table 6-1 provides detailed test data and test results for the VE South stack.

The Method 3A sampling during all tests indicated that the O_2 and CO_2 concentrations were at ambient air levels (20.9% O_2, 0% CO_2), therefore, 20.9% O_2 and 0% CO_2 values were used in all calculations.

TABLE 6-1
CHEMOURS - FAYETTEVILLE, NC
SUMMARY OF HFPO DIMER ACID TEST DATA AND TEST RESULTS
VE SOUTH STACK

Test Data			
Run number	1	2	3
Location	VE South Stack	VE South Stack	VE South Stack
Date	05/22/19	05/23/19	05/23/19
Time period	1341-1529	1042-1230	1341-1536
SAMPLING DATA:			
Sampling duration, min.	96.0	96.0	96.0
Nozzle diameter, in.	0.300	0.300	0.300
Cross sectional nozzle area, sq.ft.	0.000491	0.000491	0.000491
Barometric pressure, in. Hg	30.20	30.28	30.28
Avg. orifice press. diff., in H_2O	1.47	1.27	1.53
Avg. dry gas meter temp., deg F	84.0	93.1	101.0
Avg. abs. dry gas meter temp., deg. R	544	553	561
Total liquid collected by train, ml	41.1	27.6	47.1
Std. vol. of H_2O vapor coll., cu.ft.	1.9	1.3	2.2
Dry gas meter calibration factor	1.0107	1.0107	1.0107
Sample vol. at meter cond., dcf	60.826	57.096	63.015
Sample vol. at std. cond., dscf[(1)]	60.423	55.898	60.861
Percent of isokinetic sampling	103.5	97.6	103.1
GAS STREAM COMPOSITION DATA:			
CO_2, % by volume, dry basis	0.0	0.0	0.0
O_2, % by volume, dry basis	20.9	20.9	20.9
N_2, % by volume, dry basis	79.1	79.1	79.1
Molecular wt. of dry gas, lb/lb mole	28.84	28.84	28.84
H_20 vapor in gas stream, prop. by vol.	0.031	0.023	0.035
Mole fraction of dry gas	0.969	0.977	0.965
Molecular wt. of wet gas, lb/lb mole	28.50	28.59	28.45
GAS STREAM VELOCITY AND VOLUMETRIC FLOW DATA:			
Static pressure, in. H_2O	0.55	0.51	0.50
Absolute pressure, in. Hg	30.24	30.32	30.32
Avg. temperature, deg. F	87	90	94
Avg. absolute temperature, deg.R	547	550	554
Pitot tube coefficient	0.84	0.84	0.84
Total number of traverse points	24	24	24
Avg. gas stream velocity, ft./sec.	21.9	21.3	22.4
Stack/duct cross sectional area, sq.ft.	9.62	9.62	9.62
Avg. gas stream volumetric flow, wacf/min.	12620	12307	12951
Avg. gas stream volumetric flow, dscf/min.	11918	11697	12055

[(1)] Standard conditions = 68 deg. F. (20 deg. C.) and 29.92 in Hg (760 mm Hg)

TABLE 6-1 (cont.)
CHEMOURS - FAYETTEVILLE, NC
SUMMARY OF HFPO DIMER ACID TEST DATA AND TEST RESULTS
VE SOUTH STACK

TEST DATA			
Run number	1	2	3
Location	VE South Stack	VE South Stack	VE South Stack
Date	05/22/19	05/23/19	05/23/19
Time period	1341-1529	1042-1230	1341-1536
LABORATORY REPORT DATA, ug.			
HFPO Dimer Acid	145.4000	42.9100	59.5300
EMISSION RESULTS, ug/dscm.			
HFPO Dimer Acid	84.96	27.10	34.53
EMISSION RESULTS, lb/dscf.			
HFPO Dimer Acid	5.31E-09	1.69E-09	2.16E-09
EMISSION RESULTS, lb/hr.			
HFPO Dimer Acid	3.79E-03	1.19E-03	1.56E-03
EMISSION RESULTS, g/sec.			
HFPO Dimer Acid	4.78E-04	1.50E-04	1.96E-04

APPENDIX A
PROCESS OPERATIONS DATA

Date: 5/22/2019

Time	1000	1100	1200	1300	1400	1500	1600	1700
Stack Testing				RUN 1 - 1341-1529				
VES Product	PM/PE							
VES Precursor								
VES Condensation (HFPO)								
VES ABR (East)								
VES ABR (West)					Burnout			
VES Refining								
VES WGS Recirculation Flow	18,500 kg/h							
Dimer ISO venting								

Date: 5/23/2019

Time	800	900	1000	1100	1200	1300	1400	1500	1600	1700
Stack Testing			RUN 2 - 1042-1230				RUN 3 - 1341-1536			
VES Product	PM/PE									
VES Precursor										
VES Condensation (HFPO)										
VES ABR (East)										
VES ABR (West)						Burnout				
VES Refining										
VES WGS Recirculation Flow	18,500 kg/h									
Dimer ISO venting										

APPENDIX B
RAW AND REDUCED TEST DATA

Sample and Velocity Traverse Point Data Sheet - Method 1

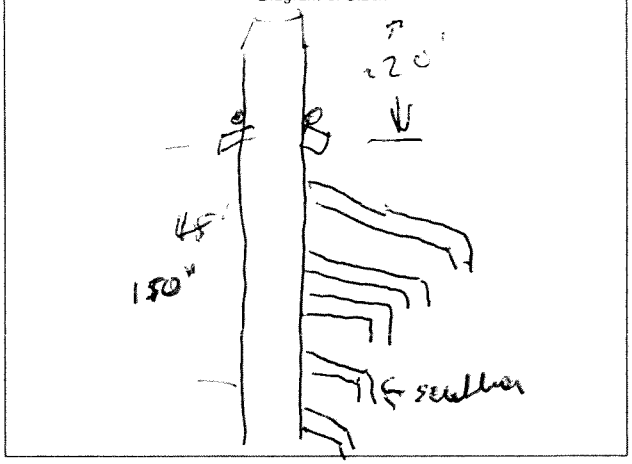
Client: Chemours
Location/Plant: Fayetteville, NC
Source: UE Scrubber
Operator: Pam
Date: 1/10/18
W.O. Number: 15413.002.002.0001

					Indicate appropriate type
Duct Type	☒	Circular	☐	Rectangular Duct	
Traverse Type	☒	Particulate Traverse	☐	Velocity Traverse	☒ CEM Traverse

Distance from far wall to outside of port (in.) = C	10
Port Depth (in.) = D	4 9/16
Depth of Duct, diameter (in.) = C-D	49 2/16
Area of Duct (ft²)	9.62
Total Traverse Points	24
Total Traverse Points per Port	12
Port Diameter (in.) ---(Flange-Threaded-Hole)	4"
Monorail Length	
Rectangular Ducts Only	
Width of Duct, rectangular duct only (in.)	
Total Ports (rectangular duct only)	
Equivalent Diameter = (2*L*W)/(L+W)	

Flow Disturbances	
Upstream - A (ft)	>20'
Downstream - B (ft)	12.5'
Upstream - A (duct diameters)	>5
Downstream - B (duct diameters)	~3.6

Diagram of Stack



Traverse Point Locations

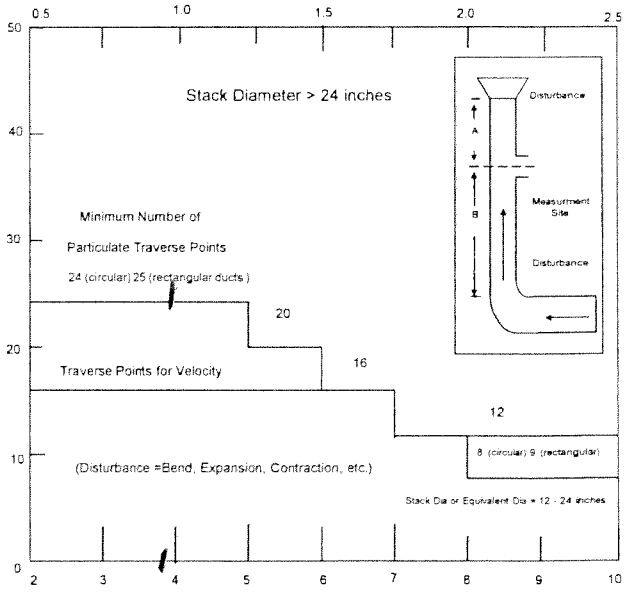
Traverse Point	% of Duct	Distance from Inside Duct Wall (in)	Distance from Outside of Port (in)
1	2.1	0.88	19.9 20.0
2	6.7	2.81	21.0
3	11.8	4.96	23.9 3/8
4	17.7	7.4	26.1
5	25.0	10.5	29.1/2
6	35.6	14.95	33.3/4 39
7	64.4	27.0	46.0
8	75	31.5	50.5
9	82.3	34.57	53 5/8
10	88.2	37.0	56.0
11	93.3	39.2	58.1/8
12	97.9	41.1	60.0

CEM 3 Point(Long Measurment Line) Stratificaton Point Locations

1	0.167		
2	0.50		
3	0.833		

Note: If stack dia < 12 inch use EPA Method 1A
(Sample port upstream of pitot port)
Note: If stack dia >24" then adjust traverse point to 1 inch from wall
If stack dia <24" then adjust traverse point to 0.5 inch from wall

Duct Diameters Upstream from Flow Disturbance (Distance A)



Duct Diameters Downstream from Flow Disturbance (Distance B)

Traverse Point Location Percent of Stack -Circular

Traverse Point	Number of Traverse Points											
	1	2	3	4	5	6	7	8	9	10	11	12
1		14.6		6.7		4.4		3.2		2.6		2.1
2		85.4		25		14.6		10.5		8.2		6.7
3				75		29.6		19.4		14.6		11.8
4				93.3		70.4		32.3		22.6		17.7
5						85.4		67.7		34.2		25
6						95.6		80.6		65.8		35.6
7								89.5		77.4		64.4
8								96.8		85.4		75
9										91.8		82.3
10										97.4		88.2
11												93.3
12												97.9

Traverse Point Location Percent of Stack -Rectangular

Traverse Point	Number of Traverse Points											
	1	2	3	4	5	6	7	8	9	10	11	12
1		25.0	16.7	12.5	10.0	8.3	7.1	6.3	5.6	5.0	4.5	4.2
2		75.0	50.0	37.5	30.0	25.0	21.4	18.8	16.7	15.0	13.6	12.5
3			83.3	62.5	50.0	41.7	35.7	31.3	27.8	25.0	22.7	20.8
4				87.5	70.0	58.3	50.0	43.8	38.9	35.0	31.8	29.2
5					90.0	75.0	64.3	56.3	50.0	45.0	40.9	37.5
6						91.7	78.6	68.8	61.1	55.0	50.0	45.8
7							92.9	81.3	72.2	65.0	59.1	54.2
8								93.8	83.3	75.0	68.2	62.5
9									94.4	85.0	77.3	70.8
10										95.0	86.4	79.2
11											95.5	87.5
12												95.8

CHEMOURS - FAYETTEVILLE, NC
INPUTS FOR HFPO DIMER ACID CALCULATIONS
VE SOUTH STACK

Test Data			
Run number	1	2	3
Location	VE South Stack	VE South Stack	VE South Stack
Date	05/22/19	05/23/19	05/23/19
Time period	1341-1529	1042-1230	1341-1536
Operator	JDO/KA	JDO/KA	JDO/KA
Inputs For Calcs.			
Sq. rt. delta P	0.38206	0.37276	0.38979
Delta H	1.4679	1.2708	1.5333
Stack temp. (deg.F)	87.3	89.9	94.3
Meter temp. (deg.F)	84.0	93.1	101.0
Sample volume (act.)	60.826	57.096	63.015
Barometric press. (in.Hg)	30.20	30.28	30.28
Volume H_2O imp. (ml)	26.0	12.3	27.0
Weight change sil. gel (g)	15.1	15.3	20.1
% CO_2	0.0	0.0	0.0
% O_2	20.9	20.9	20.9
% N_2	79.1	79.1	79.1
Area of stack (sq.ft.)	9.620	9.620	9.620
Sample time (min.)	96.0	96.0	96.0
Static pressure (in.H_2O)	0.55	0.51	0.50
Nozzle dia. (in.)	0.300	0.300	0.300
Meter box cal.	1.0107	1.0107	1.0107
Cp of pitot tube	0.84	0.84	0.84
Traverse points	24	24	24

ISOKINETIC FIELD DATA SHEET

EPA Method 0010 - HFPO Dimer Acid

Page 1 of 1

		Stack Conditions	Assumed	Actual
Client	Chemours			
W.O.#	15418.002.014.0001			
Project ID	Chemours	% Moisture	2-3	
Mode/Source ID	VE South - Scrubber	Impinger Vol (ml)		
Samp. Loc. ID	STK	Silica gel (g)		
Run No.ID	1	CO2, % by Vol	RA 0.0 ✓	
Test Method ID	M0010	O2, % by Vol	20.9 ✓	
Date ID	21MAY2019 ✓	Temperature (°F)	85	85
Source/Location	VE South Stack	Meter Temp (°F)	85	85
Sample Date	5/22/19 ✓	Static Press (in H_2O)	.5	.55 ✓
Baro. Press (in Hg)	30.20 ✓			
Operator	JDO/KA	Ambient Temp (°F)	80	

Meter Box ID	26
Meter Box Y	1.0107 ✓
Meter Box Del H	2.0869
Probe ID / Length	6'
Probe Material	Boro
Pitot / Thermocouple ID	694
Pitot Coefficient	0.84 ✓
Nozzle ID	.300
Nozzle Measurements	.300 .300 .300
Avg Nozzle Dia (in)	.300 ✓
Area of Stack (ft^2)	9.620 ✓ ✓
Sample Time	96 ✓
Total Traverse Pts	24 ✓ (12 per port)

Sample Train (ft^3)			
Leak Check @ (in Hg)	Initial	Mid-Point	Final
	.010	.004	.004
	15	6	6
Pitot leak check good	yes / no	yes / no	yes / no
Pitot Inspection good	yes / no	yes / no	yes / no
Method 3 System good	yes / no	yes / no	yes / no
Temp Check	Pre-Test Set		Post-Test Set
Meter Box Temp	83		
Reference Temp	82		
Pass/Fail (+/- 2°)	Pass / Fail		Pass / Fail
Temp Change Response ?	yes / no		yes / no

K Factor 10.0 — 9.8

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM OUTLET TEMP (°F)	PROBE TEMP (°F)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (oF)	SAMPLE TRAIN VAC (in Hg)	XAD EXIT TEMP (F)		COMMENTS
	0	1341 ✓	.15	1.50	524.524									
A 1	4		.15	1.62	527.1	88	84	117	120	68	4	64		524.529
2	8		.15	1.5	529.6	87	84	117	120	67	4	66		
3	12		.16	1.6	532.1	88	85	118	120	63	4	56		
4	16		.14	1.4	534.3	88	85	119	121	63	4	58		
5	20		.16	1.6	536.9	88	85	117	120	60	4	60		
6	24		.16	1.6	539.0	88	85	118	118	61	4	53		29.446
7	28		.15	1.5	542.6	87	85	117	122	60	4	50		
8	32		.14	1.4	545.0	88	85	117	122	59	3.5	49	✓	29.196
9	36		.12	1.2	547.6	87	85	117	121	59	3.6	48		
10	40		.10	1.0	549.6	87	84	117	120	62	3.5	48		
11	44		.09	.90	551.5	87	85	117	120	60	3	47		
12	48	1429	.09	.95	553.720	87	85	117	120	60	3	50		553.716
					553.858									553.858
B 1	4	1441	.20	2.0	557.3	87	84	117	123	68	4.5	53		
2	8		.19	1.9	559.7	88	85	118	121	68	4.5	51		-.138
3	12		.19	1.9	562.3	87	85	117	120	68	4.5	51		
4	16		.19	1.86	565.4	87	84	117	119	68	4.5	50		
5	20		.19	1.96	568.1	87	84	117	118	69	4.5	50		
6	24		.19	1.86	570.9	87	83	117	120	69	4.5	52		31.630
7	28		.17	1.67	573.7	87	83	117	121	62	4.5	55		
8	32		.15	1.47	576.0	87	82	117	119	64	4	57		
9	36		.13	1.27	578.6	87	82	117	119	64	3.5	53		
10	40		.12	1.18	580.8	87	82	117	120	64	3.5	50		
11	44		.11	1.08	583.2	87	82	117	120	63	3	49		
12	48	1529 ✓	.11	1.05	585.498	87 ✓	82 ✓	117	120	63	3	49		585.498
			Avg Delta P	Avg Delta H	Total Volume	Avg Ts ✓	Avg Tm ✓	Min/Max	Min/Max	Max	Max Vac	Min/Max		
			.149	1.468 ✓	60.826 ✓	87.333	83.958 ✓	117/118	118/123	68	4.5	64		
			Avg Sqrt Delta P	Avg Sqrt Del H	Comments:									
			.383	1.204 ✓										

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EPA Method 0010 from EPA SW-846

Dso: 103.268

103.5 Dso
3.1 % M
1.1918 dscm
60.423 Vm

ISOKINETIC FIELD DATA SHEET

EPA Method 0010 - HFPO Dimer Acid

Page 1 of 1

		Stack Conditions	Assumed	Actual
Client	Chemours	% Moisture	3	
W.O.#	15418.002.014.0001	Impinger Vol (ml)		
Project ID	Chemours	Silica gel (g)		
Mode/Source ID	VE South - Scrubber	CO2, % by Vol	0	
Samp. Loc. ID	STK	O2, % by Vol	20.9	
Run No.ID	2	Temperature (°F)	89	
Test Method ID	M0010	Meter Temp (°F)	83	
Date ID	23 21MAY2019	Static Press (in H_2O)	.17	-.51
Source/Location	VE South Stack	Ambient Temp (°F)	80	
Sample Date	5/23/19			
Baro. Press (in Hg)	30.28			
Operator	JMO / KH			

Meter Box ID	26
Meter Box Y	1.0157
Meter Box Del H	2.0868
Probe ID / Length	61
Probe Material	Steel
Pitot / Thermocouple ID	.694
Pitot Coefficient	0.84
Nozzle ID	
Nozzle Measurements	.304 .300 .300
Avg Nozzle Dia (in)	.300
Area of Stack (ft^2)	9.62
Sample Time	96
Total Traverse Pts	24

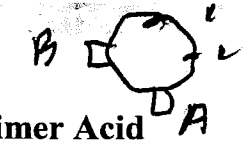
		Initial	Mid-Point	Final
Sample Train (ft^3)		.006	.001	.003
Leak Check @ (in Hg)		15	6	6
Pitot leak check good		yes / no	yes / no	yes / no
Pitot Inspection good		yes / no	yes / no	yes / no
Method 3 System good		yes / no	yes / no	yes / no
Temp Check		Pre-Test Set		Post-Test Set
Meter Box Temp		83		
Reference Temp		82		
Pass/Fail (+/- 2°)		Pass / Fail		Pass / Fail
Temp Change Response ?		yes / no		yes / no

K Factor 9.0 9.5

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft^3)	STACK TEMP (°F)	DGM OUTLET TEMP (oF)	PROBE TEMP (oF)	FILTER BOX TEMP (F)	Dryer IMPINGER EXIT TEMP (oF)	SAMPLE TRAIN VAC (in Hg)	Aux XAD EXIT TEMP (F)		COMMENTS
	0	1042			586.064									
A 1	4		.15	1.35	588.5	90	89	117	117	67	3.5	64		586.064
2	8		.15	1.35	590.9	89	90	117	118	67	3.5	57		
3	12		.15	1.35	593.4	89	88	117	117	66	3.5	59		
4	16		.15	1.35	595.9	89	88	117	116	65	3.5	58		
5	20		.17	1.53	598.4	89	88	120	123	66	3.5	56		
6	24		.17	1.53	601.0	89	88	120	120	67	3.5	58	✓	27.756
7	28		.16	1.44	603.4	89	89	120	116	68	4	61		
8	32		.14	1.26	605.6	89	89	121	122	68	3.5	55		
9	36		.12	1.08	608.1	89	89	121	119	68	3	54		
10	40		.10	.90	610.1	89	90	121	118	68	2.5	56		
11	44		.08	.72	612.3	89	91	121	120	68	2	55		613.820
12	48	1130	.10	.90	613.820	89	92	120	119	67	2	55		614.020
	0				614.020									
B 1	4	1142	.17	1.53	616.7	90	94	121	119	66	4	62		614.020
2	8		.17	1.53	618.9	90	93	120	120	66	4	61		
3	12		.17	1.53	621.4	90	94	121	119	66	4	60		
4	16		.17	1.53	624.0	91	93	119	122	65	4	60		
5	20		.16	1.44	626.1	91	95	120	120	67	4	60		29.34
6	24		.15	1.35	628.4	91	95	120	120	66	4	59		
7	28		.16	1.44	631.0	90	96	120	119	66	4	61		
8	32		.14	1.26	634.0	91	99	119	119	66	4	62		
9	36		.12	1.08	636.4	91	100	118	120	66	3	60		
10	40		.11	1.05	638.7	91	101	117	118	66	3	60		
11	44		.11	1.05	640.9	91	101	118	118	65	3	60		
12	48	1230	.10	.95	643.360	91	101	120	120	62	3	60		
			Avg Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max	Max Vac	Min/Max		
			.1404		57.096									
			Avg Sqrt Delta P	Avg Sqrt Del H	Comments:									
			.37270											

97.0 In

EPA Method 0010 from EPA SW-846



ISOKINETIC FIELD DATA SHEET

1160

EPA Method 0010 - HFPO Dimer Acid

Client	Chemours
W.O.#	15418.002.014.0001
Project ID	Chemours
Mode/Source ID	VE South - Scrubber
Samp. Loc. ID	STK
Run No.ID	3
Test Method ID	M0010
Date ID	21MAY2019
Source/Location	VE South Stack
Sample Date	5/23/19
Baro. Press (in Hg)	30.28
Operator	JMS/KH

Stack Conditions	Assumed	Actual
% Moisture	3	
Impinger Vol (ml)		
Silica gel (g)		
CO2, % by Vol	0	
O2, % by Vol	20.9	
Temperature (°F)	88	
Meter Temp (°F)	85	
Static Press (in H_2O)	NG -1.5	
Ambient Temp (°F)	80 - 85	

Meter Box ID	26		
Meter Box Y	1.0107		
Meter Box Del H	2.0464		
Probe ID / Length		6'	Sample Train (ft³)
Probe Material	Boro		Leak Check @ (in Hg)
Pitot / Thermocouple ID	694		Pitot leak check good
Pitot Coefficient	0.84		Pitot Inspection good
Nozzle ID			Method 3 System good
Nozzle Measurements	.300	.300 .300	Temp Check
Avg Nozzle Dia (in)	.300		Meter Box Temp
Area of Stack (ft²)	9.62		Reference Temp
Sample Time	96		Pass/Fail (+/- 2°)
Total Traverse Pts	24		Temp Change Response ?

K Factor 10

	Initial	Mid-Point	Final
Sample Train (ft³)	.006	.018	.095
Leak Check @ (in Hg)	7	7	9
Pitot leak check good	yes / no	yes / no	yes no
Pitot Inspection good	yes / no	yes / no	yes no
Method 3 System good	yes / no	yes / no	yes no
Temp Check	Pre-Test Set		Post-Test Set
Meter Box Temp	87		
Reference Temp	88		
Pass/Fail (+/- 2°)	Pass / Fail		Pass / Fail
Temp Change Response ?	yes / no		yes / no

TRAVERSE POINT NO.	SAMPLE TIME (min)	CLOCK TIME (plant time)	VELOCITY PRESSURE Delta P (in H2O)	ORIFICE PRESSURE Delta H (in H2O)	DRY GAS METER READING (ft³)	STACK TEMP (°F)	DGM OUTLET TEMP (oF)	PROBE TEMP (oF)	FILTER BOX TEMP (F)	IMPINGER EXIT TEMP (oF)	SAMPLE TRAIN VAC (in Hg)	XAD EXIT TEMP (F)		COMMENTS
	0	1341			643.720									
A 1	4		.16	1.6	646.4	95	101	120	125	67	4	66		643.726
2	8		.16	1.6	649.10	93	100	120	125	66	4	66		
3	12		.14	1.4	651.4	93	100	120	126	66	4	62		Lo7
4	16		.14	1.4	654.1	94	100	119	125	66	4	63		
5	20		.19	1.8	656.9	93	100	120	120	66	4	63		0000
6	24		.19	1.8	659.5	93	100	120	120	65	4	63		
7	28		.16	1.7	662.4	93	100	119	122	65	4	63		1345
8	32		.16	1.6	665.1	94	100	119	123	65	4	64		
9	36		.15	1.5	668.4	94	101	117	118	65	4	65		resume
10	40		.11	1.1	670.16	94	100	118	118	65	4	64		
11	44		.11	1.1	673.9	94	100	120	121	65	3	64		1346
12	48	1431	.10	1.0	675.018	94	100	119	119	66	3	64		675.018
	0				675.403									675.403
B 1	4	1449	.19	1.9	678.1	93	101	119	125	67	4	65		
2	8		.18	1.8	681.1	93	101	119	120	66	4	64		
3	12	1500	.18	1.8	684.11	93	101	120	125	65	4	64		
4	16		.17	1.7	686.3	93	101	120	124	65	4	64		
5	20	1508	.18	1.8	689.4	94	101	117	118	65	4	64		
6	24		.19	1.9	692.4	95	103	117	118	65	4	63		
7	28	1516	.17	1.7	694.7	96	103	117	117	65	4	62		
8	32		.16	1.6	697.9	96	103	117	117	66	4	63		
9	36	1524	.14	1.4	700.10	95	103	117	114	66	3.5	64		
10	40		.13	1.3	3.6	96	103	117	115	66	3	64		
11	44	1532	.11	1.1	5.9	96	102	117	116	66	3	65		
12	48		.11	1.1	707.120	96	101	117	119	65	3	64		707.120
		1540	Avg Delta P	Avg Delta H	Total Volume	Avg Ts	Avg Tm	Min/Max	Min/Max	Max	Max Vac	Min/Max		
		1536	Avg Sqrt Delta P	Avg Sqrt Del H	Comments:									

WESTON SOLUTIONS

EPA Method 0010 from EPA SW-846

SAMPLE RECOVERY FIELD DATA

EPA Method 0010 - HFPO Dimer Acid

Client	Chemours	W.O. #	15418.002.014.0001
Location/Plant	Fayetteville, NC	Source & Location	VE South Stack

Run No. 1 — Sample Date 5/22/19 — Recovery Date 5/22/19

Sample I.D. Chemours - VE South - Scrubber - STK - 1 - M0010 - — Analyst JDO/KS — Filter Number N/A

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Empty	HPLC H2O	HPLC H2O			1	2	615.0	Silica Gel	
Final	10	105	100	0		316.0	299.0	~~615.0~~ KS	315.1	
Initial	0	100	100	0		305.3	298.7	✓	300	
Gain	10	5	0	0		10.7	0.3	26	15.1	41.1

Impinger Color: all clear — Labeled? ✓ ✓

Silica Gel Condition: Lte 90% — Sealed? ✓

Run No. 2 — Sample Date 5/23/19 — Recovery Date 5/23/19

Sample I.D. Chemours - VE South - Scrubber - STK - 2 - M0010 - — Analyst JDO/KS — Filter Number N/A

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Empty	HPLC H2O	HPLC H2O						Silica Gel	
Final	10	95	95	0		303.8	302.6		315.3	
Initial	0	100	100	0		291.9	302.2		300	
Gain	10	-5	-5	0	0	11.9	.4	12.3	15.3	27.6

Impinger Color: all clear — Labeled? ✓

Silica Gel Condition: Lte 90% — Sealed? ✓

Run No. 3 — Sample Date 5/23/19 — Recovery Date 5/23/19

Sample I.D. Chemours - VE South - Scrubber - STK - 3 - M0010 - — Analyst JDO/KS — Filter Number N/A

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents	Empty	HPLC H2O	HPLC H2O						Silica Gel	
Final	15	100	100		310.9	300.2			320.1	
Initial	0	100	100		298.9	300.2			300	
Gain	15	0	0		12.0	0		27	20.1	47.1

Impinger Color: all clear — Labeled? ✓

Silica Gel Condition: Lte 90% — Sealed? ✓

Check COC for Sample IDs of Media Blanks: Balance Cal

	Known	Response
5/22/19	500	499.9
5/23/19	500	499.6

Source Gas Analysis Data Sheet - Modified Method 3/3A

Client: Chemours
Location/Plant: Fayetteville
Source: VE-5
W.O. Number: 15418.002.014

Analyst: VS
Date: 5/23/19
Analyzer Make & Model: Servomex Series 1400

Calibration: 5

Analysis Number	Span	Calibration Gas Value O_2 (%)	Calibration Gas Value CO_2 (%)	Analyzer Response O_2 (%)	Analyzer Response CO_2 (%)
1	Zero	0.00	0.00	0.00	0.00
2	Mid	12.06	9.018	12.1	9.0
3	High	21.25	17.05	20.3	17.1
	Average				

Run Number	Analysis Time	Analyzer Response O_2 (%)	Analyzer Response CO_2 (%)
1	0808-0815	20.8	0.01
2	1247-1255	20.8	0.02
3	1555-1601	20.9	0.02
	Average		

Run Number	Analysis Time	Analyzer Response O_2 (%)	Analyzer Response CO_2 (%)
1			
2			
3			
	Average		

Span	Cylinder ID
Mid	CC157024
High	ALM047628

**Report all values to the nearest 0.1 percent

SAMPLE RECOVERY FIELD DATA

Client Chemours W.O. #
Location/Plant Fayetteville NC Source & Location VE South Stack

Run No. BT Sample Date 5/23/14 Recovery Date 5/23/14
Sample I.D. _____ Analyst JMZ/KS Filter Number N/A

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents									Silica Gel	
Final	0	100	100	0		298.0	302.6		300	
Initial	0	200	100	0		298.1	302.6		300	
Gain	0	0	0	0		-	0	0	0	0

Impinger Color all clear Labeled? ✓
Silica Gel Condition Ice 100% Sealed? ✓

Run No. ___ Sample Date _____ Recovery Date _____
Sample I.D. _____ Analyst _____ Filter Number _____

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents									Silica Gel	
Final										
Initial										
Gain										

Impinger Color _____ Labeled? _____
Silica Gel Condition _____ Sealed? _____

Run No. ___ Sample Date _____ Recovery Date _____
Sample I.D. _____ Analyst _____ Filter Number _____

	Impinger									
	1	2	3	4	5	6	7	Imp.Total	8	Total
Contents									Silica Gel	
Final										
Initial										
Gain										

Impinger Color _____ Labeled? _____
Silica Gel Condition _____ Sealed? _____

Check COC for Sample IDs of Media Blanks

APPENDIX C
LABORATORY ANALYTICAL REPORT

Note: The complete analytical report is included on the attached CD.

eurofins | Environment Testing TestAmerica

ANALYTICAL REPORT

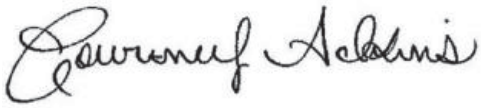
Job Number: 140-15381-1

Job Description: VE South Stack

Contract Number: LBIO-67048

For:
Chemours Company FC, LLC The
c/o AECOM
Sabre Building, Suite 300
4051 Ogletown Road
Newark, DE 19713

Attention: Michael Aucoin



Approved for release.
Courtney M Adkins
Project Manager I
6/4/2019 7:59 AM

Courtney M Adkins, Project Manager I
5815 Middlebrook Pike, Knoxville, TN, 37921
(865)291-3000
courtney.adkins@testamericainc.com
06/04/2019

Table of Contents

Table of Contents

Definitions/Glossary

Client: Chemours Company FC, LLC The
Project/Site: VE South Stack

Job ID: 140-15381-1

Qualifiers

LCMS

Qualifier	Qualifier Description
D	Sample results are obtained from a dilution; the surrogate or matrix spike recoveries reported are calculated from diluted samples.
X	Surrogate is outside control limits

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Method Summary

Client: Chemours Company FC, LLC The
Project/Site: VE South Stack

Job ID: 140-15381-1

Method	Method Description	Protocol	Laboratory
8321A	HFPO-DA	SW846	TAL DEN
8321A	PFOA and PFOS	SW846	TAL DEN
None	Leaching Procedure	TAL SOP	TAL DEN
None	Leaching Procedure for Condensate	TAL SOP	TAL DEN
None	Leaching Procedure for XAD	TAL SOP	TAL DEN

Protocol References:

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.
TAL SOP = TestAmerica Laboratories, Standard Operating Procedure

Laboratory References:

TAL DEN = Eurofins TestAmerica, Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

Sample Summary

Client: Chemours Company FC, LLC The
Project/Site: VE South Stack

Job ID: 140-15381-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received	Asset ID
140-15381-1	H-1505,1506 VES STACK R1 M0010 FH	Air	05/22/19 00:00	05/24/19 09:00	
140-15381-2	H-1507,1508,1510 VES STACK R1 M0010 BH	Air	05/22/19 00:00	05/24/19 09:00	
140-15381-3	H-1509 VES STACK R1 M0010 IMP 1,2&3 CONDENSATE	Air	05/22/19 00:00	05/24/19 09:00	
140-15381-4	H-1511 VES STACK R1 M0010 BREAKTHROUGH XAD-2 RESIN TUBE	Air	05/22/19 00:00	05/24/19 09:00	
140-15381-5	H-1512,1513 VES STACK R2 M0010 FH	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-6	H-1514,1515,1517 VES STACK R2 M0010 BH	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-7	H-1516 VES STACK R2 M0010 IMP 1,2&3 CONDENSATE	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-8	H-1518 VES STACK R2 M0010 BREAKTHROUGH XAD-2 RESIN TUBE	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-9	H-1519,1520 VES STACK R3 M0010 FH	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-10	H-1521,1522,1524 VES STACK R3 M0010 BH	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-11	H-1523 VES STACK R3 M0010 IMP 1,2&3 CONDENSATE	Air	05/23/19 00:00	05/24/19 09:00	
140-15381-12	H-1525 VES STACK R3 M0010 BREAKTHROUGH XAD-2 RESIN TUBE	Air	05/23/19 00:00	05/24/19 09:00	

Job Narrative
140-15381-1

Sample Receipt

The samples were received on May 24, 2019 at 9:00 AM in good condition and properly preserved. The temperatures of the 2 coolers at receipt time were 0.1º C and 0.1º C.

Quality Control and Data Interpretation

Unless otherwise noted, all holding times, and QC criteria were met and the test results shown in this report meet all applicable NELAC requirements.

Method 0010/Method 3542 Sampling Train Preparation

Train fractions were extracted and prepared for analysis in TestAmerica's Knoxville laboratory. Extracts and condensate samples were forwarded to the Denver laboratory for HFPO-DA analysis. All results are reported in "Total ug" per sample.

LCMS

Method 8321A: The Surrogate/Isotope Dilution Analyte (IDA) recovery associated with the following samples is below the method recommended limit: H-1511 VES STACK R1 M0010 BREAKTHROUGH XAD-2 RESIN TUBE (140-15381-4), (LCS 280-459570/2-A) and (MB 280-459556/1-A). Generally, data quality is not considered affected if the IDA signal-to-noise ratio is greater than 10:1, which is achieved for all IDA in the sample(s). All detection limits are below the lower calibration.

preparation batch 280-459556 and 280-459570 and analytical batch 280-460289 HFPO

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Comments

Reporting Limits (RLs) and Method Detection Limits (MDLs) for the HFPO-DA used in this report were derived in Denver for reporting soils and water samples. Method 0010 sampling train matrix specific RLs and MDLs have not been established for HFPO-DA. The soil and water limits are expected to be reasonable approximations of the actual matrix specific limits, under these conditions.

LCMS

Analysis Batch: 436957

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
DLCK 280-436957/13	Lab Control Sample	Total/NA	Air	8321A	

Prep Batch: 459556

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15381-2	H-1507,1508,1510 VES STACK R1 M0010 BH	Total/NA	Air	None	
140-15381-4	H-1511 VES STACK R1 M0010 BREAKTHROUG	Total/NA	Air	None	
140-15381-6	H-1514,1515,1517 VES STACK R2 M0010 BH	Total/NA	Air	None	
140-15381-8	H-1518 VES STACK R2 M0010 BREAKTHROUG	Total/NA	Air	None	
140-15381-10	H-1521,1522,1524 VES STACK R3 M0010 BH	Total/NA	Air	None	
140-15381-12	H-1525 VES STACK R3 M0010 BREAKTHROUG	Total/NA	Air	None	
MB 280-459556/1-A	Method Blank	Total/NA	Air	None	
LCS 280-459556/2-A	Lab Control Sample	Total/NA	Air	None	

Prep Batch: 459570

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15381-1	H-1505,1506 VES STACK R1 M0010 FH	Total/NA	Air	None	
140-15381-5	H-1512,1513 VES STACK R2 M0010 FH	Total/NA	Air	None	
140-15381-9	H-1519,1520 VES STACK R3 M0010 FH	Total/NA	Air	None	
MB 280-459570/1-A	Method Blank	Total/NA	Air	None	
LCS 280-459570/2-A	Lab Control Sample	Total/NA	Air	None	

Prep Batch: 459578

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15381-3	H-1509 VES STACK R1 M0010 IMP 1,2&3 CONI	Total/NA	Air	None	
140-15381-7	H-1516 VES STACK R2 M0010 IMP 1,2&3 CONI	Total/NA	Air	None	
140-15381-11	H-1523 VES STACK R3 M0010 IMP 1,2&3 CONI	Total/NA	Air	None	
MB 280-459578/1-A	Method Blank	Total/NA	Air	None	
LCS 280-459578/2-A	Lab Control Sample	Total/NA	Air	None	

Analysis Batch: 460289

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
140-15381-1	H-1505,1506 VES STACK R1 M0010 FH	Total/NA	Air	8321A	459570
140-15381-2	H-1507,1508,1510 VES STACK R1 M0010 BH	Total/NA	Air	8321A	459556
140-15381-3	H-1509 VES STACK R1 M0010 IMP 1,2&3 CONI	Total/NA	Air	8321A	459578
140-15381-4	H-1511 VES STACK R1 M0010 BREAKTHROUG	Total/NA	Air	8321A	459556
140-15381-5	H-1512,1513 VES STACK R2 M0010 FH	Total/NA	Air	8321A	459570
140-15381-6	H-1514,1515,1517 VES STACK R2 M0010 BH	Total/NA	Air	8321A	459556
140-15381-7	H-1516 VES STACK R2 M0010 IMP 1,2&3 CONI	Total/NA	Air	8321A	459578
140-15381-8	H-1518 VES STACK R2 M0010 BREAKTHROUG	Total/NA	Air	8321A	459556
140-15381-9	H-1519,1520 VES STACK R3 M0010 FH	Total/NA	Air	8321A	459570
140-15381-10	H-1521,1522,1524 VES STACK R3 M0010 BH	Total/NA	Air	8321A	459556
140-15381-11	H-1523 VES STACK R3 M0010 IMP 1,2&3 CONI	Total/NA	Air	8321A	459578
140-15381-12	H-1525 VES STACK R3 M0010 BREAKTHROUG	Total/NA	Air	8321A	459556
MB 280-459556/1-A	Method Blank	Total/NA	Air	8321A	459556
MB 280-459570/1-A	Method Blank	Total/NA	Air	8321A	459570
MB 280-459578/1-A	Method Blank	Total/NA	Air	8321A	459578
LCS 280-459556/2-A	Lab Control Sample	Total/NA	Air	8321A	459556
LCS 280-459570/2-A	Lab Control Sample	Total/NA	Air	8321A	459570
LCS 280-459578/2-A	Lab Control Sample	Total/NA	Air	8321A	459578

Client Sample ID: H-1505,1506 VES STACK R1 M0010 FH

Lab Sample ID: 140-15381-1

Date Collected: 05/22/19 00:00
Date Received: 05/24/19 09:00
Sample Container: Air Train

Matrix: Air

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	37.5		1.02	0.110	ug/Sample		05/28/19 11:10	06/03/19 12:24	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*68*	*D*	*50 - 200*	*05/28/19 11:10*	*06/03/19 12:24*	*10*

Client Sample ID: H-1507,1508,1510 VES STACK R1 M0010 BH

Lab Sample ID: 140-15381-2

Date Collected: 05/22/19 00:00
Date Received: 05/24/19 09:00
Sample Container: Air Train

Matrix: Air

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	97.6		2.75	0.550	ug/Sample		05/28/19 11:10	06/03/19 11:24	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*57*	*D*	*50 - 200*	*05/28/19 11:10*	*06/03/19 11:24*	*10*

Client Sample ID: H-1509 VES STACK R1 M0010 IMP 1,2&3 CONDENSATE

Lab Sample ID: 140-15381-3

Date Collected: 05/22/19 00:00
Date Received: 05/24/19 09:00
Sample Container: Air Train

Matrix: Air

Method: 8321A - HFPO-DA

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	10.3		0.220	0.0112	ug/Sample		05/28/19 12:21	06/03/19 12:50	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*57*		*50 - 200*	*05/28/19 12:21*	*06/03/19 12:50*	*1*

Client Sample ID: H-1511 VES STACK R1 M0010 BREAKTHROUGH XAD-2 RESIN TUBE

Lab Sample ID: 140-15381-4

Date Collected: 05/22/19 00:00
Date Received: 05/24/19 09:00
Sample Container: Air Train

Matrix: Air

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	ND		0.200	0.0400	ug/Sample		05/28/19 11:10	06/03/19 11:28	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*47*	*X*	*50 - 200*	*05/28/19 11:10*	*06/03/19 11:28*	*1*

Client Sample ID: H-1512,1513 VES STACK R2 M0010 FH

Lab Sample ID: 140-15381-5

Date Collected: 05/23/19 00:00
Date Received: 05/24/19 09:00
Sample Container: Air Train

Matrix: Air

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	22.1		1.01	0.109	ug/Sample		05/28/19 11:10	06/03/19 12:27	10

Client Sample ID: H-1512,1513 VES STACK R2 M0010 FH

Lab Sample ID: 140-15381-5

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 HFPO-DA	65	D	50 - 200	05/28/19 11:10	06/03/19 12:27	10

Client Sample ID: H-1514,1515,1517 VES STACK R2 M0010 BH

Lab Sample ID: 140-15381-6

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	17.8		0.275	0.0550	ug/Sample		05/28/19 11:10	06/03/19 11:31	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 HFPO-DA	50		50 - 200	05/28/19 11:10	06/03/19 11:31	1

Client Sample ID: H-1516 VES STACK R2 M0010 IMP 1,2&3 CONDENSATE

Lab Sample ID: 140-15381-7

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - HFPO-DA

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	3.01		0.192	0.00979	ug/Sample		05/28/19 12:21	06/03/19 12:54	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 HFPO-DA	59		50 - 200	05/28/19 12:21	06/03/19 12:54	1

Client Sample ID: H-1518 VES STACK R2 M0010 BREAKTHROUGH XAD-2 RESIN TUBE

Lab Sample ID: 140-15381-8

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	ND		0.200	0.0400	ug/Sample		05/28/19 11:10	06/03/19 11:34	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 HFPO-DA	51		50 - 200	05/28/19 11:10	06/03/19 11:34	1

Client Sample ID: H-1519,1520 VES STACK R3 M0010 FH

Lab Sample ID: 140-15381-9

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	18.7		0.126	0.0136	ug/Sample		05/28/19 11:10	06/03/19 12:31	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 HFPO-DA	56		50 - 200	05/28/19 11:10	06/03/19 12:31	1

Client Sample ID: H-1521,1522,1524 VES STACK R3 M0010 BH

Lab Sample ID: 140-15381-10

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	35.7		0.275	0.0550	ug/Sample		05/28/19 11:10	06/03/19 11:37	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*52*		*50 - 200*	*05/28/19 11:10*	*06/03/19 11:37*	*1*

Client Sample ID: H-1523 VES STACK R3 M0010 IMP 1,2&3 CONDENSATE

Lab Sample ID: 140-15381-11

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - HFPO-DA

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	5.13		0.228	0.0116	ug/Sample		05/28/19 12:21	06/03/19 12:57	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*56*		*50 - 200*	*05/28/19 12:21*	*06/03/19 12:57*	*1*

Client Sample ID: H-1525 VES STACK R3 M0010 BREAKTHROUGH XAD-2 RESIN TUBE

Lab Sample ID: 140-15381-12

Date Collected: 05/23/19 00:00
Matrix: Air
Date Received: 05/24/19 09:00
Sample Container: Air Train

Method: 8321A - PFOA and PFOS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
HFPO-DA	ND		0.200	0.0400	ug/Sample		05/28/19 11:10	06/03/19 11:41	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
13C3 HFPO-DA	*53*		*50 - 200*	*05/28/19 11:10*	*06/03/19 11:41*	*1*

APPENDIX D
SAMPLE CALCULATIONS

SAMPLE CALCULATIONS FOR
HFPO DIMER ACID (METHOD 0010)

Client: Chemours | **Plant: Fayetteville, NC**
Test Number: Run 3 | **Test Date: 05/23/19**
Test Location: VE South Stack | **Test Period: 1341-1536**

1. HFPO Dimer Acid concentration, lbs/dscf.

$$Conc1 = \frac{W \times 2.2046 \times 10^{-9}}{Vm(std)}$$

$$Conc1 = \frac{59.5 \times 2.2046 \times 10\text{-}9}{60.861}$$

Conc1 = 2.16E-09

Where:

W = Weight of HFPO Dimer Acid collected in sample in ug.

Conc1 = Division Stack HFPO Dimer Acid concentration, lbs/dscf.

2.2046×10^{-9} = Conversion factor from ug to lbs.

2. HFPO Dimer Acid concentration, ug/dscm.

Conc2 = W / (Vm(std) x 0.02832)

Conc2 = 59.5 / (60.861 x 0.02832)

Conc2 = 34.53

Where:

Conc2 = Division Stack HFPO Dimer Acid concentration, ug/dscm.

0.02832 = Conversion factor from cubic feet to cubic meters.

3. HFPO Dimer Acid mass emission rate, lbs/hr.

$MR1_{(Outlet)}$ = Conc1 x Qs(std) x 60 min/hr

$MR1_{(Outlet)}$ = 2.16E-09 x 12055 x 60

$MR1_{(Outlet)}$ = 1.56E-03

Where:

$MR1_{(Outlet)}$ = Division Stack HFPO Dimer Acid mass emission rate, lbs/hr.

4. HFPO Dimer Acid mass emission rate, g/sec.

$MR2_{(Outlet)}$ = PMR1 x 453.59 / 3600

$MR2_{(Outlet)}$ = 1.56E-03 x 453.59 /3600

$MR2_{(Outlet)}$ = 1.96E-04

Where:

$MR2_{(Outlet)}$ = Division Stack HFPO Dimer Acid mass emission rate, g/sec.

453.6 = Conversion factor from pounds to grams.

3600 = Conversion factor from hours to seconds.

EXAMPLE CALCULATIONS FOR
VOLUMETRIC FLOW AND MOISTURE AND ISOKINETICS

Client: Chemours	**Facility: Fayetteville, NC**
Test Number: Run 3	**Test Date: 05/23/19**
Test Location: VE South Stack	**Period: 1341-1536**

1. Volume of dry gas sampled at standard conditions (68 deg F, 29.92 in. Hg), dscf.

$$Vm(std) = \frac{17.64 \times Y \times Vm \times \left(Pb + \frac{\text{delta H}}{13.6} \right)}{(Tm + 460)}$$

$$Vm(std) = \frac{17.64 \times 1.0107 \times 63.015 \times \left(30.28 + \frac{1.533}{13.6} \right)}{101.04 + 460} = 60.861$$

Where:

Vm(std) =	Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscf.
Vm =	Volume of gas sample measured by the dry gas meter at meter conditions, dcf.
Pb =	Barometric Pressure, in Hg.
delt H =	Average pressure drop across the orifice meter, in H_2O
Tm =	Average dry gas meter temperature , deg F.
Y =	Dry gas meter calibration factor.
17.64 =	Factor that includes ratio of standard temperature (528 deg R) to standard pressure (29.92 in. Hg), deg R/in. Hg.
13.6 =	Specific gravity of mercury.

2. Volume of water vapor in the gas sample corrected to standard conditions, scf.

$$Vw(std) = (0.04707 \times Vwc) + (0.04715 \times Wwsg)$$

$$Vw(std) = (0.04707 \times 27.0) + (0.04715 \times 20.1) = 2.22$$

Where:

Vw(std) =	Volume of water vapor in the gas sample corrected to standard conditions, scf.
Vwc =	Volume of liquid condensed in impingers, ml.
Wwsg =	Weight of water vapor collected in silica gel, g.
0.04707 =	Factor which includes the density of water (0.002201 lb/ml), the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft^3)/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), ft^3/ml.
0.04715 =	Factor which includes the molecular weight of water (18.0 lb/lb-mole), the ideal gas constant 21.85 (in. Hg) (ft^3)/lb-mole)(deg R); absolute temperature at standard conditions (528 deg R), absolute pressure at standard conditions (29.92 in. Hg), and 453.6 g/lb, ft^3/g.

3. Moisture content

$$bws = \frac{Vw(std)}{Vw(std) + Vm(std)}$$

$$bws = \frac{2.22}{2.22 + 60.861} = 0.035$$

Where:

bws = Proportion of water vapor, by volume, in the gas stream, dimensionless.

4. Mole fraction of dry gas.

Md = 1 - bws

Md = 1 - 0.035 = 0.965

Where:

Md = Mole fraction of dry gas, dimensionless.

5. Dry molecular weight of gas stream, lb/lb-mole.

MWd = (0.440 x % CO_2) + (0.320 x % O_2) + (0.280 x (% N_2 + % CO))

MWd = (0.440 x 0.0) + (0.320 x 20.9) + (0.280 x (79.1 + 0.00))

MWd = 28.84

Where:

MWd = Dry molecular weight , lb/lb-mole.
% CO2 = Percent carbon dioxide by volume, dry basis.
% O_2 = Percent oxygen by volume, dry basis.
% N_2 = Percent nitrogen by volume, dry basis.
% CO = Percent carbon monoxide by volume, dry basis.
0.440 = Molecular weight of carbon dioxide, divided by 100.
0.320 = Molecular weight of oxygen, divided by 100.
0.280 = Molecular weight of nitrogen or carbon monoxide, divided by 100.

6. Actual molecular weight of gas stream (wet basis), lb/lb-mole.

MWs = (MWd x Md) + (18 x (1 - Md))

MWs = (28.84 x 0.965) +(18 (1 - 0.965)) = 28.45

Where:

MWs = Molecular weight of wet gas, lb/lb-mole.
18 = Molecular weight of water, lb/lb-mole.

7. Average velocity of gas stream at actual conditions, ft/sec.

$$Vs = 85.49 \times Cp \times ((\text{delt } p)^{1/2})avg \times \left(\frac{Ts\ (avg)}{Ps \times MWs} \right)^{1/2}$$

$$Vs = 85.49 \times 0.84 \times 0.38979 \times \left(\frac{554}{30.32 \times 28.45} \right)^{\wedge}1/2 = 22.4$$

Where:

Vs = Average gas stream velocity, ft/sec.

85.49 = Pitot tube constant, ft/sec $\times \frac{(\text{lb/lb-mole})(\text{in. Hg})^{1/2}}{(\text{deg R})(\text{in } H_2O)}$

Cp = Pitot tube coefficient, dimensionless.

Ts = Absolute gas stream temperature, deg R = Ts, deg F + 460.

Ps = Absolute gas stack pressure, in. Hg. = Pb + $\frac{P(\text{static})}{13.6}$

delt p = Velocity head of stack, in. H_2O.

8. Average gas stream volumetric flow rate at actual conditions, wacf/min.

$$Qs(act) = 60 \times Vs \times As$$

$$Qs(act) = 60 \times 22.4 \times 9.62 = 12951$$

Where:

Qs(act) = Volumetric flow rate of wet stack gas at actual conditions, wacf/min.

As = Cross-sectional area of stack, ft^2.

60 = Conversion factor from seconds to minutes.

9. Average gas stream dry volumetric flow rate at standard conditions, dscf/min.

$$Qs(std) = 17.64 \times Md \times \frac{Ps}{Ts} \times Qs(act)$$

$$Qs(std) = 17.64 \times 0.965 \times \frac{30.32}{554.3} \times 12951$$

$$Qs(std) = 12055$$

Where:

Qs(std) = Volumetric flow rate of dry stack gas at standard conditions, dscf/min.

10. Isokinetic variation calculated from intermediate values, percent.

$$I = \frac{17.327 \times Ts \times Vm(std)}{Vs \times O \times Ps \times Md \times (Dn)^2}$$

$$I = \frac{17.327 \times 554 \times 60.861}{22.4 \times 96 \times 30.32 \times 0.965 \times (0.300)^{\wedge}2} = 103.1$$

Where:

I =	Percent of isokinetic sampling.
O =	Total sampling time, minutes.
Dn =	Diameter of nozzle, inches.
17.327 =	Factor which includes standard temperature (528 deg R), standard pressure (29.92 in. Hg), the formula for calculating area of circle $D^{2/4}$, conversion of square feet to square inches (144), conversion of seconds to minutes (60), and conversion to percent (100), $\frac{(\text{in. Hg})(\text{in}^2)(\text{min})}{(\text{deg R})(\text{ft}^2)(\text{sec})}$

APPENDIX E
EQUIPMENT CALIBRATION RECORDS

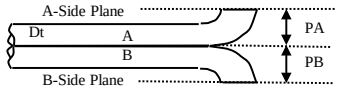
Type S Pitot Tube Inspection Data Form

Pitot Tube Identification Number: **P-694**

Inspection Date 2/19/19 Individual Conducting Inspection ks

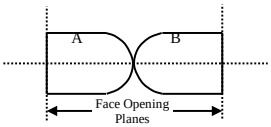
If all Criteria PASS Cp is equal to 0.84

		PASS/FAIL
Distance to A Plane (PA) - inches	0.46	PASS
Distance to B Plane (PB) - inches	0.46	PASS
Pitot OD (D_t) - inches	0.375	

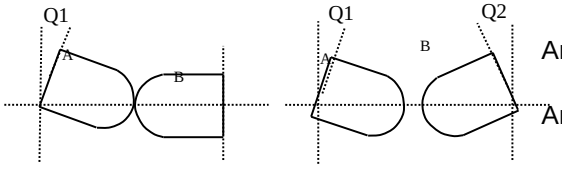


$1.05\ D_t < P < 1.5\ D_t$

PA must Equal PB



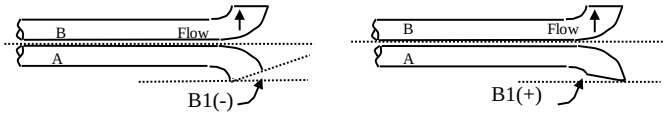
Are Open Faces Aligned Perpendicular to the Tube Axis: (●) YES ( ) NO — PASS



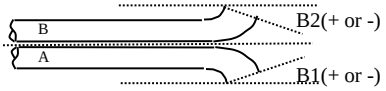
Angle of Q1 from vertical A Tube- degrees (absolute): 0 — PASS

Angle of Q2 from vertical B Tube- degrees (absolute): 0 — PASS

Q1 and Q2 must be $\leq 10^o$



Angle of B1 from vertical A Tube- degrees (absolute): 0 — PASS

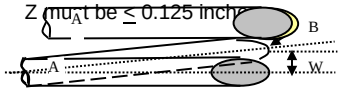


Angle of B1 from vertical B Tube- degrees (absolute): 0 — PASS

B1 or B2 must be $\leq 5^o$

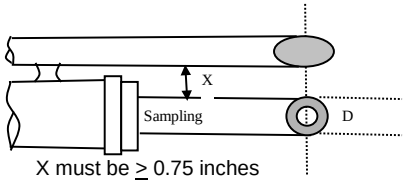
Horizontal offset between A and B Tubes (Z) - inches: 0.004 — PASS

Z must be $\leq$ 0.125 inches



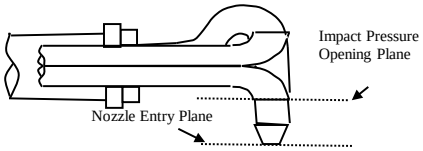
Vertical offset between A and B Tubes (W) - inches: 0.015 — PASS

W must be $\leq$ 0.03125 inches

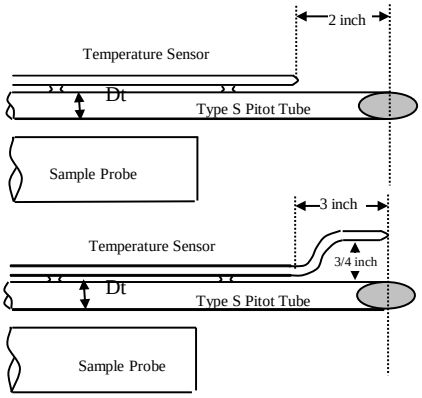


Distance between Sample Nozzle and Pitot (X) - inches: 0.8 — PASS

X must be $\geq$ 0.75 inches



Impact Pressure Opening Plane is above the Nozzle Entry Plane: (●) YES ( ) NO ( ) NA



Thermocouple meets the Distance Criteria in the adjacent figure: (●) YES ( ) NO ( ) NA

Thermocouple meets the Distance Criteria in the adjacent figure: ( ) YES ( ) NO (●) NA

Airgas Specialty Gases
Airgas USA, LLC
6141 Easton Road
Bldg 1
Plumsteadville, PA 18949
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E03NI79E15A00E4	Reference Number:	160-401424145-1
Cylinder Number:	CC157024	Cylinder Volume:	150.5 CF
Laboratory:	124 - Plumsteadville - PA	Cylinder Pressure:	2015 PSIG
PGVP Number:	A12019	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Feb 26, 2019

Expiration Date: Feb 26, 2027

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	9.000 %	9.018 %	G1	+/- 0.6% NIST Traceable	02/26/2019
OXYGEN	12.00 %	12.06 %	G1	+/- 0.3% NIST Traceable	02/26/2019
NITROGEN	Balance			-	

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	061507	K014984	13.94 % CARBON DIOXIDE/NITROGEN	0.57%	Jan 30, 2024
NTRM	16060507	CC401541	23.204 % OXYGEN/NITROGEN	0.2%	Dec 24, 2021

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
HORIBA VA5011 T5V6VU9P NDIR CO2	NDIR	Feb 12, 2019
SIEMENS OXYMAT 61 S01062 O2	PARAMAGNETIC	Feb 18, 2019

Triad Data Available Upon Request

Signature on file
Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
600 Union Landing Road
Cinnaminson, NJ 08077-0000
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E03NI62E15A0224	Reference Number:	82-401288925-1
Cylinder Number:	ALM047628	Cylinder Volume:	157.2 CF
Laboratory:	124 - Riverton (SAP) - NJ	Cylinder Pressure:	2015 PSIG
PGVP Number:	B52018	Valve Outlet:	590
Gas Code:	CO2,O2,BALN	Certification Date:	Sep 04, 2018

Expiration Date: Sep 04, 2026

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
CARBON DIOXIDE	17.00 %	17.05 %	G1	+/- 0.7% NIST Traceable	09/04/2018
OXYGEN	21.00 %	21.25 %	G1	+/- 0.5% NIST Traceable	09/04/2018
NITROGEN	Balance			-	

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	13060804	CC415400	24.04 % CARBON DIOXIDE/NITROGEN	+/- 0.6%	May 16, 2019
NTRM	09061420	CC273671	22.53 % OXYGEN/NITROGEN	+/- 0.4%	Mar 08, 2019

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Horiba VIA 510-CO2-19GYCXEG	NDIR	Aug 09, 2018
Horiba MPA 510-O2-7TWMJ041	Paramagnetic	Aug 09, 2018

Triad Data Available Upon Request

Signature on file
Approved for Release

INTERFERENCE CHECK

Date: 12/4/14-12/5/14
Analyzer Type: Servomex - O_2
Model No: 4900
Serial No: 49000-652921
Calibration Span: 21.09 %
Pollutant: 21.09% O_2 - CC418692

INTERFERENT GAS	ANALYZER RESPONSE		% OF CALIBRATION SPAN[(a)]
	INTERFERENT GAS RESPONSE (%)	INTERFERENT GAS RESPONSE, WITH BACKGROUND POLLUTANT (%)	
CO_2 (30.17% CC199689)	0.00	-0.01	0.00
NO (445 ppm CC346681)	0.00	0.02	0.11
NO_2 (23.78 ppm CC500749)	NA	NA	NA
N_2O (90.4 ppm CC352661)	0.00	0.05	0.24
CO (461.5 ppm XC006064B)	0.00	0.02	0.00
SO_2 (451.2 ppm CC409079)	0.00	0.05	0.23
CH_4 (453.1 ppm SG901795)	NA	NA	NA
H_2 (552 ppm ALM048043)	0.00	0.09	0.44
HCl (45.1 ppm CC17830)	0.00	0.03	0.14
NH_3 (9.69 ppm CC58181)	0.00	0.01	0.03
TOTAL INTERFERENCE RESPONSE			**1.20**
METHOD SPECIFICATION			**< 2.5%**

[(a)] The larger of the absolute values obtained for the interferent tested with and without the pollutant present was used in summing the interferences.

Chad Walker

INTERFERENCE CHECK

Date: 12/4/14-12/5/14
Analyzer Type: Servomex - CO_2
Model No: 4900
Serial No: 49000-652921
Calibration Span: 16.65%
Pollutant: 16.65% CO_2 - CC418692

INTERFERENT GAS	ANALYZER RESPONSE		% OF CALIBRATION SPAN[(a)]
	INTERFERENT GAS RESPONSE (%)	INTERFERENT GAS RESPONSE, WITH BACKGROUND POLLUTANT (%)	
CO_2 (30.17% CC199689)	NA .	NA	NA
NO (445 ppm CC346681)	0.00	0.02	0.10
NO_2 (23.78 ppm CC500749)	0.00	0.00	0.02
N_2O (90.4 ppm CC352661)	0.00	0.01	0.04
CO (461.5 ppm XC006064B)	0.00	0.01	0.00
SO_2 (451.2 ppm CC409079)	0.00	0.11	0.64
CH_4 (453.1 ppm SG901795)	0.00	0.07	0.44
H_2 (552 ppm ALM048043)	0.00	0.04	0.22
HCl (45.1 ppm CC17830)	0.10	0.06	0.60
NH_3 (9.69 ppm CC58181)	0.00	0.02	0.14
TOTAL INTERFERENCE RESPONSE			**2.19**
METHOD SPECIFICATION			**< 2.5%**

[(a)] The larger of the absolute values obtained for the interferent tested with and without the pollutant present was used in summing the interferences.

Chad Walker

Long Cal and Temperature Cal Datasheet for Standard Dry Gas Meter Console

Calibrator PM | **Meter Box Number** 26 | **Ambient Temp** 71

Date 18-Jan-19 | **Wet Test Meter Number** P-2952 | **Temp Reference Source** Thermocouple Simulator (Accuracy +/- 1°F)

Dry Gas Meter Number 16300942

Baro Press, in Hg (Pb)	29.79

Setting	Gas Volume		Temperatures					Calibration Results	
Orifice Manometer	Wet Test Meter	Dry gas Meter	Wet Test Meter	Dry Gas Meter					
in H_20 (ΔH)	ft^3 (Vw)	ft^3 (Vd)	°F (Tw)	Outlet, °F (Td_o)	Inlet, °F (Td_i)	Average, °F (Td)	Time, min (O)	Y	ΔH
0.5	5.0	4.524	71.0	72.00	72.00	72.5	13.5	1.0044	2.0538
		9.510		73.00	73.00				
		4.986		72.50	72.50				
1.0	7.0	9.510	71.0	72.00	72.00	72.5	13.3	1.0083	2.0341
		16.455		73.00	73.00				
		6.945		72.50	72.50				
1.5	10.0	16.455	71.0	73.00	73.00	73.5	16.0	1.0105	2.1596
		26.361		74.00	74.00				
		9.906		73.50	73.50				
2.0	10.0	26.361	71.0	74.00	74.00	75.0	13.5	1.0156	2.0442
		36.233		76.00	76.00				
		9.872		75.00	75.00				
3.0	10.0	36.233	71.0	76.00	76.00	76.5	11.3	1.0145	2.1423
		46.119		77.00	77.00				
		9.886		76.50	76.50				
							Average	**1.0107**	**2.0868**

Vw - Gas Volume passing through the wet test meter
Vd - Gas Volume passing through the dry gas meter
Tw - Temp of gas in the wet test meter
Tdi - Temp of the inlet gas of the dry gas meter
Tdo - Temp of the outlet gas of the dry gas meter
Td - Average temp of the gas in the dry gas meter

0 - Time of calibration run
Pb - Barometric Pressure
ΔH - Pressure differential across orifice
Y - Ratio of accuracy of wet test meter to dry gas meter

$$Y = \frac{Vw * Pb * (td + 460)}{Vd * \left[Pb + \frac{(\Delta H)}{13.6} \right] * (tw + 460)}$$

$$\Delta H = \left[\frac{0.0317 * \Delta H}{Pb * (td + 460)} \right] * \left[\frac{(tw + 460) * O}{Vw} \right]^2$$

Reference Temperature	Temperature Reading from Individual Thermocouple Input [1]						Average Temperature Reading	Temp Difference [2] (%)
Select Temperature ○ °C ◉ °F	Channel Number							
	1	2	3	4	5	6		
32	31	31	31	31	31		31.0	0.2%
212	212	212	212	212	212		212.0	0.0%
932	931	931	931	931	931		931.0	0.1%
1832	1830	1830	1830	1830	1830		1830.0	0.1%

1 - Channel Temps must agree with +/- 5°F or 3°C

2 - Acceptable Temperature Difference less than 1.5 %

$$\text{Temp Diff} = \left[\frac{(\text{Reference Temp}(^\circ F) + 460) - (\text{Test Temp}(^\circ F) + 460)}{\text{Reference Temp}(^\circ F) + 460} \right]$$

Y Factor Calibration Check Calculation

MODIFIED METHOD 0010 TEST TRAIN

VE SOUTH STACK

METER BOX NO. 26

05/22/2019 & 05/23/2019

	Run 1	Run 2	Run 3
MWd = Dry molecular weight source gas, lb/lb-mole.			
0.32 = Molecular weight of oxygen, divided by 100.			
0.44 = Molecular weight of carbon dioxide, divided by 100.			
0.28 = Molecular weight of nitrogen or carbon monoxide, divided by 100.			
% CO_2 = Percent carbon dioxide by volume, dry basis.	0.0	0.0	0.0
% O_2 = Percent oxygen by volume, dry basis.	20.9	20.9	20.9

$$MWd = (0.32 * O_2) + (0.44 * CO_2) + (0.28 * (100 - (CO_2 + O_2)))$$

$$MWd = (0.32 * 20.9) + (0.44 * 0) + (0.28 * (100 - (0 + 20.9)))$$

$$MWd = (6.69) + (0.00) + (22.15)$$

MWd =	28.84	28.84	28.84

Tma = Source Temperature, absolute(^{o}R)			
Tm = Average dry gas meter temperature , deg F.	84.0	93.1	101.0

$$Tma = Ts + 460$$

$$Tma = 83.96 + 460$$

Tma =	543.96	553.13	561.04

Ps = Absolute meter pressure, inches Hg.			
13.60 = Specific gravity of mercury.			
delta H = Avg pressure drop across the orifice meter during sampling, in H2O	1.47	1.27	1.53
Pb = Barometric Pressure, in Hg.	30.20	30.28	30.28

$$Pm = Pb + (delta\ H / 13.6)$$

$$Pm = 30.2 + (1.46791666666667 / 13.6)$$

Pm =	30.31	30.37	30.39

Yqa = dry gas meter calibration check value, dimensionless.			
0.03 = (29.92/528)(0.75)2 (in. Hg/°/R) cfm2.			
29.00 = dry molecular weight of air, lb/lb-mole.			
Vm = Volume of gas sample measured by the dry gas meter at meter conditions, dcf.	60.826	57.096	63.015
Y = Dry gas meter calibration factor (based on full calibration)	1.0107	1.0107	1.0107
Delta H@ = Dry Gas meter orifice calibration coefficient, in. H2O.	2.0868	2.0868	2.0868
avg SQRT Delta H = Avg SQRT press. drop across the orifice meter during sampling , in. H_2O	1.2036	1.1219	1.2326
O = Total sampling time, minutes.	96	96	96

$$Yqa = (O / Vm) * SQRT (0.0319 * Tma * 29) / (Delta\ H@ * Pm * MWd) * avg\ SQRT\ Delta\ H$$

$$Yqa = (96.00 / 60.83) * SQRT (0.0319 * 543.96 * 29) / (2.09 * 30.31 * 28.84) * 1.20$$

$$Yqa = 1.578 * SQRT 503.216 / 1,823.903 * 1.20$$

Yqa =	0.9978	0.9981	1.0004

Diff = Absolute difference between Yqa and Y	1.28	1.25	1.02

$$Diff = ((Y - Yqa) / Y) * 100$$

$$Diff = ((1.0107 - 0.998) / 1.0107) * 100$$

Average Diff = 1.18

Allowable = 5.0

APPENDIX F
LIST OF PROJECT PARTICIPANTS

The following Weston employees participated in this project.

Jeff O'Neill	Senior Project Manager
Kris Ansley	Team Member
Kyle Schweitzer	Team Member
Nick Guarino	Team Member