1. PROJECT OVERVIEW

Test Program Summary

Introduction

Marathon Petroleum Company LP contracted CleanAir Engineering (CleanAir) to complete testing on the CCR Interheater (EU14-CCRPLINTHR-S1) at the Detroit Refinery located in Detroit, MI. The test program included particulate matter (FPM) testing intended to demonstrate compliance with the MDEQ Permit No. MI-ROP-A9831-2012c.

For the testing described in this report, CleanAir mistakenly provided the crew with filters prepared for Method 5B instead of Method 5. The methods differ in how the filters are prepared prior to testing and how the filters are analyzed after testing. As further discussed in a memorandum from CleanAir to MPC dated September 24, 2020 presented in Appendix I of this report, this difference imparted a significant positive bias to the measured particulate emissions. Due to this error and the resulting bias, these tests results are not representative of true unit emissions and should be discarded. Consequently, particulate emissions are presented in this report but not evaluated against the applicable limits.

Section 2 Results provides a more detailed account of the test conditions and data analysis. Test program information, including the test parameters, on-site schedule and a project discussion, begin below.

Test Program Details

Parameters

The test program included the following emissions measurements:

- particulate matter (PM) as filterable particulate matter (FPM)
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas temperature
- flue gas flow rate

Schedule

Testing was performed on August 18, 2020. The on-site schedule followed during the test program is outlined in Table 1-1.

Table 1-1:
Test Schedule

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	CCR Interheater Stack	USEPA Method 5	FPM	08/18/20	08:47	09:50
2	CCR Interheater Stack	USEPA Method 5	FPM	08/18/20	10:18	11:21
3	CCR Interheater Stack	USEPA Method 5	FPM	08/18/20	11:55	12:58
4	CCR Interheater Stack	USEPA Method 5	FPM	08/18/20	13:25	14:28

Discussion

Test Scope Synopsis

FPM Testing

A total of four (4) 60-minute Method 5 test runs were performed. FPM emission results were calculated in units of pounds per million Btu (lb/MMBtu). The final result was expressed as the average of the three (3) highest runs.

Calculations

Emission results in units of dry volume-based concentration (lb/dscf, ppmdv) were converted into units of pound per million BTU (lb/MMBtu) using an oxygen-based fuel factor (F_d) for refinery gas provided by MPC.

Test Conditions

The unit was operated at the maximum normal operating capacity during each of the emissions compliance test runs. MPC was responsible for logging any relevant process-related data and providing it to CleanAir for inclusion in the test reports.

End of Section

2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices, specifically Appendix C Parameters.

Table 2-1:
CCR Interheater Stack – FPM

Run No.		1	2*	3	4	Average
Date (2020)		Aug 18	Aug 18	Aug 18	Aug 18	
Start Time (approx.)		08:47	10:18	11:55	13:25	
Stop Time (approx.)		09:50	11:21	12:58	14:28	
Process Conditions						
R_P	Production Rate (BPD)	20,000	20,002	20,005	20,009	**20,004**
P_1	Fuel Consumption (mscf/day)	2,836	2,829	2,819	2,813	**2,824**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,631	8,631	8,631	8,631	**8,631**
H_i	Actual heat input (MMBtu/hr)	97.9	97.6	97.3	97.1	**97.5**
Gas Conditions						
O_2	Oxygen (dry volume %)	5.3	5.4	5.3	5.4	**5.3**
CO_2	Carbon dioxide (dry volume %)	8.9	8.8	8.9	8.8	**8.9**
T_s	Stack temperature (°F)	626	632	630	629	**628**
B_w	Actual water vapor in gas (% by volume)	15.7	15.6	15.0	15.3	**15.3**
Gas Flow Rate						
Q_a	Volumetric flow rate, actual (acfm)	58,900	57,400	59,400	57,500	**58,600**
Q_s	Volumetric flow rate, standard (scfm)	28,200	27,300	28,300	27,400	**28,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	23,800	23,100	24,100	23,200	**23,700**
Sampling Data						
V_{mstd}	Volume metered, standard (dscf)	42.17	40.30	42.67	41.00	**41.95**
%I	Isokinetic sampling (%)	102.2	100.7	102.8	102.4	**102.5**
Laboratory Data[1]						
m_{filter}	Matter collected on filter(s) (g)	0.00243	0.00247	0.00303	0.00298	
m_s	Matter collected in solvent rinse(s) (g)	0.00127	0.00093	0.00089	0.00114	
m_n	Total FPM (g)	0.00370	0.00340	0.00392	0.00412	
FPM Results						
C_{sd}	Particulate Concentration (lb/dscf)	1.93E-07	1.86E-07	2.03E-07	2.22E-07	**2.06E-07**
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.276	0.257	0.292	0.309	**0.292**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00224	0.00216	0.00234	0.00258	**0.00239**

Average includes 3 runs. * indicates that the run is not included in the average.

The particulate results in this table are not believed to be representative of true emissions.

[1] Front half filter tare weights were determined subsequent to baking at 160°C, final weights were determined subsequent to baking at 105°C.

End of Section

3. DESCRIPTION OF INSTALLATION

Process Description

MPC's facility in Detroit, Michigan, produces refined petroleum products from crude oil. MPC must continue to demonstrate that select process units are in compliance with permitted emission limits.

The Continuous Catalytic Regeneration Platformer Unit (EG14-CCRPLATFORMER) is a catalytic reformer that rearranges the structure of low octane naphtha feed into higher-octane reformates. Hydrogen is produced as a product of the reaction and is used in other refinery processes. The CCR Interheater (EU14-CCRPLINTHTR) heats the intermediate reformate reactants prior to its re-entry into the multi-staged reactor system.

The unit is fired by refinery fuel gas. Emissions are vented to the atmosphere via the CCR Interheater Stack (SV14-H4A) where testing was performed.

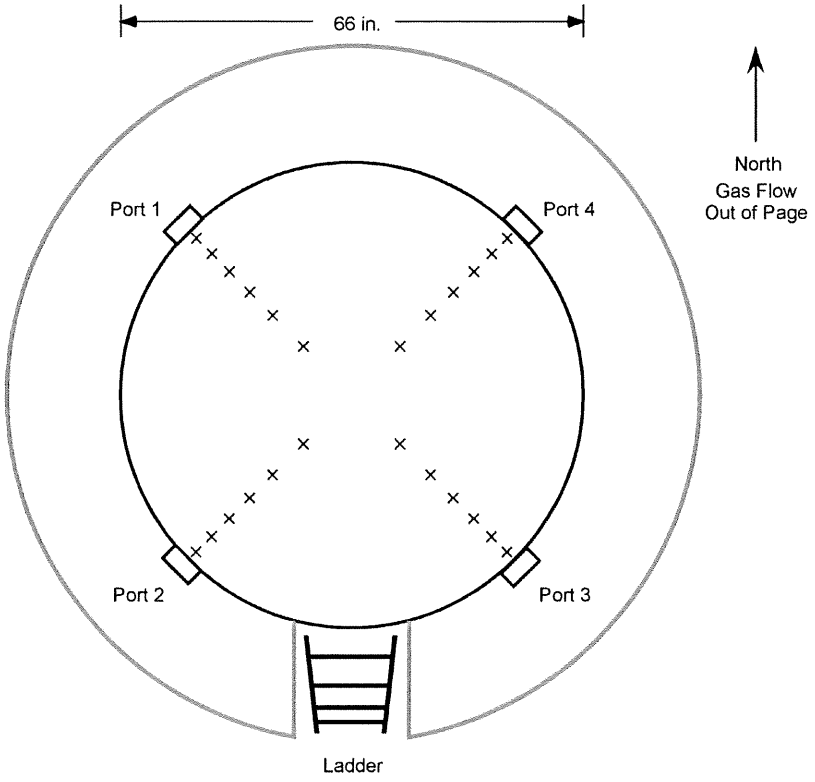
Test Location

The sample point locations were determined by EPA Method 1 specifications. Table 3-1 presents the sampling information for the test location described in this report. The figure shown on page 5 represents the layout of the test location.

Table 3-1:
Sampling Point Information

Source Constituent	Method	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
CCR Interheater							
FPM	EPA M5	1-4	2	12	2.5	60	3-1

Figure 3-1:
FPM Sample Point Layout (EPA Method 1)



Samplin Point	% of Stack Diameter	Port to Point Distance (inches)
1	97.9	64.6
2	93.3	61.6
3	88.2	58.2
4	82.3	54.3
5	75.0	49.5
6	64.4	42.5
7	35.6	23.5
8	25.0	16.5
9	17.7	11.7
10	11.8	7.8
11	6.7	4.4
12	2.1	1.4

Duct diameters upstream from flow disturbance (A): 13.1 Limit: 0.5
Duct diameters downstream from flow disturbance (B):3.6 Limit: 2.0

End of Section

4. METHODOLOGY

Procedures and Regulations

The test program sampling measurements followed procedures and regulations outlined by the USEPA and Michigan Department of Environment, Great Lakes, and Energy (EGLE). These methods appear in detail in Title 40 of the CFR and at https://www.epa.gov/emc. Appendix A includes diagrams of the sampling apparatus, as well as specifications for sampling, recovery and analytical procedures.

CleanAir follows specific QA/QC procedures outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods," EPA/600/R-94/038C. Appendix D contains additional QA/QC measures, as outlined in CleanAir's internal Quality Manual.

Title 40 CFR Part 60, Appendix A

Method 1	"Sample and Velocity Traverses for Stationary Sources"
Method 2	"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
Method 3	"Gas Analysis for the Determination of Dry Molecular Weight"
Method 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 3B	"Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air"
Method 4	"Determination of Moisture Content in Stack Gases"
Method 5	"Determination of Particulate Matter Emissions from Stationary Sources"

Methodology Discussion

FPM – USEPA Method 5

The front-half (Method 5 portion) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 248°F ± 25°F and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements. Filters for this test were mistakenly prepared for Method 5B rather than for Method 5 resulting in a high bias for particulate matter emissions. See Appendix I for more details.

After exiting the heated M5 filter, the flue gas passed through flexible line to a series of knock-out jars surrounded by ice. The moisture collected in these jars was measured to determine the flue gas moisture but not further analyzed. The sample gas then flowed into a calibrated dry gas meter where the collected sample gas volume was determined.

The front-half portion of the sample train (nozzle, probe and heated filter) was recovered per Method 5 requirements, using acetone as the recovery solvent. All samples and blanks were returned to CleanAir Analytical Services in Palatine, Illinois, for gravimetric analysis. Upon receipt, the filters dessicated for 24 hours at ambient temperature followed by an oven dry at 220°F. The front-half rinses were evaporated at ambient temperature and pressure. The masses from each fraction were then summed for a total FPM mass.

End of Section

Specification Sheet for EPA Method 5

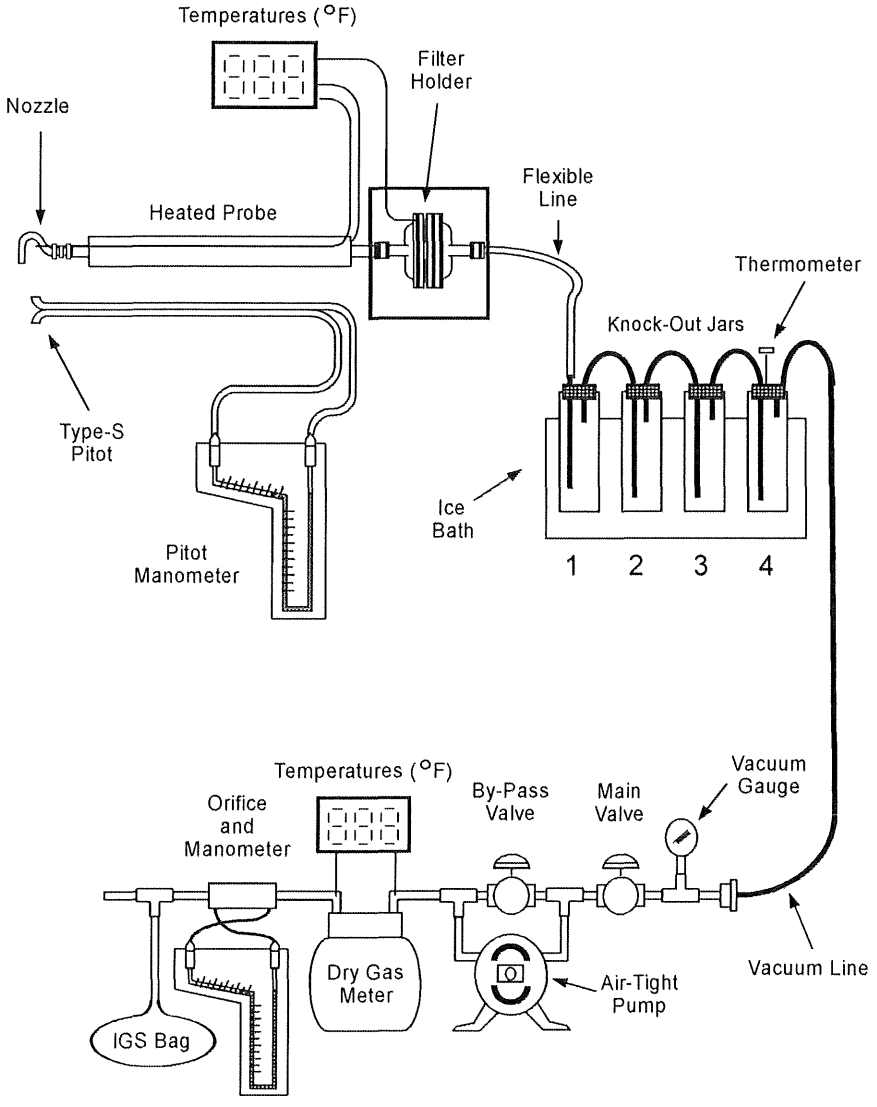
Source Location Name(s)	CCR Interheater
Pollutant(s) to be Determined	Particulate Matter (PM)
Other Parameters to be Determined from Train	Gas Density, Moisture, Flow Rate

	Standard Method Specification	Actual Specification Used
Pollutant Sampling Information		
Duration of Run	N/A	60 minutes
No. of Sample Traverse Points	N/A	12
Sample Time per Point	N/A	3 minutes
Sampling Rate	Isokinetic (90-110%)	Isokinetic (90-110%)
Sampling Probe		
Nozzle Material	Stainless Steel or Glass	Borosilicate Glass
Nozzle Design	Button-Hook or Elbow	Button-Hook
Probe Liner Material	Borosilicate or Quartz Glass	Borosilicate Glass
Effective Probe Length	N/A	9 feet
Probe Temperature Set-Point	248˚F±25˚F	248˚F±25˚F
Velocity Measuring Equipment		
Pitot Tube Design	Type S	Type S
Pitot Tube Coefficient	N/A	0.833
Pitot Tube Calibration by	Geometric or Wind Tunnel	Wind-Tunnel
Pitot Tube Attachment	Attached to Probe	Attached to Probe
Metering System Console		
Meter Type	Dry Gas Meter	Dry Gas Meter
Meter Accuracy	±2%	±1%
Meter Resolution	N/A	0.01 cubic feet
Meter Size	N/A	0.1 dcf/revolution
Meter Calibrated Against	Wet Test Meter or Standard DGM	Wet Test Meter
Pump Type	N/A	Rotary Vane
Temperature Measurements	N/A	Type K Thermocouple/Pyrometer
Temperature Resolution	5.4˚F	1.0˚F
ΔP Differential Pressure Gauge	Inclined Manometer or Equivalent	Inclined Manometer
ΔH Differential Pressure Gauge	Inclined Manometer or Equivalent	Inclined Manometer
Barometer	Mercury or Aneroid	Digital Barometer calibrated w/Mercury Aneroid
Filter Description		
Filter Location	After Probe	Exit of Probe
Filter Holder Material	Quartz	Borosilicate Glass
Filter Support Material	Glass Frit	Teflon
Cyclone Material	N/A	None
Filter Heater Set-Point	248˚F±25˚F	248˚F±25˚F
Filter Material	Glass Fiber	Quartz Fiber
Other Components		
Description	N/A	N/A
Location	N/A	N/A
Operating Temperature	N/A	N/A

Specification Sheet for EPA Method 5

	Standard Method Specification	Actual Specification Used
Impinger Train Description		
Type of Glassware Connections	Ground Glass or Equivalent	Ground Glass with Silicone Grease
Connection to Probe or Filter by	Direct Glass Connection	Direct Glass Connection
Number of Impingers	4	4
Impinger Stem Types		
Impinger 1	Modified Greenburg-Smith	KO Jar (Open Tip)
Impinger 2	Greenburg-Smith	KO Jar (Open Tip)
Impinger 3	Modified Greenburg-Smith	KO Jar (Open Tip)
Impinger 4	Modified Greenburg-Smith	KO Jar (Open Tip)
Impinger 5		
Impinger 6		
Impinger 7		
Impinger 8		
Gas Density Determination		
Sample Collection	Multi-point integrated	Multi-Point Integrated
Sample Collection Medium	Flexible Gas Bag	Vinyl Bag
Sample Analysis	Orsat or Fyrite Analyzer	CEM
Sample Recovery Information		
Probe Brush Material	Nylon Bristle	Nylon Bristle
Probe Rinse Reagent	Acetone	Acetone
Probe Rinse Wash Bottle Material	Glass or Polyethylene	Teflon
Probe Rinse Storage Container	Glass or Polyethylene	Glass
Filter Recovered?	Yes	Yes
Filter Storage Container	N/A	Polystyrene
Impinger Contents Recovered?	Provision	Archived
Impinger Rinse Reagent	Deionized Distilled Water	N/A
Impinger Wash Bottle	Glass or Polyethylene	N/A
Impinger Storage Container	Glass or Polyethylene	N/A
Analytical Information		
Method 4 H_2O Determination by	Volumetric or Gravimetric	Gravimetric and Volumetric
Filter Preparation Conditions	Dessicate 24 hours minimum at ambient temperature	Dessicate 24 hours minimum at ambient temperature
Front-Half Rinse Preparation	Evaporate at ambient temperature and pressure	Evaporate at ambient temperature and pressure
Back-Half Analysis	N/A	N/A
Additional Analysis	N/A	None

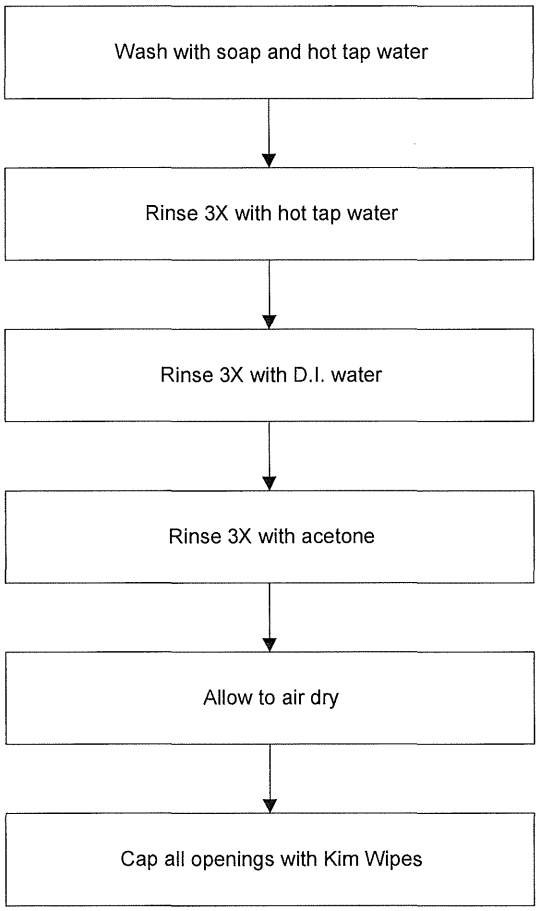
EPA Method 5
Sampling Train Configuration



Knock Out Jar Contents

Knock Out Jar 1	DI H_2O
Knock Out Jar 2	DI H_2O
Knock Out Jar 3	Empty
Knock Out Jar 4	Silica gel

EPA Method 5
Glassware Preparation Procedures



EPA Method 5
Sample Recovery Flowchart

- Tare all sample containers before sample collection
- Mark all liquid levels and final weights on the outside of each sample container
- Seal all sample containers with Teflon tape
- If recycling, bake silica gel for two hours at 350 degrees F (175 degrees C)

Container 1
Quartz Filter
Petri Dish

Remove with tweezers to original container. Brush any loose particulate or filter fibers into sample container

If necessary fold in half and place into container

Visual Inspection

Container 2
Front Half (FH) Rinse
500 ml Glass

Probe liner, nozzle, cyclone or cyclone bypass and filter FH

Brush/rinse 3X with acetone (6X for metal components)

Visual Inspection

Label container and measure volume by weight

Container 3
Silica Gel

Measure volume by weight, note any color change

Recycle silica gel

*Containers 4 and 7 are required when the testing includes a back half analysis

Container 4*
Back Half (BH) Rinse
500 ml Plastic

BH filter housing, Z-piece, impingers 1, 2, 3 and U-Bends

Measure volume by weight

Empty contents into labeled container

Rinse with water

Visual Inspection

Label container and measure volume by weight

Blanks

Container 5
Filter Blank
Plastic Petri Dish

Clean, unused tared filter

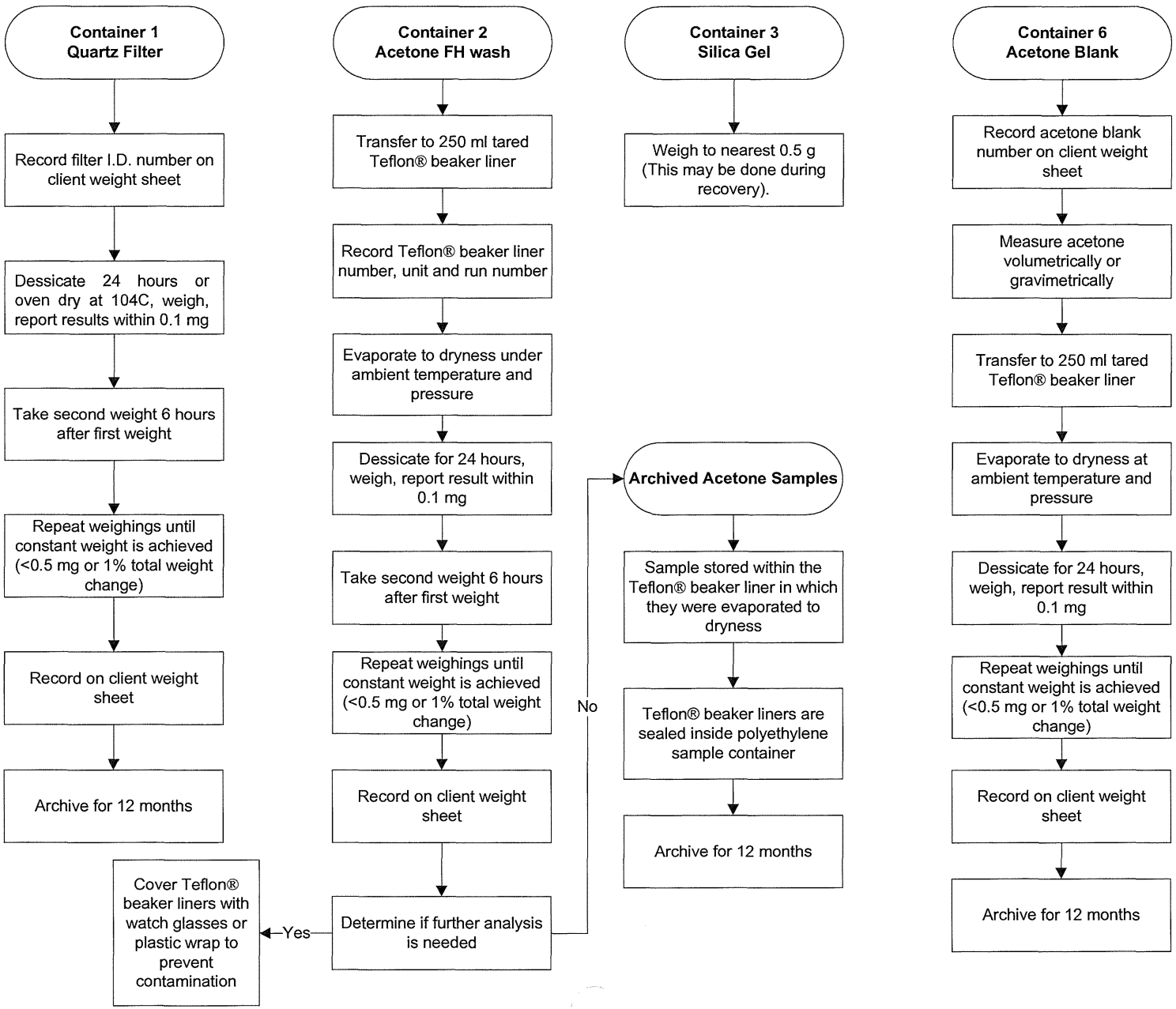
Container 6
Acetone Blank
500 ml Glass

200 ml of acetone from rinse bottle. Record lot number

Container 7*
D.I. Water Blank
250 ml Plastic

200 ml of water from rinse bottle

EPA Method 5
Analytical Flowchart



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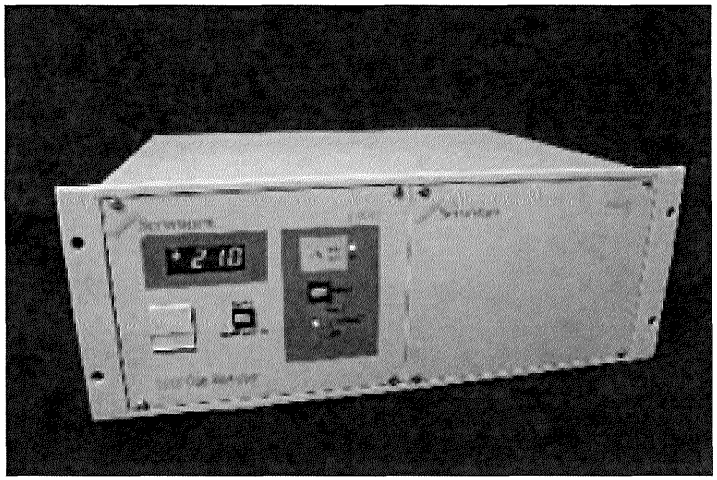
Servomex 1420C Oxygen Analyzer



Rental and Application Notes:

- Shipping Weight: 28 lbs.
- The analyzer measures the partial pressure of oxygen in the sample gas. Therefore, any change in sample pressure at the measuring cell will have an effect, which is proportional to the change in absolute pressure from the time of calibration.
- The Servomex 1420C/1415C can be plumbed together in a 19" rack mount. The combined weight is 44 lbs.
- These units are compatible with the older 1400B series.

Specifications:

- Weight: 12 lbs.
- Dimensions: 19" x 7" x 14".
- Power: 120VAC.
- Output: 0-1V or 4 - 20mA.
- Range: 0 - 25 & 100% O_2.
- Response Time (T_{90}): 2.5 sec.
- Accuracy: $\pm$ 0.1%.
- Flow Rate: 1 - 6 L/min.
- Inlet Pressure: 1-10 psig.
- Vent Pressure: 11.8 to 15.9 psia.
- Linearity: $\pm$ 0.1%.
- Repeatability: $\pm$ 0.1% O_2.
- Zero Drift: < $\pm$ 0.002% O_2/hour.
- Span Drift: < $\pm$ 0.002% O_2/hour.
- Relative Humidity: 0 - 90% non-condensing.

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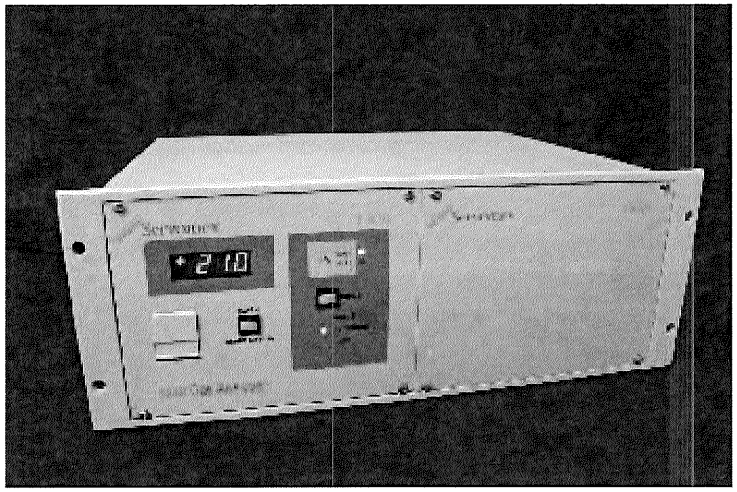
Servomex 1415 CO_2 Analyzer



Rental and Application Notes:

- Shipping Weight: 28 lbs.
- The Servomex 1420C/1415C can be plumbed together in a 19" rack mount. The combined weight is 44 lbs.
- These units are compatible wiith the older 1400B series.

Specifications:

- Weight: 12 lbs.
- Dimensions: 19" x 7" x 14"
- Power: 120VAC.
- Output: 0-1v non-isolated or 4-20mA.
- Range: 0-20 & 25% CO_2.
- Response Time (T_{90}): <10 seconds.
- Accuracy: 1% of selected range.
- Flow Rate: 1 - 6 L/min.
- Inlet Pressure: 1 - 10 psig.
- Vent Pressure: 13.1 to 16.0 psia.
- Linearity: 1% of selected range.
- Repeatability: 1% of selected range.
- Zero Drift: 2% of full scale/week.
- Span Drift: 1% of reading/day.
- Relative Humidity: 0% - 90% non-condensing.
- Storage Temperature: -4°F to 158°F.
- Infrared Detector.