

Noeleen Keavey

Attachments: 1. REGLTL4210115 Rehab Glassco Air Emissions.pdf

From: Mark McGarry [<mailto:mmcgarry@axisenv.ie>]

Sent: 23 September 2015 12:57

To: Magnus Amajirionwu

Cc: Elaine Murray

Subject: RE: Response to ADM query

Magnus,

In terms of high Total Organic Carbon (TOC), this was monitored by Air Scientific Limited to determine what the TOC could consist of. Speciated organic monitoring was carried out on the emissions to determine what the compounds could be and to eliminate the possibility that the emissions are 100% benzene.

The analysis carried out for a top 10 VOC screen did not indicate any specific type of organic compound in the emissions. This concluded the suspicions that the TOC which is emitted from the stack was unburnt methane from the fuel rather than a TA Luft Organic Compound / benzene. The report of the investigation for TOC versus speciated organic analysis is attached.

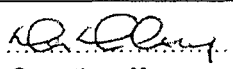
Regards

Mark

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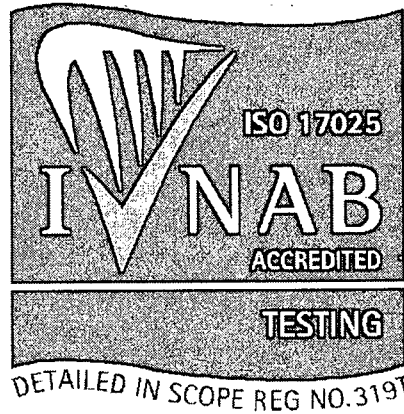
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Report Title	Air Emissions Compliance Monitoring Emissions Report
Company address	Air Scientific Ltd., 40 Coolraine Heights, Old Cratloe Road, Limerick
Stack Emissions Testing Report Commissioned by	Rehab Glassco Limited
Facility Name	Rehab Glassco Limited
Contact Person	Paul Hodder / Zeki Mustafa
EPA Licence Number	W0279-01
Licence Holder	Rehab Glassco Ltd
Stack Reference Number	A1 / A2
Dates of the Monitoring Campaign	21-01-2015
Job Reference Number	REGLTL4210115
Report Written By	Mr. Gregory Dempsey
Report Approved by	Mr. Mark McGarry
Stack Testing Team	David Noonan and Daniel Mullins
Report Date	25-02-2015
Report Type	Test Report Compliance Monitoring
Version	1
Signature of Approver	 Operations Manager

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Executive Summary

Monitoring Objectives

Overall Aim of the monitoring Campaign

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values as specified in the site licence.

Special Requirements

There were no special requirements.

Target Parameters

Total Gaseous Organic Carbon (TOC)
T A Luft Organics
Volumetric Flow Rates ($\text{m}^3.\text{hr}^{-1}$)

Emission Limit Values

A1	mg.m^{-3}
TOC	80
T A Luft Organics	Not applicable
Volume ($\text{m}^3.\text{hr}^{-1}$)	9,500

Reference Conditions

Reference Conditions	Value
Oxygen Reference %	-
Temperature K	273.15
Total Pressure kPa	101.3
Moisture %	-

Target Parameters

Total Gaseous Organic Carbon (TOC)
T A Luft Organics
Volumetric Flow Rates (m ³ .hr ⁻¹)

Emission Limit Values

A2	mg.m ⁻³
TOC	80
T A Luft Organics	Not applicable
Volume (m ³ .hr ⁻¹)	8,000

Reference Conditions

Reference Conditions	Value
Oxygen Reference %	
Temperature K	273.15
Total Pressure kPa	101.3
Moisture %	

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Executive Summary

Overall Results

A1	Concentration				
Parameter	Units	Result	MU +/-	Limit	Compliant
Total Gaseous Organic Carbon (TOC)	mg.m ⁻³	45.9	1.59	80	Yes
T A Luft Organics Class I/II/III					
Run 1	mg.m ⁻³	<0.41	0.02		
Run 2		<0.42	0.02		
Run 3		<0.72	0.02		
Volumetric Flow Rate (Ref.)	m ³ .hr ⁻¹	5,600	-	9,500	-

A2	Concentration				
Parameter	Units	Result	MU +/-	Limit	Compliant
Total Gaseous Organic Carbon (TOC)	mg.m ⁻³	59.6	1.98	80	Yes
T A Luft Organics Class I/II/III					
Run 1	mg.m ⁻³	<0.40	0.01		Yes
Run 2		<0.46	0.01		
Run 3		<0.72	0.01		
Volumetric Flow Rate (Ref.)	m ³ .hr ⁻¹	5,914	-	8,000	Yes

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Accreditation details

Air Scientific Limited	INAB Number: 319T
External Analytical Laboratory	Accreditation number: UKAS 0605

Executive Summary

Process details

Stack Name	A1 – Old Drying Plant
Process status	Normal
Capacity (per/hour) (if applicable)	Variable
Continuous or Batch Process	Continuous
Feedstock	Glass
Abatement System	Bag Filters
Abatement Systems Running Status	Normal
Fuel	Natural Gas
Plume Appearance	Yes
Other information	None

Stack Name	A2 – New Drying Plant
Process status	Normal
Capacity (per/hour) (if applicable)	Variable
Continuous or Batch Process	Continuous
Feedstock	Glass
Abatement System	Bag Filters
Abatement Systems Running Status	Normal
Fuel	Gas
Plume Appearance	No
Other information	None

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Executive Summary

Monitoring, Equipment & Analytical Methods

Parameter	Standard	Technical Procedure	Accredited Testing	Analytical Technique	Equipment / Media	Equipment ID Used on Site
Total Gaseous Organic Carbon (TOC)	EN12619:2013	2009	Yes	Flame Ionisation Detection	FID	ASLLK12EQ529 ASLLK12EQ500 ASLLK12EQ505
T A Luft Organics	EN13649:2002	2019	Yes	Solvent Desorption/ GCMS	Activated Carbon	ASLLK12EQ507 ASLLK12EQ514 ASLLK12EQ542
Volumetric Flow Rate	EN 16911:2013	2005	Yes	Manometer / Pitot / Calculation	Manometer / Pitot / Calculation	ASLLK13EQ500 ASLLK14EQ506

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Sampling Deviations

Parameter	A1
EN12619:2013	None
EN13649:2002	None
EN 16911:2013	None
Flow Rates	EN 16911 - in accordance with MID 6911-1

Reference Documents

Risk Assessment (RA)	SOP 1011
Site Review (SR)	SOP 1015
Site Specific Protocol (SSP)	SOP 1015

Suitability of Sample Location

General Information	Value
Permanent/Temporary	Permanent
Inside/ Outside	Outside

Platform Details

Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements	Value	Comment
Sufficient Working area to manipulate probe and measuring instruments	Yes	-
Platform has 2 handrails (approx. 0.5m & 1.0 m high)	Yes	-
Platform has vertical base boards (approx. 0.25 m high)	Yes	-
Platform has chains / self-closing gates at top of ladders	No	-
There are no obstructions present which hamper insertion of sampling equipment	Yes	-
Safe Access Available	Yes	-
Easy Access Available	Yes	-

Sampling Location / Platform Improvement Recommendations

None

BSEN 15259 Homogeneity Test Requirements

Not applicable

Select Option :

- 1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack
- 2: Test results were obtained from previous Homogeneity test carried out by ASL
- 3: Test results were obtained from previous Homogeneity test carried out by Alternative contractor

Sampling Deviations

Parameter	A2
EN12619:2013	None
EN13649:2002	None
EN 16911:2013	None
Flow Rates	EN 16911 - in accordance with MID 6911-1

Reference Documents

Risk Assessment (RA)	SOP 1011
Site Review (SR)	SOP 1015
Site Specific Protocol (SSP)	SOP 1015

Suitability of Sample Location

General Information	Value
Permanent/Temporary	Permanent
Inside/ Outside	Inside

Platform Details		
Irish EPA Technical Guidance Note AG1 / BS EN 15259 Platform Requirements	Value	Comment
Sufficient Working area to manipulate probe and measuring instruments	Yes	-
Platform has 2 handrails (approx. 0.5m & 1.0m high)	Yes	-
Platform has vertical base boards (approx. 0.25 m high)	Yes	-
Platform has chains / self-closing gates at top of ladders	No	-
There are no obstructions present which hamper insertion of sampling equipment	Yes	-
Safe Access Available	Yes	-
Easy Access Available	Yes	-

Sampling Location / Platform Improvement Recommendations
None

BSEN 15259 Homogeneity Test Requirements
Not applicable
Select Option :
1: There is no requirement to perform a BSEN15259 Homogeneity Test on this stack
2: Test results were obtained from previous Homogeneity test carried out by ASL
3: Test results were obtained from previous Homogeneity test carried out by Alternative contractor

Stack Diagram

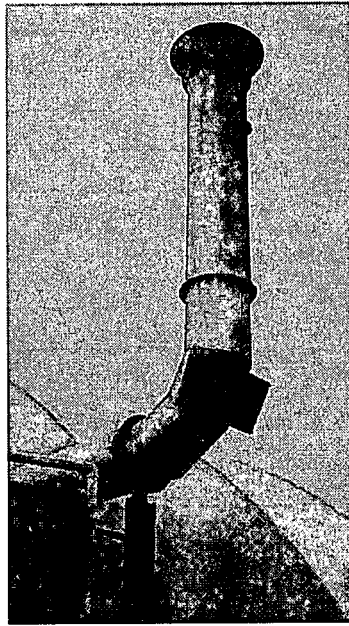


Figure 1: A1

Stack Diagram



Figure 2: A2

1. APPENDICES

Appendix I Monitoring Personnel & Equipment

Stack Emissions Monitoring Personnel

Team Leader	Name	David Noonan
	System approval	ASL Team Leader Approved
Technician	Name	Daniel Mullins
	System approval	ASL Technician Approved

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Appendix II Stack Raw Data

[Faint, illegible table content]

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Title: Determination of Total Organic Compounds
Method: EN 12619:2013
Client: Rehab Glassco
Stack Reference: A1

Licence Limits

Emission Limit Value 80 mg.m⁻³
 Flow Rate Limit 9,500 m³.Hr⁻¹

Results

TOC Concentration 45.9 mg.m⁻³
 Flow Rate 5,637 m³.Hr⁻¹
 Uncertainty of Measurement 1.59 mg.m⁻³

Reference Conditions

Temperature (K) 273.13 °K
 Pressure (kPa) 101.3 kPa
 Gas (Wet or Dry) -
 Oxygen - %

Quality Data

Sampling Time 21/01/2015 10:56 -
 Instrument Range 100 ppm
 Span Gas Value 78 ppm
 Acceptable Gas Range Yes 50 - 90% of Range
 Oven Temperature 181 °C
 Average Temperature 180 °C
 Temperature Acceptable Yes Yes or No
 Sample line temperature 181 C

Zero Drift

Zero Down Sampling Line (Pre) 0 ppm
 Zero Down Sampling Line (Post) -0.2 ppm
 Zero drift -0.2 ppm
 Allowable Zero Drift 1.56 ppm
 Zero Drift Acceptable Yes Yes or No

Span Drift

Span (Pre) 78 ppm
 Span (Post) 77.9 ppm
 Span Drift -0.1 ppm
 Allowable Span Drift 1.56 ppm
 Span Drift Acceptable Yes Yes or No

Leak Check

Span Gas Conc. 78 ppm
 Recorded Conc. down Line (Pre) 78 ppm
 Leak Result 0 ppm
 Leak check acceptable (< 2%) 1.6 (Y/N)

Parameter

Standard EN 12619:2013
 Technical Procedure 2009
 Probe material Stainless Steel
 Filtration Type Ceramic Filter
 Heated Head Filter Used Yes
 Heated Line Temperature 180 Deg C
 Span Gas Reference Number ASLLK14ING524
 Span Gas Expiry Date Feb-17
 Span Gas Start Pressure (bar) 35 bar
 Gas Cylinder Concentration (ppm) 78 ppm
 Span Gas Uncertainty (%) 0.8 %
 Zero Gas Type Air
 Number of Sampling Lines Used 1
 Number of Sampling Points Used 1
 Sample Point I.D's 1

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Measured Quantities

Certified Range of Analyser	1000	ppm
Operational Range of Analyser	100	ppm
Measured Reading	29	ppm
Non linearity	0.4	ppm
Temperature Dependent Zero drift	0.15	ppm Per Degree
Temperature Dependent Span drift	0.1	% Per Degree
Cross-sensitivity	0.1	ppm
Leak	0	ppm
Calibration Gas uncertainty	0.8	ppm

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Title: Determination of Stack Flow Rate
Method: EN 16911-1
Client: Rebag Glassco
Stack Reference: A1

Stack details	Value	Units
Date of survey	20/01/2015	
Time of survey	11:00	
Type	Circular	
Stack Diameter / Depth, D	0.48	Length (m) m
Stack Width, W	-	m
Average Stack Gas Temp., Ta	112.5	385.65 C
Average Static Pressure, P static	0.4	kPa/mbar
Average Barometric Pressure, Pb	99.51	kPa
Type of Pitot	S	
Are Water Droplets Present ?	No	
Average Pitot Tube Calibration Coeff, Cp	0.82	
No local negative flow	No	
Highly homogeneous flow stream/gas velocity	Yes	
Sample Port Size	101.6	mm
Initial Pitot Leak Check	Pass	
Final Pitot Leak Check	Pass	
Orientation of Duct	Vertical	
Pitot Tube Cp	0.998	
Number of Lines Available	2	
Number of Lines Used	2	

Sampling Line A

Point	Distance	Pa	Temp C	Velocity	Oxygen	Swirl
1	0.07	104	112.5	12.4	17.5	<15
2	0.41	100	112.5	12.1	17.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		102	112.5	12.25	17.50	<15
Min		100	112.5	12.13	17.5	<15
Max		104	112.5	12.37	17.5	<15

Sampling Line B

Point	Distance	Pa	Temp C	Velocity	Oxygen	Swirl
1	0.07	109	112.5	12.7	17.5	<15
2	0.41	102	112.5	12.3	17.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		105.5	112.5	12.46	17.5	<15
Min		102	112.5	12.25	17.5	<15
Max		109	112.5	12.66	17.5	<15

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Average stack Gas Velocity	12.35	m/s
Lowest Differential Pressure	100.00	Pa
Lowest Gas Velocity	12.13	m/s
Highest Gas Velocity	12.66	m/s
Average Differential Pressure	103.75	Pa
Velocity Ratio of High to Low (3:1)	1.04	
Average Angle of flow	<15	

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Molar Mass
Carbon Dioxide CO2	-	3.4		44.01
Oxygen O2	-	17.5		32
Nitrogen N2	-	79.1		28.1
Moisture (H2O)	-	-	0	18.02

Reference Conditions	Units	Numbers
Temperature	K	273.13
Total Pressure	kPa	101.3
Moisture	%	-
Oxygen (Dry)	%	-

General Stack Details

Stack details	Units	Value
Stack Diameter / Depth, D	m	0.48
Stack Width, W	m	
Stack Area, A	m ²	0.18
Average Stack Gas Temp., Ta	C	112.5
Average Static Pressure, P static	kPa	0.4
Average Barometric Pressure, Pb	kPa	99.51
Average Pitot Tube Calibration Coeff, Kpt		0.82

Calc box Area

Circular Duct	Rectangular Duct
R =	Length (m)
R2 =	Width (m)
Area = Pie*R2	Area

Stack Gas Composition & Molecular Weights

Component	Molar Mass M	Density Kg/m3 p	Conc Dry % v/v	Dry Volume Fraction r
Carbon Dioxide CO2	44.01	1.96	3.4	0.034
Oxygen O2	32	1.43	17.5	0.175
Nitrogen N2	28.1	1.25	79.1	0.791
Moisture (H2O)	18.02	0.80		

where $p = M/22.41$

$p_i = r \times p$

	Dry Conc kg/m3 pi	Conc wet % v/v	Wet Volume Fraction r	Wet Conc kg/m3 pi
Carbon Dioxide CO2	0.07	3.40	0.03	0.07
Oxygen O2	0.25	17.50	0.18	0.25
Nitrogen N2	0.99	79.10	0.79	0.99
Moisture (H2O)	-	0	0.00	0.00

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P STD	kg/m ³	1.308
Wet Density (STP), P STW	kg/m ³	1.308
Dry Density (Actual), P Actual	kg/m ³	0.910
Average wet Density (Actual), P ActualW	kg/m ³	0.910

Where

P STD = sum of component concentrations, kg/m³ (excluding water vapour)
 P STW = (P STD + pi of H₂O) / (1 + (pi of H₂O / 0.8036))
 P actual = P STD x (T STP / (P STP)) x (Pa / Ta)
 P actual W (at each sampling point) = P STW x (Ts / Ps) x (Pa / Ta)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF
Temperature	K	385.65	273.13
Total Pressure	kPa	99.51	101.3
Moisture	%	.0	-
Oxygen (Dry)	%	17.5	-

Gas Volumetric Flowrate	Units	Result
Gas Volumetric Flow Rate (Actual)	m ³ /hr	8049
Gas Volumetric Flow Rate (STP, Wet)	m ³ /hr	5600
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	5600
Gas Volumetric Flowrate REF to Oxygen	m ³ /hr	

Where

Actual = Va * A * 3600
 STP Wet = Actual x (Ts / Ta) x (Pa / Ps) x 3600
 STP, Dry = STP Wet / (100 - (100 / Water Vapour %))
 REF = STP Dry x (100 - Water Vapour %) / (100 - Water Vapour Ref) x (20.9 - O₂m) / (20.9 - O₂ Ref)

Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	100.00	Pa	>5 Pa	Pass	EN16911
Lowest Gas Velocity	12.13	m/s	-	-	-
Highest Gas Velocity	12.66	m/s	-	-	-
Ratio of Above	1.04	:1	<3:1	Pass	EN16911
Mean Velocity	12.35	m/s	-	-	-
Angle of flow	<15	degrees	< 15	Pass	EN16911
No local negative flow	No	-	-	-	-
Homogeneous flow	Yes	-	-	-	-

Calculation of stack Gas Velocity, V

Velocity at Traverse Point, V = Kcp * Sqroot ((2 * DP) / Density) 227.93535

Where

Kpt = Pitot tube calibration coefficient 0.82
 Compressibility correction factor, assumed at a constant 0.998 0.998

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Title: Determination of Speciated Organic Compounds
Method: EN 13649
Client: Rehab Glassco
Test Date: 21/01/2015
Test Time: 10:44 11:17 11:47
Laboratory Used: RPS
Certificate Numbers: WK15- 0450
Stack Reference: A1

Leak Check Results

Prior to test:	0	0	0	l/min
Post Test:	0	0	0	l/min
Sample Volume Flow Rate:	0.422	0.419	0.411	l/min
Standard Requirement:	<5	<5	<5	%
Test Result:	0	0	0	%
Test Status	Pass	Pass	Pass	

Calibration Details

Pump Number:	ASLLK12EQ500	ASLLK12EQ542	ASLLK12EQ500	
Calibration Unit:	ASLLK12EQ529	ASLLK12EQ529	ASLLK12EQ529	
Calibration Unit Uncertainty:	<2	<2	<2	%
Calibration Rate Before Test:	0.42	0.42	0.41	litres per minute
Calibration Rate After Test:	0.423	0.419	0.412	litres per minute
Maximum allowed flow	0.5	0.5	0.5	litres per minute
Average sample Volume:	0.4215	0.4195	0.411	litres per minute
Sample Test Time:	30	30	30	minutes
Pump Gas Temperature:	9.6	9.6	9.6	°C
Pump Sample Pressure:	100.2	100.2	100.2	kPa
Actual Sample Volume:	0.01265	0.01259	0.01233	m ³
Normalised Gas Volume:	0.01208	0.01203	0.01178	Nm ³

Tube Details

Tube Type:	226-09	226-09	226-09	
Tube Identification Number:	5542909535	5105206597	5105206594	
Blank Identification Number:	5105206601	5105206601	5105206601	
Main Adsorbent Layer	400	400	400	mg
Backup Adsorbent Layer	200	200	200	mg
Containment Material	Glass	Glass	Glass	
Breakthrough Occurred	No	No	No	
Tubes in Lab in <7 days	Yes	Yes	Yes	
Tubes >7 days were stored	<4	<4	<4	Deg C
Tubes >7 days were stored	Dark	Dark	Dark	
Transport Container Airtight	Yes	Yes	Yes	
Exposed to Sunlight	No	No	No	
Transport Temp <20 Deg C	Yes	Yes	Yes	
Field Blank <10% Analyte Value	Yes	Yes	Yes	
Field Blank <10% ELV	Yes	Yes	Yes	

Test Details

Adsorption Tube Temperature:	9.6	9.6	9.6	°C
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Stack Flow Rates

Normalised Flow Rate:	5,600	m ³ .hr ⁻¹		
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Speciated Organic Results

<i>Class I</i>	<i>ug/tube</i>	<i>mg.m⁻³</i>
VOC Run 1	5	0.41
VOC Run 2	5	0.42
VOC Run 3	5	0.42

	Concentration <i>mg.m⁻³</i>	Uncertainty <i>mg.m⁻³</i>	ELV <i>mg.m⁻³</i>
VOC Run 1	0.41	0.02	-
VOC Run 2	0.42	0.02	-
VOC Run 3	0.42	0.02	-

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Title: Determination of Total Organic Compounds
Method: EN 12619:2013
Client: Rehab Glassco
Stack Reference: A2

Licence Limits

Emission Limit Value 80 mg.m⁻³
 Flow Rate Limit 8,000 m³.Hr⁻¹

Results

TOC Concentration 59.6 mg.m⁻³
 Flow Rate 5,931 m³.Hr⁻¹
 Uncertainty of Measurement 1.98 mg.m⁻³

Reference Conditions

Temperature (K) 273.13 °K
 Pressure (kPa) 101.3 kPa
 Gas (Wet or Dry) -
 Oxygen - %

Quality Data

Units
 Sampling Time 21/01/2015 13:06 -
 Instrument Range 100 ppm
 Span Gas Value 78 ppm
 Acceptable Gas Range Yes 50 - 90% of Range
 Oven Temperature 180 °C
 Average Temperature 180 °C
 Temperature Acceptable Yes Yes or No
 Sample line temperature 181 C

Zero Drift

Units
 Zero Down Sampling Line (Pre) 0 ppm
 Zero Down Sampling Line (Post) -0.2 ppm
 Zero drift -0.2 ppm
 Allowable Zero Drift 1.56 ppm
 Zero Drift Acceptable Yes Yes or No

Span Drift

Units
 Span (Pre) 78 ppm
 Span (Post) 77.8 ppm
 Span Drift -0.2 ppm
 Allowable Span Drift 1.56 ppm
 Span Drift Acceptable Yes Yes or No

Leak Check

Span Gas Conc. 78 ppm
 Recorded Conc. down Line (Pre) 78 ppm
 Leak Result 0 ppm
 Leak check acceptable (< 2%) 1.6 (Y/N)

Parameter

Standard EN 12619:2013
 Technical Procedure 2009
 Probe material Stainless Steel
 Filtration Type Ceramic Filter
 Heated Head Filter Used Yes
 Heated Line Temperature 180 Deg C
 Span Gas Reference Number ASLLK14ING524
 Span Gas Expiry Date Feb-17
 Span Gas Start Pressure (bar) 30 bar
 Gas Cylinder Concentration (ppm) 78 ppm
 Span Gas Uncertainty (%) 0.8 %
 Zero Gas Type Air
 Number of Sampling Lines Used 1
 Number of Sampling Points Used 1
 Sample Point I.D's 1

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Measured Quantities

Certified Range of Analyser	1000	ppm
Operational Range of Analyser	100	ppm
Measured Reading	37	ppm
Non linearity	0.4	ppm
Temperature Dependent Zero drift	0.15	ppm Per Degree
Temperature Dependent Span drift	0.1	% Per Degree
Cross-sensitivity	0.1	ppm
Leak	0	ppm
Calibration Gas uncertainty	0.8	ppm

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Title: Determination of Stack Flow Rate
Method: EN 16911-1
Client: Rehab Glassco
Stack Reference: A2

Stack details	Value	Units
Date of survey	20/01/2015	
Time of survey	13:00	
Type	Circular	
Stack Diameter / Depth, D	0.45	Length (m) m
Stack Width, W	-	m
Average Stack Gas Temp., Ta	65.8	338.95 C
Average Static Pressure, P static	0.2	mbar
Average Barometric Pressure, Pb	100.1	kPa
Type of Pitot	S	
Are Water Droplets Present ?	No	
Average Pitot Tube Calibration Coeff, Cp	0.82	
No local negative flow	No	
Highly homogeneous flow stream/gas velocity	Yes	
Sample Port Size	101.6	mm
Initial Pitot Leak Check	Pass	
Final Pitot Leak Check	Pass	
Orientation of Duct	Vertical	
Pitot Tube Cp	0.998	
Number of Lines Available	2	
Number of Lines Used	2	

Sampling Line A

Point	Distance	Pa	Temp C	Velocity	Oxygen	Swirl
1	0.07	145	65.8	13.7	19.5	<15
2	0.38	124	65.8	12.7	19.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		134.5	65.8	13.19	19.50	<15
Min		124	65.8	12.67	19.5	<15
Max		145	65.8	13.71	19.5	<15

Sampling Line B

Point	Distance	Pa	Temp C	Velocity	Oxygen	Swirl
1	0.07	126	65.8	12.8	19.5	<15
2	0.38	125	65.8	12.7	19.5	<15
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	-	-	-	-	-	-
Average		125.5	65.8	12.75	19.5	<15
Min		125	65.8	12.73	19.5	<15
Max		126	65.8	12.78	19.5	<15

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Average stack Gas Velocity	12.97	m/s
Lowest Differential Pressure	124.00	Pa
Lowest Gas Velocity	12.67	m/s
Highest Gas Velocity	13.71	m/s
Average Differential Pressure	130.00	Pa
Velocity Ratio of High to Low (3:1)	1.17	
Average Angle of flow	<15	

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Molar Mass
Carbon Dioxide CO2	-	1.5		44.01
Oxygen O2	-	19.5		32
Nitrogen N2	-	79		28.1
Moisture (H2O)	-	-	0	18.02

Reference Conditions	Units	Numbers
Temperature	K	273.13
Total Pressure	kPa	101.3
Moisture	%	-
Oxygen (Dry)	%	-

General Stack Details

Stack details	Units	Value
Stack Diameter / Depth, D	m	0.45
Stack Width, W	m	
Stack Area, A	m ²	0.16
Average Stack Gas Temp., Ta	C	65.8
Average Static Pressure, P static	kPa	0.2
Average Barometric Pressure, Pb	kPa	100.1
Average Pitot Tube Calibration Coeff, Kpt		0.82

Calc box Area

Circular Duct	Value	Rectangular Duct
R =	0.225	Length (m) 0
R2 =	0.050625	Width (m) -
Area = Pie*R2	0.16	Area -

Stack Gas Composition & Molecular Weights

Component	Molar Mass M	Density Kg/m3 p	Conc Dry % v/v	Dry Volume Fraction r
Carbon Dioxide CO2	44.01	1.96	1.5	0.015
Oxygen O2	32	1.43	19.5	0.195
Nitrogen N2	28.1	1.25	79	0.79
Moisture (H2O)	18.02	0.80		

where $p = M/22.41$
 $\pi = r \times p$

	Dry Conc kg/m3 pi	Conc wet % v/v	Wet Volume Fraction r	Wet Conc kg/m3 pi
Carbon Dioxide CO2	0.03	1.50	0.02	0.03
Oxygen O2	0.28	19.50	0.20	0.28
Nitrogen N2	0.99	79.00	0.79	0.99
Moisture (H2O)	-	0	0.00	0.00

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Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P STD	kg/m ³	1.298
Wet Density (STP), P STW	kg/m ³	1.298
Dry Density (Actual), P Actual	kg/m ³	1.034
Average wet Density (Actual), P ActualW	kg/m ³	1.034

Where

P STD = sum of component concentrations, kg/m³ (excluding water vapour)

P STW = (P STD + pi of H2O) / (1 + (pi of H2O / 0.8036))

P actual = P STD x (T STP / (P STP)) x (Pa / Ta)

P actual W (at each sampling point) = P STW x (Ts / Ps) x (Pa / Ta)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF
Temperature	K	338.95	273.13
Total Pressure	kPa	100.1	101.3
Moisture	%	0	-
Oxygen (Dry)	%	19.5	-

Gas Volumetric Flowrate	Units	Result
Gas Volumetric Flow Rate (Actual)	m ³ /hr	7427
Gas Volumetric Flow Rate (STP, Wet)	m ³ /hr	5914
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	5914
Gas Volumetric Flowrate REF to Oxygen	m ³ /hr	

Where

Actual = Va * A * 3600

STP Wet = Actual x (Ts / Ta) x (Pa / Ps) x 3600

STP , Dry = STP Wet / (100 - (100 / Water Vapour %))

REF = STP Dry x (100 - Water Vapour %) / (100 - Water Vapour Ref) x (20.9 - O₂m) / (20.9 - O₂ Ref)

Sampling Plane Validation Criteria	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	124.00	Pa	>5 Pa	Pass	EN16911
Lowest Gas Velocity	12.67	m/s	-	-	-
Highest Gas Velocity	13.71	m/s	-	-	-
Ratio of Above	1.08	:1	<3:1	Pass	EN16911
Mean Velocity	12.97	m/s	-	-	-
Angle of flow	<15	degrees	< 15	Pass	EN16911
No local negative flow	No	-	-	-	-
Homogeneous flow	Yes	-	-	-	-

Calculation of stack Gas Velocity, V

Velocity at Traverse Point, V = Kcp * Sqroot ((2 * DP) / Density) 251.4644

Where

Kpt = Pitot tube calibration coefficient 0.82

Compressibility correction factor, assumed at a constant 0.998 0.998

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Title: Determination of Speciated Organic Compounds
Method: EN 13649
Client: Rehab Glassco
Test Date: 21/01/2005
Test Time: 12:57 13:44 14:30
Laboratory Used: RPS
Certificate Numbers: WK15-0450
Stack Reference: A2

Leak Check Results

Prior to test:	0	0	0	l/min
Post Test:	0	0	0	l/min
Sample Volume Flow Rate:	0.447	0.382	0.248	l/min
Standard Requirement:	<5			%
Test Result:	0			%
Test Status	Pass			

Calibration Details

Pump Number:	ALSCLK12EQ500	ASLLK12EQ500	ASLLK12EQ540	
Calibration Unit:	ASLLK12EQ529	ASLLK12EQ529	ASLLK12EQ529	
Calibration Unit Uncertainty:	<2			%
Calibration Rate Before Test:	0.446	0.383	0.25	litres per minute
Calibration Rate After Test:	0.448	0.381	0.245	litres per minute
Maximum allowed flow	0.5	0.5	0.5	litres per minute
Average sample Volume:	0.447	0.382	0.2475	litres per minute
Sample Test Time:	30	30	30	minutes
Pump Gas Temperature:	14.5	14.5	14.5	°C
Pump Sample Pressure:	100.1	100.1	100.1	kPa
Actual Sample Volume:	0.01341	0.01146	0.00743	m ³
Normalised Gas Volume:	0.01258	0.01075	0.00697	Nm ³

Tube Details

Tube Type:	226-09	226-09	226-09	
Tube Identification Number:	5105206598	5105206595	5105206593	
Blank Identification Number:	4879621572	4879621572	4879621572	
Main Adsorbent Layer	400	400	400	mg
Backup Adsorbent Layer	200	200	200	mg
Containment Material	Glass	Glass	Glass	
Breakthrough Occurred				
Tubes in Lab in <7 days	Yes	Yes	Yes	
Tubes >7 days were stored	<4	<4	<4	Deg C
Tubes >7 days were stored	Dark	Dark	Dark	-
Transport Container Airtight	Yes	Yes	Yes	
Exposed to Sunlight	No	No	No	
Transport Temp <20 Deg C	Yes	Yes	Yes	
Field Blank <10% Analyte Value	Yes	Yes	Yes	
Field Blank <10% ELV	Yes	Yes	Yes	

Test Details

Adsorption Tube Temperature: 14.5 °C

Stack Flow Rates

Normalised Flow Rate: 5914 m³.hr⁻¹

Speciated Organic Results

Class	ug/tube	mg.m⁻³	kg.hr⁻¹
VOC Run 1	5	0.40	0.0024
VOC Run 2	5	0.46	0.0027
VOC Run 3	5	0.72	0.0042

	Concentration	Uncertainty	ELV
	mg.m⁻³	mg.m⁻³	mg.m⁻³
VOC Run 1	0.40	0.01	-
VOC Run 2	0.46	0.01	-
VOC Run 3	0.72	0.01	-

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