



Test Report



0002



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PPC COMPLIANCE TESTING FOR PAXFORD COMPOSITES LIMITED 17TH MARCH 2015

Permit Number: **B01/02**

Operator Name: **Paxford Composites Ltd**

Installation Name: **Paxford Composites**

Dates of Monitoring Visit: **17th March 2015**

Contract Reference: **B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01**

Client Contact: **Grahame Bloxham**

Client Organisation: **Paxford Composites Ltd**

Address: **2 - 4 Redwongs Way
Huntingdon
PE29 7HB**


Monitoring Organisation: **National Physical Laboratory (NPL)**

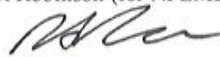
Address: **Hampton Road
Teddington
Middlesex
TW11 0LW**

Date of Report: **17th April 2015**

Report Author: **Matthew Ellison**

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Report Approver: Kevin Blakley
MCERTS Registration: MM-03-317
Level & TEs Held: Level 2, TE1, TE2, TE3 & TE4
Signature: 

NPL Authorised Signatory
Name: Mr R Robinson (for NPLML)
Signature: 

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1.1 Monitoring Objectives

NPL were awarded a contract by Paxford Composites Limited to carry out emissions compliance testing at their factory in Huntingdon. The scope of work includes carrying out monitoring on two spray paint booths.

Each spray paint booth was monitored for Particulates, Isocyanates and VOCs. Each test lasted for half an hour and was conducted during normal operation of the spray booths.

Results have been reported at standard conditions (273K and 101.3 kPa) on a wet gas basis. Testing was carried out on the 17th March 2015.

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1.2.1 Particulate Monitoring Results

Client: Paxford Composites Ltd
Site: Paxford Composites

Emission Point		Spray Booth One		Spray Booth Two	
Test Designation		Run One	Blank	Run One	Blank
Emission Limit Value	mg/m ³ , Reference Conditions	50	-	50	-
Periodic Monitoring Result	Reference Conditions	27.0	1.1	13.5	<0.5
Uncertainty (95% Confidence Level)	Reference Conditions	2.4	-	1.3	-
	Units	mg/m ³			
Reference Conditions		273K, 101.3 kPa on a wet gas basis			
Date	dd/mm/yyyy	17/03/2015		17/03/2015	
Sample Period	From hh:mm	11:05	-	14:15	-
	To hh:mm	11:35	-	14:45	-
Monitoring Method		BS EN 13284-1			
Accreditation		UKAS & MCERTS			
Process Status		Spray paint batch run			

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1.2.2 Isocyanates (HDI) Monitoring Results

Client: Paxford Composites Ltd
Site: Paxford Composites

Emission Point		Spray Booth One		Spray Booth Two	
Test Designation		Run One	Blank	Run One	Blank
Emission Limit Value	mg/m ³ , Reference Conditions	0.1	-	0.1	-
Periodic Monitoring Result	Reference Conditions	<0.0006	<0.0003	<0.0004	<0.0002
Uncertainty (95% Confidence Level)	Reference Conditions	<0.0001	-	<0.0001	-
	Units	mg/m ³			
Reference Conditions		273K, 101.3 kPa on a wet gas basis			
Date	dd/mm/yyyy	17/03/2015		17/03/2015	
Sample Period	From hh:mm	11:53	-	15:05	-
	To hh:mm	12:23	-	15:35	-
Monitoring Method		US EPA CTM 36			
Accreditation		None			
Process Status		Spray paint batch run			

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1.2.3 VOCs Monitoring Results

Client: Paxford Composites Ltd
Site: Paxford Composites

Emission Point		Spray Booth One	Spray Booth Two
Test Designation		Run One	Run One
Emission Limit Value	mgC/m ³ , Reference Conditions	50	50
Periodic Monitoring Result	Reference Conditions	83.8	98.7
Uncertainty (95% Confidence Level)	Reference Conditions	10.0	11.9
	Units	mgC/m ³	
Reference Conditions		273K, 101.3 kPa on a wet gas basis	
Date	dd/mm/yyyy	17/03/2015	17/03/2015
Sample Period	From hh:mm	11:15	15:05
	To hh:mm	11:45	15:35
Monitoring Method		BS EN 12619:2013	
Accreditation		UKAS & MCERTS	
Process Status		Spray paint batch run	

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1.3 Operating Information

Paxford Composites is located in Huntingdon and specialises in design and manufacturing of a wide range of components. The site also has spray painting facilities and can use a variety of different paints such as Epoxy, Polyurethane and Polyester.

The site has three spray paint booths each approximately the size of a garage, this allows large items to be transported inside. Air is pumped in from outside and can be heated if necessary to aid in the curing of the products. The paint filled air is then passed through a filter before being emitted to the atmosphere via a vent stack. Each batch run lasts approximately 20 to 30 minutes, depending upon how many layers of paint are required, and the size of the components. Only spray booths one and two were tested as spray booth three wasn't being used and is scheduled for decommissioning.

Continuous or Batch Process?	Batch Process
What part of the batch process was sampled? (If applicable)	The whole batch process was sampled
What fuel was used during monitoring? (If applicable)	None
What feedstock was used during monitoring? (If applicable)	None
What was the load during monitoring?	N/A
What abatement systems are present? Were they in operation?	A filter is installed in the vent system to reduce particulate emissions. This was in operation during the time of the monitoring
Periodic monitoring results and corresponding CEM values	There are no CEMS installed on the spray booths

1.4 Monitoring Deviations

Were all substances in the monitoring objectives monitored? If not why?	All substances set out in the objectives were monitored
Were all substances monitored in accordance to the relevant method? If not why?	Due to the duct area size of each spray booth, two sampling lines are required to monitor particulates to BS EN 13284:1. Whilst ports were provided, only one port on each spray booth could be accessed due to external obstructions and general accessibility.
Were there any other issues relevant to the monitoring results?	No

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1.5 Conclusions

NPL carried out the emissions monitoring for particulates, isocyanates and VOCs on two paint spray booths on the 17th March 2015. No homogeneity tests have been carried out.

1.6 References

1. STA – Risk Assessment Guide: Industrial-emission monitoring – Version 12 - June 2012.
2. Environmental Agency - Manual Stack emission monitoring performance standard for Organisations – Version 7.2 - November 2011.
3. Environmental Agency – M1 Technical Guidance Note – Sampling requirements for stack emission monitoring – Version 6 –January 2010.
4. Environmental Agency – M2 Technical Guidance Note – Monitoring of stack emissions to air – Version 10 – October 2013.
5. Guidance on Assessing Measurement Uncertainty in Stack Emissions Monitoring, by Pullen J and Robinson R, Source Testing Association, Quality Guidance Note QGN1.

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APPENDIX 1

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2.1.1 Emissions Testing Personnel Details

Name	Role	MCERTS Number	Certification Level & Expiry Dates					
			Level 1	Level 2	TE1	TE2	TE3	TE4
Kevin Blakley	Team Leader	MM-03-317	Mar-2016	Mar-2016	Mar-2016	Mar-2016	Sep-2018	May-2019
Matthew Ellison	Team Leader	MM-05-682	Sep-2018	Sep-2018	Sep-2018	Sep-2018	Dec-2018	Sep-2018

2.1.2 Emissions Testing Procedures

Determinand	VOCs	Particulates	Isocyanates	Moisture	Stack Flow	Temperature
SRM Standard	BS EN 12619	BS EN 13284-1	US EPA CTM 36	BS EN 14790	BS EN 16911	BS EN 16911
Instrument	FID	APEX Method 5	APEX Method 5	APEX Method 5	Pitot	Type K Thermocouple
Instrument Serial No.	AS0202	AS0008	AS0008	AS0008	AS0568	AS0614a
Principle	FID	Gravimetric	HPLC	Gravimetric	Flow	Temperature
Operational Range	0 - 100 ppm	N/A	N/A	N/A	N/A	N/A
Certified Range	0 - 15 mg/m ³	N/A	N/A	N/A	N/A	N/A
Uncertainty	15%	15%	25%	20%	N/A	N/A
NPL Procedure	QPAS B 538	QPAS B 536	In House	QPAS B 540	QPAS B 567	QPAS B 567
UKAS Accreditation	YES	YES	NO	YES	YES	YES

Particulate and Isocyanate sampling was conducted using an APEX Method 5 and sampling train. A sample was extracted through a filter and then down a heated probe and sample line. The stack gas was then passed through a series of impingers to remove the moisture before passing through a dry gas meter (DGM) and out to atmosphere. The particulate filter had been weighed in a laboratory before and after testing in order to determine any weight gain. The isocyanate filter had been pre treated and sent to an analytical laboratory for analysis.

VOC analysis was conducted using a SICK Bernath FID (Flame Ionisation Detector). A sample of stack gas was drawn through a heated filter and heated line before passing into the analyser.

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The FID analyser zero and span settings were checked before and after each test run using zero grade nitrogen (ex BOC), a suitable gas mixture (BOC beta gas standard), traceable to national reference standards and a gas dilution system. The certified accuracies of the gas standards are listed below: -

SB1

Component	Sample Location	Cylinder ID	Certified Amount	Instrument Range	Certified Uncertainty
Propane	SB1	188218	61.6 ppm	0 - 100 ppm	1%

SB2

Component	Sample Location	Cylinder ID	Certified Amount	Instrument Range	Certified Uncertainty
Propane	SB2	188218	61.6 ppm	0 - 100 ppm	1%

These measurement uncertainties are expressed at a 95% level of confidence.

A leak test was conducted before testing to confirm hydraulic integrity of the gaseous sampling system. This was conducted by sending nitrogen down the entire sample line and ensuring a zero reading was obtained.

The electrical volt/millivolt outputs from the FID analyser was collected by a squirrel data logger and downloaded to digital media at the end of the day. Under the program used during the tests, the software records and stores individual readings every 2 seconds. From this data, the logger can perform a series of calculations to output 1 minute averaged measurement on a mass/volume basis. After each 1 minute average has been established the data buffer is reset and the process repeats.

2.1.3 Equipment Checklist Reference

See workfile PX07MAR15/Equipment Checklist

2.1.4 Data Capture Location Reference

All data collected is transferred onto digital media at the end of the day, and then stored on the NPL internal servers upon arrival back at base. The location reference for this is below:


P:\Stack Emissions Team\Paxford Composites\PX07MAR15\7. Monitoring Record Sheets

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APPENDIX 2

2.2.1 - Stack Diagram & Traverse Information


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Monitoring Objective	SB1 Traverse	Site:	Paxford Composites	Stack ID:	Spray Booth One			
Date	17/03/2015	Site Team:	KCB/MRE	Time of Survey:	10:45			
Tape Measure ID	AS0591	Diagram of Sample Location:						
Laser Measurement Device ID	N/A							
Traverse Pitot Type	S-Type							
Traverse Pitot Tube ID	AS0568							
Pitot Assembly Visual Inspection (Pre)	Pass							
Pitot Leak Check @ ...	Pass							
Traverse Manometer Type	Inclined Liquid							
Traverse Manometer ID	AS0008							
Damping Device used	No							
Traverse Temp. Readout ID	AS0008							
Traverse Thermocouple ID	AS0257a							
Static Pressure	Δp (mmH2O)	Comments/Deviations:						
	0.00							
	Pass							
Swirl Test Conducted	Yes	Duct Dimensions						
Protractor ID	AS0622							
Post-Test Blockage Test (L-Type only)								
Post-Test Pitot Leak Check @ ...	Pass							
Pitot Assembly Visual Inspection (Post)	Pass	Duct Dimensions						
Conditions	Value	Units	Port ID	Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Port Depth
Stack pressure	768.33	mmHg	A					
Ref O ₂ Value	21	%	B					
Moisture Content	1	%	C					
CO	0	ppm	D					
CO ₂	0	%	Circular Duct					
N ₂	79.05	%	Line ID	Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Duct Diameter
O ₂	20.95	%	A					
Dry Molecular wt	28.84		B					
Stack Molecular wt	28.73		Rectangular Duct					
Duct Diameter	0.77	m	Line ID	Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Duct Depth
Duct Depth		m	A					
Duct Width		m	B					
Area of stack	0.47	m ²	C					
Pbar	1024.1	mbar	D					
Pbar	768	mmHg		Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Duct Width
Pitot tube coeff	0.83		Outside Side Division					
Reference Temp	273	K					Static Measurement	Δp (mmH2O)
Reference Pressure	760	mmHg					Measurement Line	Reading 1 Reading 2 (180°)
Ambient Temperature	18	°C	Enter manually from previous visit		Circular Duct	Rectangular Duct	A	0.00 0.00
			Duct Diameter (m)		0.77		B	
			Duct Depth (m)				C	
			Duct Width (m)				D	
			Post-Test Blockage Test (L-Type)		Traverse Point	Δp Reading (mm H ₂ O)	Δp Reading (mm H ₂ O)	Δp Average (mm H ₂ O)
			Reading 1					
			Reading 2					

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SAMPLING LINE: A										
Traverse Point	Distance into duct (m)	Δp Spot Reading mm H ₂ O	Δp Spot Reading mm H ₂ O	Δp Spot Reading mm H ₂ O	Δp Average mm H ₂ O	Δp Pa	Stack Temp T _s °C	Velocity @ stack gas T&P on wet gas basis m/s	Angle of Swirl °	$\sqrt{\Delta p}$
1	0.09	2.80	2.80	2.80	2.80	27.40	19	5.58	10	1.67
2	0.39	2.40	2.20	2.40	2.33	22.84	19	5.10	9	1.53
3	0.68	1.00	1.00	1.00	1.00	9.79	20	3.34	10	1.00
4										
5										
6										
7										
8										
9										
10										
Average values		2.1	2.0	2.1	2.0	20.0	19.3	4.7	9.7	1.4
Duct / Stack Flow Characteristics:						Average	Units	Flow Criteria Measurements		
Stack Velocity at stack gas T & P and a wet gas basis						4.67	m s ⁻¹	Is the Flow Ratio 3:1 or less?		1.7
Stack flow @ STP, O ₂ (ref) and on a dry gas basis						N/A	m ³ s ⁻¹			.1
Stack flow @ stack gas T & P and on a wet gas basis						2.18	m ³ s ⁻¹	Any local negative flow?		NO
Stack flow @ stack gas T & P and on a dry gas basis						2.15	m ³ s ⁻¹	Flow <15° of duct axis?		YES
Stack flow @ STP and on a wet gas basis						2.05	m ³ s ⁻¹			
Stack flow @ STP, O ₂ (ref) and on a wet gas basis						N/A	m ³ s ⁻¹	Minimum Δp detected > 0.5 mmH ₂ O		YES

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Monitoring Objective	SB2 Traverse	Site:	Paxford Composites	Stack ID:	Spray Booth Two			
Date	17/03/2015	Site Team:	KCB/MRE	Time of Survey:	14:00			
Tape Measure ID	AS0591	Diagram of Sample Location: 						
Laser Measurement Device ID	N/A							
Traverse Pitot Type	S-Type							
Traverse Pitot Tube ID	AS0568							
Pitot Assembly Visual Inspection (Pre)	Pass							
Pitot Leak Check @ ...	Pass							
Traverse Manometer Type	Inclined Liquid							
Traverse Manometer ID	AS0008							
Damping Device used	No							
Traverse Temp. Readout ID	AS0008							
Traverse Thermocouple ID	AS0257a							
Static Pressure	Δp (mmH2O)	Comments/Deviations:						
	0.00							
	Pass							
Swirl Test Conducted	Yes							
Protractor ID	AS0622							
Post-Test Blockage Test (L-Type only)								
Post-Test Pitot Leak Check @ ...	Pass							
Pitot Assembly Visual Inspection (Post)	Pass	Duct Dimensions						
Conditions	Value	Units	Port ID	Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Port Depth
Stack pressure	768.33	mmHg	A					
Ref O ₂ Value	21	%	B					
Moisture Content	1	%	C					
CO	0	ppm	D					
CO ₂	0	%						
N ₂	79.05	%	Line ID	Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Duct Diameter
O ₂	20.95	%	A					
Dry Molecular wt	28.84		B					
Stack Molecular wt	28.73							
Duct Diameter	0.90	m	Line ID	Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Duct Depth
Duct Depth		m	A					
Duct Width		m	B					
Area of stack	0.64	m ²	C					
Pbar	1024.1	mbar	D					
Pbar	768	mmHg		Reading 1 (m)	Reading 2 (m)	Reading 3 (m)	Average	Duct Width
Pitot tube coeff	0.83		Outside Side Division					
Reference Temp	273	K					Static Measurement	Δp (mmH2O)
Reference Pressure	760	mmHg					Measurement Line	Reading 1 Reading 2 (180°)
Ambient Temperature	18	°C	Enter manually from previous visit	Circular Duct	Rectangular Duct	A	0.00	0.00
			Duct Diameter (m)	0.9		B		
			Duct Depth (m)			C		
			Duct Width (m)			D		
			Post-Test Blockage Test (L-Type)	Traverse Point	Δp Reading (mm H ₂ O)	Δp Reading (mm H ₂ O)	Δp Reading (mm H ₂ O)	Δp Average (mm H ₂ O)
			Reading 1					
			Reading 2					

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SAMPLING LINE: A										
Traverse Point	Distance into duct (m)	Δp Spot Reading mm H ₂ O	Δp Spot Reading mm H ₂ O	Δp Spot Reading mm H ₂ O	Δp Average mm H ₂ O	Δp Pa	Stack Temp T _s °C	Velocity @ stack gas T&P on wet gas basis m/s	Angle of Swirl °	$\sqrt{\Delta p}$
1	0.10	5.80	5.60	6.00	5.79	56.77	20	8.05	8	2.41
2	0.45	6.00	6.20	6.20	6.12	60.03	20	8.28	7	2.47
3	0.80	5.60	5.40	5.40	5.46	53.50	20	7.81	9	2.34
4										
5										
6										
7										
8										
9										
10										
Average values		5.8	5.7	5.9	5.8	56.8	20.0	8.0	8.0	2.4
Duct / Stack Flow Characteristics:						Average	Units	Flow Criteria Measurements		
Stack Velocity at stack gas T & P and a wet gas basis						8.04	m s ⁻¹	Is the Flow Ratio 3:1 or less?		1.1
Stack flow @ STP, O ₂ (ref) and on a dry gas basis						N/A	m ³ s ⁻¹	Any local negative flow?		NO
Stack flow @ stack gas T & P and on a wet gas basis						5.12	m ³ s ⁻¹	Flow <15° of duct axis?		YES
Stack flow @ stack gas T & P and on a dry gas basis						5.06	m ³ s ⁻¹	Minimum Δp detected > 0.5 mmH ₂ O		YES
Stack flow @ STP and on a wet gas basis						4.82	m ³ s ⁻¹			
Stack flow @ STP, O ₂ (ref) and on a wet gas basis						N/A	m ³ s ⁻¹			

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2.2.2 - One Minute Averaged Gaseous Emissions Data

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Paxford Composites - Spray Booth One
273K, 101.3 kPa, on a Wet Gas Basis
17th March 2015

Time	VOCs (mgC/m ³)
11:15	41.7
11:16	44.8
11:17	89.9
11:18	157
11:19	185.7
11:20	241
11:21	158.6
11:22	88.3
11:23	66.4
11:24	49
11:25	43
11:26	39.3
11:27	43.3
11:28	33.2
11:29	57.0
11:30	157.1
11:31	197.4
11:32	183.0
11:33	183.9
11:34	105.6
11:35	62.0
11:36	47.5
11:37	47.2
11:38	42.2
11:39	39.6
11:40	35.5
11:41	39.8
11:42	30.2
11:43	27.3
11:44	30.5
11:45	31.0
Maximum	241
Minimum	27.3
Average	83.8

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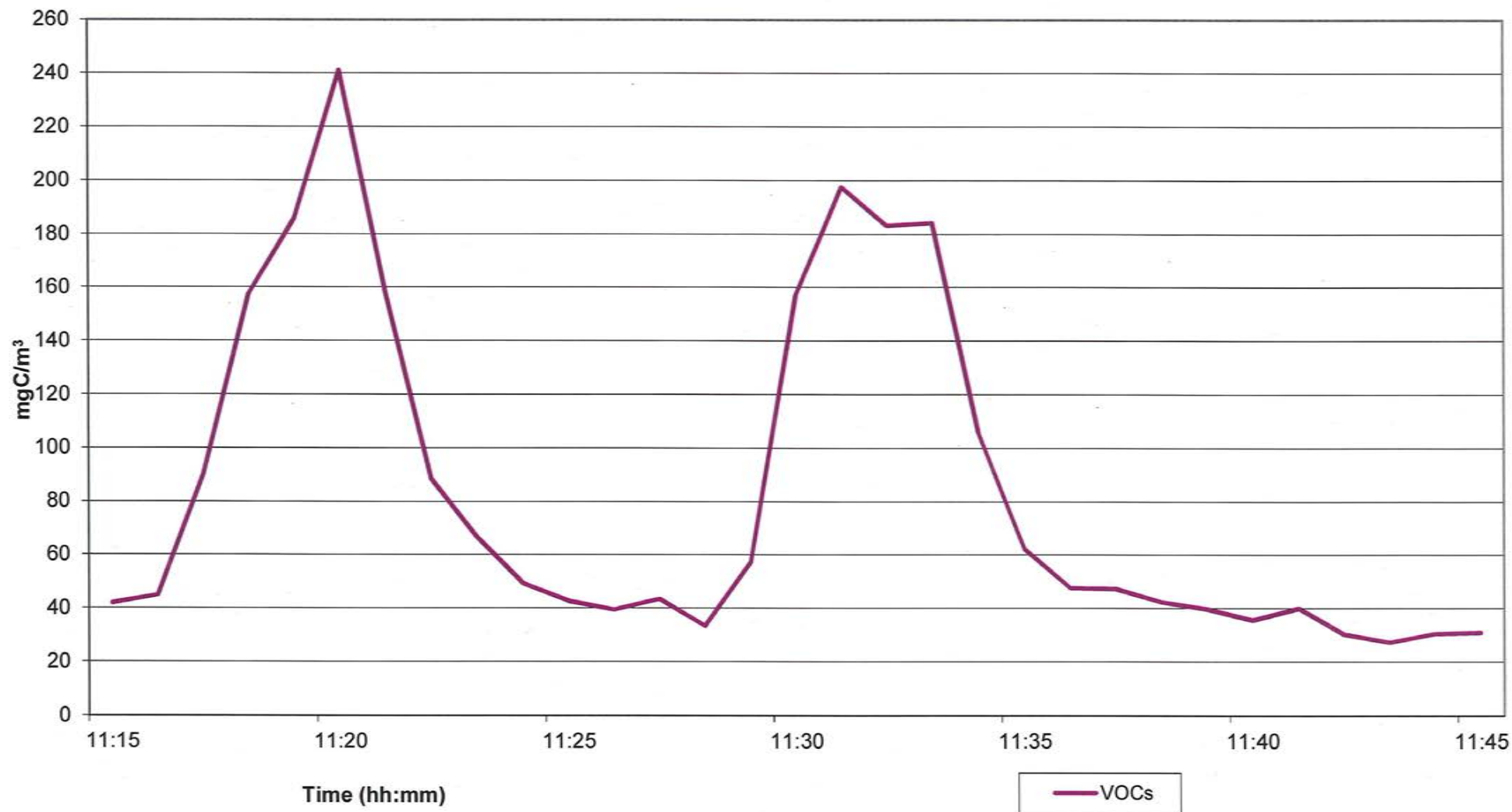
Paxford Composites - Spray Booth Two
273K, 101.3 kPa, on a Wet Gas Basis
17th March 2015

Time	VOCs (mgC/m ³)
15:05	5.5
15:06	15.6
15:07	104.6
15:08	178
15:09	217.3
15:10	163
15:11	125.0
15:12	74.3
15:13	40.6
15:14	38
15:15	84
15:16	137.2
15:17	141.7
15:18	179.8
15:19	127.3
15:20	87.3
15:21	39.5
15:22	31.1
15:23	23.6
15:24	20.7
15:25	27.1
15:26	84.9
15:27	150.9
15:28	138.5
15:29	220.0
15:30	243.0
15:31	196.9
15:32	60.3
15:33	45.9
15:34	31.5
15:35	25.8
Maximum	243
Minimum	5.5
Average	98.7

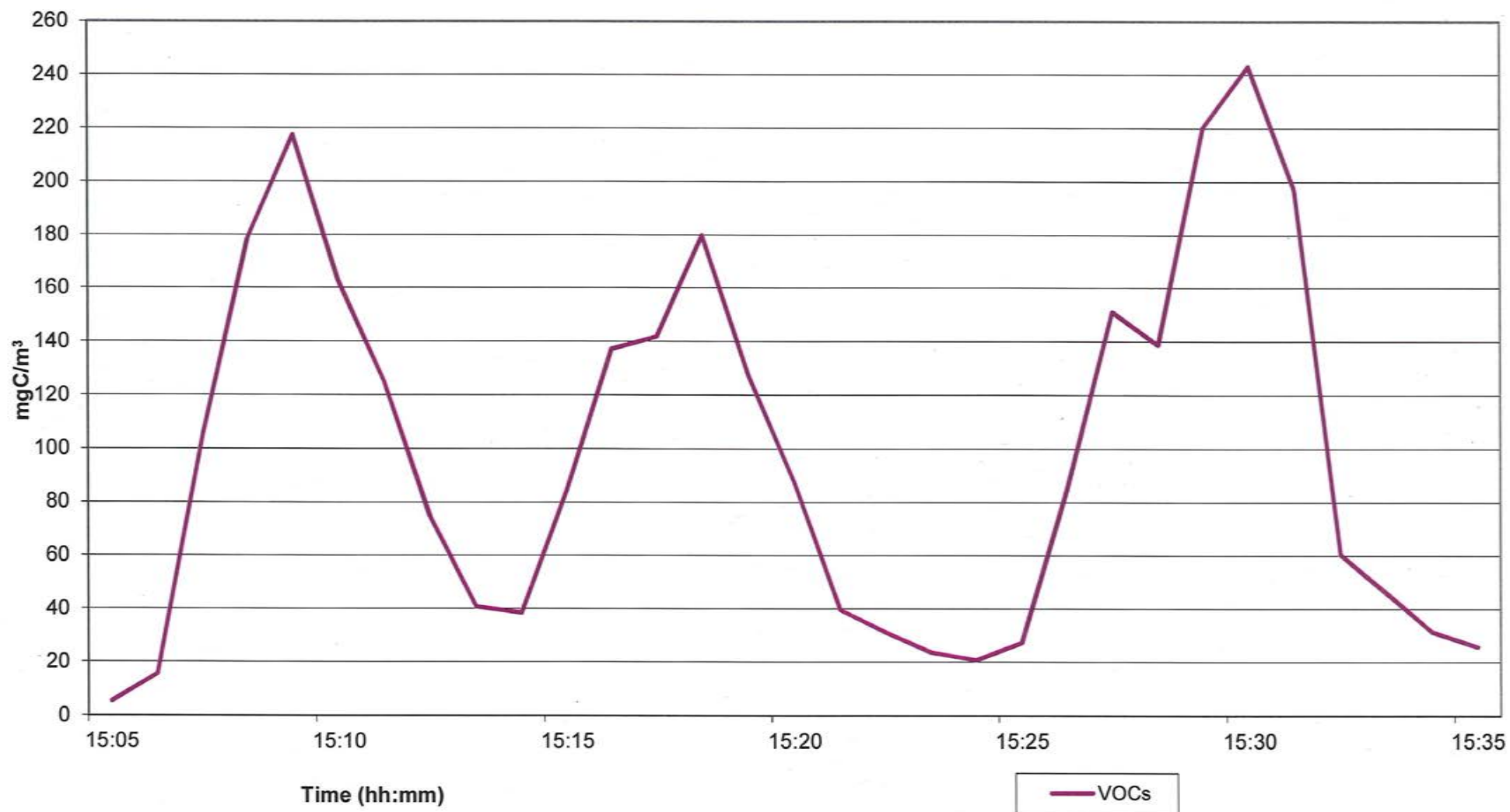
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2.2.3 - VOCs Emissions Graphical Data

Paxford Composites Spray Booth One - Minute Averaged Gaseous Emissions Data - 17th March 2015
(273.15K, 101.325kPa, on a Wet Gas basis) using the NPL Conventional Analysis Package



Paxford Composites Spray Booth Two - Minute Averaged Gaseous Emissions Data - 17th March 2015
(273.15K, 101.325kPa, on a Wet Gas basis) using the NPL Conventional Analysis Package



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2.2.4 - Gas Calibration Log

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GAS CALIBRATION MEASUREMENTS

Client:	Paxford Composites	Date:	17/03/2015	Horiba ID:	None
Site:	Huntingdon	Job Number:	PX07MAR15	FID ID:	AS0202
Stack ID:	Spray Booth One	Mobile Lab ID:	VU64 VXV	Sonimix ID:	None
Reference oxygen %	None	Nitrogen cylinder ID:	Zero Grade	Initial N ₂ pressure bar	None

GAS CALIBRATION LOG - DIRECT CALIBRATION

		SO ₂	CO	NO _x	O ₂	CO ₂	VOCs
Gas Cylinder ID:							188218
Initial Reg. Pressure bar							150
Cylinder Concentration:							61.6 ppm C ₃ H ₈
Span Value:							61.6 ppm C ₃ H ₈
Analyser Range:0 -							100 ppm C ₃ H ₈
Check Zero	Time						10:52
	Reading						0 ppm C ₃ H ₈
	Initial Gain						4.49
Adjust Zero	Time						10:53
	Reading						0 ppm C ₃ H ₈
	Final Gain						4.49
Check Span	Time						10:55
	Reading						58.4 ppm C ₃ H ₈
	Initial Gain						1.58
Adjust Span	Time						10:56
	Reading						61.7 ppm C ₃ H ₈
	Final Gain						1.72
Check Zero	Time						10:57
	Reading						0.0 ppm C ₃ H ₈

GAS CALIBRATION LOG - SYSTEM CAL (Including heated line and chiller unit)

		SO ₂	CO	NO _x	O ₂	CO ₂	VOCs
Span Value:							61.6 ppm C ₃ H ₈
Check Zero	Time						10:59
	Reading						0.0 ppm C ₃ H ₈
	Pass/fail						PASS
Check Span	Time						11:00
	Reading						61.3 ppm C ₃ H ₈
	Response Time/s						15
	Pass/fail						PASS

GAS CALIBRATION LOG - POST CAL (Including heated line and chiller unit)

		SO ₂	CO	NO _x	O ₂	CO ₂	VOCs
Span Value:							61.6 ppm C ₃ H ₈
Check Zero	Time						11:58
	Reading						0.1 ppm C ₃ H ₈
Check Span	Time						11:59
	Reading						61.5 ppm C ₃ H ₈
	Reg Pressure						150
Zero Drift check @2x repeatability zero							0.0 ppm C ₃ H ₈
Acceptance							Accept
Zero Drift (%)							0.1
Span Drift (%)							0.2
Acceptance zero							Accept
Acceptance span							Accept

CALIBRATION TO BE CARRIED OUT BY OR UNDER THE SUPERVISION OF MCERTS QUALIFIED PERSONNEL WITH LEVEL TWO AND TE4

Name:	Matthew Ellison
MCERTS ID:	MM-05-682

Personnel Present:	KCB/MRE
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Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *MEB*

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NATIONAL PHYSICAL LABORATORY
Continuation Sheet

GAS CALIBRATION MEASUREMENTS

Client:	Paxford Composites	Date:	17/03/2015	Horiba ID:	None
Site:	Huntingdon	Job Number:	PX07MAR15	FID ID:	AS0202
Stack ID:	Spray Booth Two	Mobile Lab ID:	VU64 VXV	Sonimix ID:	None
Reference oxygen %	None	Nitrogen cylinder ID:	Zero Grade	Initial N ₂ pressure bar	None

GAS CALIBRATION LOG - DIRECT CALIBRATION

		SO ₂	CO	NOx	O ₂	CO ₂	VOCs
Gas Cylinder ID:							188218
Initial Reg. Pressure bar							150
Cylinder Concentration:							61.6 ppm C ₃ H ₈
Span Value:							61.6 ppm C ₃ H ₈
Analyser Range:0 -							100 ppm C ₃ H ₈
Check Zero	Time						14:20
	Reading						0.016 ppm C ₃ H ₈
	Initial Gain						4.49
Adjust Zero	Time						14:21
	Reading						0 ppm C ₃ H ₈
	Final Gain						4.49
Check Span	Time						14:23
	Reading						64.0 ppm C ₃ H ₈
	Initial Gain						1.72
Adjust Span	Time						14:24
	Reading						61.6 ppm C ₃ H ₈
	Final Gain						1.61
Check Zero	Time						14:25
	Reading						0.0 ppm C ₃ H ₈

GAS CALIBRATION LOG - SYSTEM CAL (Including heated line and chiller unit)

		SO ₂	CO	NOx	O ₂	CO ₂	VOCs
Span Value:							61.6 ppm C ₃ H ₈
Check Zero	Time						14:27
	Reading						0.0 ppm C ₃ H ₈
	Pass/fail						PASS
Check Span	Time						14:28
	Reading						61.4 ppm C ₃ H ₈
	Response Time/s						15
	Pass/fail						PASS

GAS CALIBRATION LOG - POST CAL (Including heated line and chiller unit)

		SO ₂	CO	NOx	O ₂	CO ₂	VOCs
Span Value:							61.6 ppm C ₃ H ₈
Check Zero	Time						15:43
	Reading						0.0 ppm C ₃ H ₈
Check Span	Time						15:44
	Reading						61.3 ppm C ₃ H ₈
	Reg Pressure						150
Zero Drift check @2x repeatability zero							0.0 ppm C ₃ H ₈
Acceptance							Accept
Zero Drift (%)							0.0
Span Drift (%)							0.4
Acceptance zero							Accept
Acceptance span							Accept

CALIBRATION TO BE CARRIED OUT BY OR UNDER THE SUPERVISION OF MCERTS QUALIFIED PERSONNEL WITH LEVEL TWO AND TE4

Name:	Matthew Ellison
MCERTS ID:	MM-05-682

Personnel Present:	KCB/MRE
--------------------	---------

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *ms*

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NATIONAL PHYSICAL LABORATORY
Continuation Sheet

2.2.5 - Particulate Summary Sheets

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Spray Booth One - Particulate Results Summary

Field	Units	Blank	TEST 1
Date	dd/mm/yyyy	17/03/2015	17/03/2015
Test No.		Blank	SB1 Particulates Test 1
Filter No.		15TF001	15TF002
Stack Description		SB1	SB1
Start Time	hh:mm	-	11:05
End Time	hh:mm	-	11:35
Total Time	min	-	30
Stack Temp.	C	-	19
Gas Meter Temp	C	-	22
Gas Meter Pressure	kPa	-	102.4
Filter	mg	0.0	2.0
Washings	mg	0.2	4.0
TOTAL Mass Collected	mg	0.2	6.0
Acetone Residue Blank	mg	0.2	-
Test H2O	% Vol	-	2.0
Stack Temp	°C	-	18.7
Stack Pressure	kPa	-	102.4
Nozzle Diameter	mm	-	6.03
Duct Area	m ²	-	0.47
Isokinicity	%	-	98
Stack Velocity	Stack T & P, uncorrected, ms ⁻¹	-	4.68
Gas Vol. Sampled	Dry Gas Basis, Ambient T and P	-	0.25
Gas Vol. Sampled	Wet Gas Basis, Standard T and P	-	0.22
Particulate Concentration	Wet Gas Basis, Standard T and P, mg Nm⁻³	1.1	27.0
Expanded Uncertainty	+/-mg Nm ⁻³ , 95% Conf. k=2	-	2.4
Emission Limit Value (ELV)	Wet Gas Basis, Standard T and P, mg Nm ⁻³	50	50
Percentage of Emission Limit Value (ELV) for Test	Wet Gas Basis, Standard T and P, %	2	54
Mass Emission	Wet Gas Basis, Standard T and P, g s ⁻¹	-	0.06


NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Spray Booth Two - Particulate Results Summary

Field	Units	Blank	TEST 1
Date	dd/mm/yyyy	17/03/2015	17/03/2015
Test No.		Blank	SB2 Particulates Test 1
Filter No.		15TF003	15TF004
Stack Description		SB2	SB2
Start Time	hh:mm	-	14:15
End Time	hh:mm	-	14:45
Total Time	min	-	30
Stack Temp.	C	-	21
Gas Meter Temp	C	-	21
Gas Meter Pressure	kPa	-	102.4
Filter	mg	0.0	2.8
Washings	mg	0.1	2.5
TOTAL Mass Collected	mg	<0.2	5.3
Acetone Residue Blank	mg	0.2	-
Test H2O	% Vol	-	1.4
Stack Temp	°C	-	21.0
Stack Pressure	kPa	-	102.4
Nozzle Diameter	mm	-	6.03
Duct Area	m ²	-	0.64
Isokinicity	%	-	103
Stack Velocity	Stack T & P, uncorrected, ms ⁻¹	-	7.88
Gas Vol. Sampled	Dry Gas Basis, Ambient T and P	-	0.44
Gas Vol. Sampled	Wet Gas Basis, Standard T and P	-	0.39
Particulate Concentration	Wet Gas Basis, Standard T and P, mg Nm⁻³	<0.5	13.5
Expanded Uncertainty	+/-mg Nm ⁻³ , 95% Conf. k=2	-	1.3
Emission Limit Value (ELV)	Wet Gas Basis, Standard T and P, mg Nm ⁻³	50	50
Percentage of Emission Limit Value (ELV) for Test	Wet Gas Basis, Standard T and P, %	1	27
Mass Emission	Wet Gas Basis, Standard T and P, g s ⁻¹	-	0.06

2.2.6 - Method 5 Sample Sheets

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Test no	SB1 Particulates Test 1		Site:	Paxford Composites		Stack Description:	SB1	
Date	17-3-15	dd/mm/yy	Filter No:	15TF002		Absorber No(s):	T01/A-D	
nozzle diameter	6.03	mm	Blank I.D.:	15TF001				
Stack Pres (with +/- above barometric if unknown enter zero)	0	mmH ₂ O	SITE TEAM:		KCB/MRE			
			COMMENTS:		Spray Booth One Particulates Test 1 of 1			
end volume reading	652.523	m ³				Control Box I.D. No:	AS0008	
start volume reading	652.272	m ³	end time	11:35	hh:mm	Stack Thermocouple I.D. No.	AS0257a	
volume sampled	0.25	m ³	start time	11:05	hh:mm	Probe I.D. No.	AS0257	
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.	AS0628	
			stop time	00:00	hh:mm	Pitot I.D. No.	AS0568	
Stack pressure	768.33	mmHg	Diagram of Sample Location: 					
Gas Meter Calibration Factor Y	0.9261							
Ref oxygen Value	21	%						
Moisture content	2.0	%						
CO	0	ppm						
CO ₂	0	%						
N ₂	79.05	%						
O ₂	20.95	%						
dry molecular wt	28.84							
stack molecular wt	28.62							
Orifice ΔH@ Factor	57.70	mmH ₂ O						
area of stack	0.47	m ²	LEAK CHECK					
Pbar	1024.1	mbar	Pre Vac (in Hg): 10			Post Vac (in Hg): 1.0		
Pbar	768.3	mmHg						
pitot tube coeft	0.83		Leak rate (m ³ /l) or (%): <2%			Leak rate (m ³ /l) or (%): <2%		
Reference Temp	273	K						
Reference Pressure	760	mmHg						

NATIONAL PHYSICAL LABORATORY
Continuation Sheet


	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
1:	11:05	652.2720	A1	5	2.80	11.8	18	160	N/A	17	N/A	20	20	1.0
2:	11:10	652.3190	A1	5	3.00	12.6	19	158	N/A	15	N/A	22	22	1.0
3:	11:15	652.3720	A2	5	2.60	10.9	18	159	N/A	15	N/A	22	22	1.0
4:	11:20	652.4200	A2	5	2.20	9.2	19	160	N/A	15	N/A	23	23	1.0
5:	11:25	652.4600	A3	5	1.00	4.2	18	160	N/A	15	N/A	23	23	1.0
6:	11:30	652.4930	A3	5	0.80	3.4	20	160	N/A	16	N/A	24	24	1.0
7:	11:35	652.5230	STOP											
8:														
9:														
10:														

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
44:														
45:														
46:														
47:														
48:														
Summary values		652.52		30		8.68	18.7	159.5	#DIV/0!	15.5	n/a		22.3	1.0

Duct / Stack Flow Characteristics:	SB1		Units
Test No	SB1 Particulates Test 1		
Stack Velocity at stack gas T & P and a wet gas basis		4.68	m s ⁻¹
Stack flow @ STP, O ₂ (ref) and on a dry gas basis		N/A	m ³ s ⁻¹
Stack flow @ stack gas T & P and on a wet gas basis		2.20	m ³ s ⁻¹
Stack flow @ stack gas T & P and on a dry gas basis		2.15	m ³ s ⁻¹
Stack flow @ STP and on a wet gas basis		2.08	m ³ s ⁻¹
Stack flow @ STP, O ₂ (ref) and on a wet gas basis		N/A	m ³ s ⁻¹
Gas vol. samp. @ STP and on a dry gas basis		0.22	m ³
Gas vol. samp. @ STP, O ₂ (ref), and on a dry gas basis		N/A	m ³
Gas vol. samp. @ STP and on a wet gas basis		0.22	m ³
Gas vol. samp. @ STP, O ₂ (ref) and on a wet gas basis		N/A	m ³
Percentage Isokinicity		98	%

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Test no	SB1 Isocyanates Test 1		Site:	Paxford Composites		Stack Description:	SB1	
Date	17-3-15	dd/mm/yy	Filter No:	N/A		Absorber No(s):	T01/A-D	
nozzle diameter	6.03	mm	Blank I.D.:	N/A				
Stack Pres (with +/- above barometric if unknown enter zero)	0	mmH ₂ O	SITE TEAM:		KCB/MRE			
			COMMENTS:		Spray Booth One Isocyanates Test 1 of 1			
end volume reading	652.816	m ³				Control Box I.D. No:	AS0008	
start volume reading	652.547	m ³	end time	12:23	hh:mm	Stack Thermocouple I.D. No.	AS0257a	
volume sampled	0.27	m ³	start time	11:53	hh:mm	Probe I.D. No.	AS0257	
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.	AS0628	
			stop time	00:00	hh:mm	Pitot I.D. No.	AS0568	
Stack pressure	768.33	mmHg	Diagram of Sample Location: 					
Gas Meter Calibration Factor Y	0.9261							
Ref oxygen Value	21	%						
Moisture content	1.1	%						
CO	0	ppm						
CO ₂	0	%						
N ₂	79.05	%						
O ₂	20.95	%						
dry molecular wt	28.84							
stack molecular wt	28.72							
Orifice ΔH@ Factor	57.70	mmH ₂ O						
area of stack	0.47	m ²	LEAK CHECK					
Pbar	1024.1	mbar	Pre Vac (in Hg): 10			Post Vac (in Hg): 1.0		
Pbar	768.3	mmHg						
pitot tube coeft	0.83		Leak rate (m ³ /l) or (%): <2%			Leak rate (m ³ /l) or (%): <2%		
Reference Temp	273	K						
Reference Pressure	760	mmHg						

NATIONAL PHYSICAL LABORATORY
Continuation Sheet


	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
1:	11:53	652.5470	A1	5	3.00	12.6	19	161	N/A	14	N/A	22	22	1.0
2:	11:58	652.5980	A1	5	3.20	13.4	20	161	N/A	15	N/A	22	22	1.0
3:	12:03	652.6500	A2	5	2.40	10.1	18	160	N/A	15	N/A	21	21	1.0
4:	12:08	652.6960	A2	5	2.40	10.1	18	160	N/A	14	N/A	21	21	1.0
5:	12:13	652.7420	A3	5	1.20	5.0	18	161	N/A	15	N/A	21	21	1.0
6:	12:18	652.7790	A3	5	1.20	5.0	18	160	N/A	16	N/A	22	22	1.0
7:	12:23	652.8160	STOP											
8:														
9:														
10:														

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
44:														
45:														
46:														
47:														
48:														
Summary values		652.82		30		9.38	18.5	160.5	#DIV/0!	14.8	n/a		21.5	1.0

Duct / Stack Flow Characteristics:	SB1		Units
Test No	SB1 Isocyanates Test 1		
Stack Velocity at stack gas T & P and a wet gas basis	4.90	ms ⁻¹	
Stack flow @ STP, O ₂ (ref) and on a dry gas basis	N/A	m ³ s ⁻¹	
Stack flow @ stack gas T & P and on a wet gas basis	2.30	m ³ s ⁻¹	
Stack flow @ stack gas T & P and on a dry gas basis	2.28	m ³ s ⁻¹	
Stack flow @ STP and on a wet gas basis	2.18	m ³ s ⁻¹	
Stack flow @ STP, O ₂ (ref) and on a wet gas basis	N/A	m ³ s ⁻¹	
Gas vol. samp. @ STP and on a dry gas basis	0.23	m ³	
Gas vol. samp. @ STP, O ₂ (ref), and on a dry gas basis	N/A	m ³	
Gas vol. samp. @ STP and on a wet gas basis	0.24	m ³	
Gas vol. samp. @ STP, O ₂ (ref) and on a wet gas basis	N/A	m ³	
Percentage Isokinicity	99	%	

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Test no	SB2 Particulates Test 1		Site:	Paxford Composites		Stack Description:	SB2			
Date	17-3-15	dd/mm/yy	Filter No:	15TF004		Absorber No(s):	T01/A-D			
nozzle diameter	6.03	mm	Blank I.D.:	15TF003						
Stack Pres (with +/- above barometric if unknown enter zero)	0	mmH ₂ O	SITE TEAM:		KCB/MRE					
			COMMENTS:		Spray Booth Two Particulates Test 1 of 1					
end volume reading	653.303	m ³				Control Box I.D. No:	AS0008			
start volume reading	652.860	m ³	end time	14:45	hh:mm	Stack Thermocouple I.D. No.	AS0257a			
volume sampled	0.44	m ³	start time	14:15	hh:mm	Probe I.D. No.	AS0257			
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.	AS0628			
			stop time	00:00	hh:mm	Pitot I.D. No.	AS0568			
Stack pressure	768.33	mmHg	Diagram of Sample Location: 							
Gas Meter Calibration Factor Y	0.9261									
Ref oxygen Value	21	%								
Moisture content	1.4	%								
CO	0	ppm								
CO ₂	0	%								
N ₂	79.05	%								
O ₂	20.95	%								
dry molecular wt	28.84									
stack molecular wt	28.68									
Orifice ΔH@ Factor	57.70	mmH ₂ O								
area of stack	0.64	m ²	LEAK CHECK							
Pbar	1024.1	mbar	Pre Vac (in Hg):			10	Post Vac (in Hg):		1.0	
Pbar	768.3	mmHg	Leak rate (m ³ /l) or (%):			<2%		Leak rate (m ³ /l) or (%):		<2%
pitot tube coeft	0.83									
Reference Temp	273	K								
Reference Pressure	760	mmHg								

NATIONAL PHYSICAL LABORATORY
Continuation Sheet


	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp Ts °C	Probe Temp Tp °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in Tm(in) °C	Meter out Tm(out) °C	Vacuum in Hg
1:	14:15	652.8600	A1	5	4.60	19.3	22	161	N/A	16	160	18	18	1.0
2:	14:20	652.9180	A1	5	5.80	24.4	22	160	N/A	15	160	19	19	1.0
3:	14:25	652.9920	A2	5	6.20	26.0	23	160	N/A	17	160	20	20	1.0
4:	14:30	653.0780	A2	5	6.00	25.2	20	160	N/A	19	160	21	21	1.0
5:	14:35	653.1660	A3	5	5.20	21.8	20	159	N/A	23	160	22	22	1.0
6:	14:40	653.2320	A3	5	5.40	22.7	19	160	N/A	23	160	23	23	1.0
7:	14:45	653.3030	STOP											
8:														
9:														
10:														

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
44:														
45:														
46:														
47:														
48:														
Summary values		653.30		30		23.24	21.0	160.0	#DIV/0!	18.8	160.0		20.5	1.0

Duct / Stack Flow Characteristics:	SB2		Units
Test No	SB2 Particulates Test 1		
Stack Velocity at stack gas T & P and a wet gas basis	7.88		ms ⁻¹
Stack flow @ STP, O ₂ (ref) and on a dry gas basis	N/A		m ³ s ⁻¹
Stack flow @ stack gas T & P and on a wet gas basis	5.04		m ³ s ⁻¹
Stack flow @ stack gas T & P and on a dry gas basis	4.97		m ³ s ⁻¹
Stack flow @ STP and on a wet gas basis	4.73		m ³ s ⁻¹
Stack flow @ STP, O ₂ (ref) and on a wet gas basis	N/A		m ³ s ⁻¹
Gas vol. samp. @ STP and on a dry gas basis	0.39		m ³
Gas vol. samp. @ STP, O ₂ (ref), and on a dry gas basis	N/A		m ³
Gas vol. samp. @ STP and on a wet gas basis	0.39		m ³
Gas vol. samp. @ STP, O ₂ (ref) and on a wet gas basis	N/A		m ³
Percentage Isokinicity	103		%

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Test no	SB2 Isocyanates Test 1		Site:	Paxford Composites		Stack Description:	SB1	
Date	17-3-15	dd/mm/yy	Filter No:	N/A		Absorber No(s):	T01/A-D	
nozzle diameter	6.03	mm	Blank I.D.:	N/A				
Stack Pres (with +/- above barometric if unknown enter zero)	0	mmH ₂ O	SITE TEAM:		KCB/MRE			
			COMMENTS:		Spray Booth Two Isocyanates Test 1 of 1			
end volume reading	653.755	m ³				Control Box I.D. No:	AS0008	
start volume reading	653.337	m ³	end time	15:35	hh:mm	Stack Thermocouple I.D. No.	AS0257a	
volume sampled	0.42	m ³	start time	15:05	hh:mm	Probe I.D. No.	AS0257	
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.	AS0628	
			stop time	00:00	hh:mm	Pitot I.D. No.	AS0568	
Stack pressure	768.33	mmHg	<div style="display: flex; align-items: center;"> <div style="flex: 1;">Diagram of Sample Location:</div>  </div>					
Gas Meter Calibration Factor Y	0.9261							
Ref oxygen Value	21	%						
Moisture content	0.9	%						
CO	0	ppm						
CO ₂	0	%						
N ₂	79.05	%						
O ₂	20.95	%						
dry molecular wt	28.84							
stack molecular wt	28.75							
Orifice ΔH@ Factor	57.70	mmH ₂ O						
area of stack	0.64	m ²	LEAK CHECK					
Pbar	1024.1	mbar	Pre Vac (in Hg):			5	Post Vac (in Hg):	
Pbar	768.3	mmHg				1.0		
pitot tube coeft	0.83		Leak rate (m ³ /l) or (%):			<2%		
Reference Temp	273	K				Leak rate (m ³ /l) or (%):		
Reference Pressure	760	mmHg						

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
1:	15:05	653.3370	A1	5	4.60	19.3	25	160	N/A	15	160	21	21	1.0
2:	15:10	653.4010	A1	5	5.00	21.0	22	159	N/A	15	160	22	22	1.0
3:	15:15	653.4690	A2	5	5.80	24.4	22	160	N/A	15	160	22	22	1.0
4:	15:20	653.5420	A2	5	5.60	23.5	22	160	N/A	18	160	23	23	1.0
5:	15:25	653.6140	A3	5	5.00	21.0	21	160	N/A	19	160	23	23	1.0
6:	15:30	653.6950	A3	5	5.00	21.0	20	160	N/A	23	160	24	24	1.0
7:	15:35	653.7550	STOP											
8:														
9:														
10:														

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

	Start Time at this Position or Setting hh: mm	volume reading at start m ³	Probe position	Time at each position / min	Δp mm H ₂ O	Δh mm H ₂ O	Stack Temp T _s °C	Probe Temp T _p °C	Oven Temp °C	Impinger Temp °C	Resin/L ine °C	Meter in T _m (in) °C	Meter out T _m (out) °C	Vacuum in Hg
44:														
45:														
46:														
47:														
48:														
Summary values		653.76		30		21.70	22.0	159.8	#DIV/0!	17.5	160.0		22.5	1.0

Duct / Stack Flow Characteristics:	SB1		Units
Test No	SB2 Isocyanates Test 1		
Stack Velocity at stack gas T & P and a wet gas basis	7.62		ms ⁻¹
Stack flow @ STP, O ₂ (ref) and on a dry gas basis	N/A		m ³ s ⁻¹
Stack flow @ stack gas T & P and on a wet gas basis	4.88		m ³ s ⁻¹
Stack flow @ stack gas T & P and on a dry gas basis	4.83		m ³ s ⁻¹
Stack flow @ STP and on a wet gas basis	4.56		m ³ s ⁻¹
Stack flow @ STP, O ₂ (ref) and on a wet gas basis	N/A		m ³ s ⁻¹
Gas vol. samp. @ STP and on a dry gas basis	0.36		m ³
Gas vol. samp. @ STP, O ₂ (ref), and on a dry gas basis	N/A		m ³
Gas vol. samp. @ STP and on a wet gas basis	0.37		m ³
Gas vol. samp. @ STP, O ₂ (ref) and on a wet gas basis	N/A		m ³
Percentage Isokinicity	100		%

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

2.2.7 - Moisture Calculations

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test RecordForm

Test No:	SB1 Particulates
Date:	17-3-15
pbar (mbar):	1024
pbar (mmHg):	768
nozzle diameter (mm):	6.03
Temp of Meter (in)/(out) °C:	22
ΔH_{ave} (mmH ₂ O):	8.7
Filter No (if app):	15TF002

Site:	Paxford Composites
Stack:	SB1
Site Team:	KCB/MRE
Data Entered By:	

End Volume Reading	652.52	m ³
Start Volume reading	652.27	m ³
Volume Sampled	0.25	m ³

end time	11:35	hr:min
start time	11:05	hr:min
total time	00:30	hr:min

IMPINGER	1	2	3	4	5	6	7	Initials of Analyst
Absorber Solution (Type):	DI Water	DI Water	Empty	Silica Gel				MRE
Sample No:	T01/A	T01/B	T01/C	T01/D				MRE
Analysis Required:	Moisture							MRE
Weight of Jars plus absorber plus washings (g)								
Weight of Jars plus absorber after sampling (g)	815.6	809.7	657.6	847.6				MRE
Weight of Jars plus absorber (g)	814.5	809.8	657.6	844.7				MRE
Weight of Jars (g)	608.5	588	657.6	590.5				MRE
Weight Gain (g)	1.1	-0.1	0	2.9				

Total Weight Gain (1+2+3+4) (g)	3.9
---------------------------------	-----

Gas Volume of water at 0°C (l)	4.86
Gas Meter volume at 0°C (l)	234.76

Moisture content of Gases (%)	2.0
-------------------------------	-----

NOTES:

at 0°C
Volume (l) of water in gas phase is $V_{wc} = 1.2444 \times \text{wt of water collected (g)}$
Volume of gas sampled by meter (l) dry $V_{mc} = 359.2 \times \text{gas meter reading (m}^3) \times (P_{bar} + \Delta H/13.6) / (\text{meter temp} + 273)$

moisture content (fraction) = $V_{wc}/(V_{wc}+V_{mc})$

an approximation is: 1 m³ of gas weighs approx 1.2 kg

moisture content approx =
$$\frac{\text{wt of water collected (g)} \times 100}{\text{wt of water collected (g)} + (\text{m}^3 \text{ of gas on meter} \times 1200)}$$

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *Wub*

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NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test Record Form

Test No:	SB1 Isocyanates
Date:	17-3-15
pbar (mbar):	1024
pbar (mmHg):	768
nozzle diameter (mm):	6.03
Temp of Meter (in)/(out) °C:	22
ΔH_{ave} (mmH ₂ O):	9.4
Filter No (if app):	N/A

Site:	Paxford Composites
Stack:	SB1
Site Team:	KCB/MRE
Data Entered By:	

End Volume Reading	652.82	m ³
Start Volume reading	652.55	m ³
Volume Sampled	0.27	m ³

end time	12:23	hr:min
start time	11:53	hr:min
total time	00:30	hr:min

IMPINGER	1	2	3	4	5	6	7	Initials of Analyst
Absorber Solution (Type):	DI Water	DI Water	Empty	Silica Gel				MRE
Sample No:	T01/A	T01/B	T01/C	T01/D				MRE
Analysis Required:	Moisture							MRE
Weight of jars plus absorber plus washings (g)								
Weight of Jars plus absorber after sampling (g)	835.5	708.2	628.2	865.2				MRE
Weight of Jars plus absorber (g)	836.3	708.1	628.2	862.3				MRE
Weight of Jars (g)	622.5	502.9	628.2	584.4				MRE
Weight Gain (g)	-0.8	0.1	0	2.9				

Total Weight Gain (1+2+3+4) (g)	2.2
---------------------------------	-----

Gas Volume of water at 0°C (l)	2.74
Gas Meter volume at 0°C (l)	252.32

Moisture content of Gases (%)	1.1
-------------------------------	-----

NOTES:

at 0°C
Volume (l) of water in gas phase is $V_{wc} = 1.2444 \times \text{wt of water collected (g)}$
Volume of gas sampled by meter (l) dry $V_{mc} = 359.2 \times \text{gas meter reading (m}^3\text{)} \times (\text{Pbar} + \Delta H/13.6) / (\text{meter temp} + 273)$

moisture content (fraction) = $V_{wc}/(V_{wc}+V_{mc})$

an approximation is: 1 m³ of gas weighs approx 1.2 kg

moisture content approx =
$$\frac{\text{wt of water collected (g)} \times 100}{\text{wt of water collected (g)} + (\text{m}^3 \text{ of gas on meter} \times 1200)}$$

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test Record Form

Test No:	SB2 Particulates
Date:	17-3-15
pbar (mbar):	1024
pbar (mmHg):	768
nozzle diameter (mm):	6.03
Temp of Meter (in)/(out) °C:	21
ΔH_{ave} (mmH ₂ O):	23.2
Filter No (if app):	15TF004

Site:	Paxford Composites
Stack:	SB2
Site Team:	KCB/MRE
Data Entered By:	

End Volume Reading	653.30	m ³
Start Volume reading	652.86	m ³
Volume Sampled	0.44	m ³

end time	14:45	hr:min
start time	14:15	hr:min
total time	00:30	hr:min

IMPINGER	1	2	3	4	5	6	7	Initials of Analyst
Absorber Solution (Type):	DI Water	DI Water	Empty	Silica Gel				MRE
Sample No:	T01/A	T01/B	T01/C	T01/D				MRE
Analysis Required:	Moisture							MRE
Weight of jars plus absorber plus washings (g)								
Weight of Jars plus absorber after sampling (g)	814.2	809.9	657.6	853.7				MRE
Weight of Jars plus absorber (g)	815.6	809.7	657.6	847.6				MRE
Weight of Jars (g)	608.5	588	657.6	590.5				MRE
Weight Gain (g)	-1.4	0.2	0	6.1				

Total Weight Gain (1+2+3+4) (g)	4.9
---------------------------------	-----

Gas Volume of water at 0°C (l)	6.10
Gas Meter volume at 0°C (l)	417.50

Moisture content of Gases (%)	1.4
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NOTES:

at 0°C

Volume (l) of water in gas phase is $V_{wc} = 1.2444 \times \text{wt of water collected (g)}$

Volume of gas sampled by meter (l) dry $V_{mc} = 359.2 \times \text{gas meter reading (m}^3\text{)} \times (\text{Pbar} + \Delta H/13.6) / (\text{meter temp} + 273)$

moisture content (fraction) = $V_{wc}/(V_{wc} + V_{mc})$

an approximation is: 1 m³ of gas weighs approx 1.2 kg

moisture content approx =

$\text{wt of water collected (g)} \times 100$

$\text{wt of water collected (g)} + (\text{m}^3 \text{ of gas on meter} \times 1200)$

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *MB*

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NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test RecordForm

Test No:	SB2 Isocyanates
Date:	17-3-15
pbar (mbar):	1024
pbar (mmHg):	768
nozzle diameter (mm):	6.03
Temp of Meter (in)/(out) °C:	23
ΔH_{ave} (mmH ₂ O):	21.7
Filter No (if app):	N/A

Site:	Paxford Composites
Stack:	SB1
Site Team:	KCB/MRE
Data Entered By:	

End Volume Reading	653.76	m ³
Start Volume reading	653.34	m ³
Volume Sampled	0.42	m ³

end time	15:35	hr:min
start time	15:05	hr:min
total time	00:30	hr:min

IMPINGER	1	2	3	4	5	6	7	Initials of Analyst
Absorber Solution (Type):	DI Water	DI Water	Empty	Silica Gel				MRE
Sample No:	T01/A	T01/B	T01/C	T01/D				MRE
Analysis Required:	Moisture							MRE
Weight of jars plus absorber plus washings (g)								
Weight of Jars plus absorber after sampling (g)	833.4	707.3	628.2	870.9				MRE
Weight of Jars plus absorber (g)	835.5	708.2	628.2	865.2				MRE
Weight of Jars (g)	622.5	502.9	628.2	584.4				MRE
Weight Gain (g)	-2.1	-0.9	0	5.7				

Total Weight Gain (1+2+3+4) (g)	2.7
---------------------------------	-----

Gas Volume of water at 0°C (l)	3.36
Gas Meter volume at 0°C (l)	391.21

Moisture content of Gases (%)	0.9
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NOTES:

at 0°C
Volume (l) of water in gas phase is $V_{wc} = 1.2444 \times \text{wt of water collected (g)}$
Volume of gas sampled by meter (l) dry $V_{mc} = 359.2 \times \text{gas meter reading (m}^3\text{)} \times (\text{Pbar} + \Delta H/13.6) / (\text{meter temp} + 273)$

moisture content (fraction) = $V_{wc}/(V_{wc}+V_{mc})$

an approximation is: 1 m³ of gas weighs approx 1.2 kg

moisture content approx =
$$\frac{\text{wt of water collected (g)} \times 100}{\text{wt of water collected (g)} + (\text{m}^3 \text{ of gas on meter} \times 1200)}$$

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *mb*

Version 1

2.2.8 - Uncertainty Calculations

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

Uncertainty calculation for Gaseous Measurement of TOC to BS EN 12619

Spray Booth One

Limit value	50 mg/m ³ (corrected) TOC	Cal gas conc	98.87 mg.m ⁻³ TOC
Measured concentration	83.8 mg/m ³	Full Scale	160.5 mg/m ³
Measured concentration	83.8 mg/m ³ (Corrected)		

Correction for reference conditions				
	O ₂ , %	Moisture, %	Pressure, KPa	Temperature, K
ref	20.90	0.00	101.30	273.00
measured	20.90	0.00	101.30	273.00
Uncert	0.00	1.00	0.00	1.00
Factors	1.00	1.00	1.00	1.00
Uncertainty in factor	0.00	0.01	0.00	0.00
Correction Factor	1.00	uf	0.01	

Effect of drift	
0.34 mg/m ³	
0.21 % full scale	

Performance characteristics	Value		specification
Response time	15	seconds	60.000
Logger sampling interval	60	seconds	
Measurement period	31	minutes	
Number of readings in measurement	31		
Repeatability at zero	0.133	mg/m ³	0.133 mg/m ³
Repeatability at span level	0.15	mg/m ³	0.2 mg/m ³
Deviation from linearity (lack of fit)	0.4	mg/m ³	< 0.4 mg/m ³
Zero drift	0.14	mg/m ³	0.4 mg/m ³ (long term)
Span drift	0.24	mg/m ³	0.7 mg/m ³ (long term)
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa
atmospheric pressure dependence	0.8	% of full scale/2 kPa	<3% / 2 kPa
ambient temperature dependence	0.01	mg/m ³	0.5 mg/m ³ /10k (at span)
O ₂ (% vol)	20	0.2	mg/m ³
SO ₂ (mg/m ³)	260	0.2	mg/m ³
NO (mg/m ³)	860	0.2	mg/m ³
NO ₂ (mg/m ³)	150	0.2	mg/m ³
CO (mg/m ³)	430	0.2	mg/m ³
CO ₂ (% vol)	18	0.2	mg/m ³
HCl (mg/m ³)	40	0.2	mg/m ³
H ₂ O (% vol)	20	0.2	mg/m ³
dependence on voltage	0.1	% full scale/10V	<2% range
Control gas reading difference	10	% of value	within 15% of test gas value (5 mg/m ³)
losses in the line (leak)	1	% of value	< 0.1%vol /10 volt
Uncertainty of calibration gas	1.29	% of value	< 2% of value

	ranges	min	max	value at calib
flow	95.00	105	100	kPa
pressure	100.76	100.92	100.88	kPa
temp	287	288.5	287.5	K
O ₂ range	6	16	20	% vol
SO ₂ range	0	300	0	mg/m ³
NO range	0	600	0	mg/m ³
NO ₂ range	0	50	0	mg/m ³
CO range	0	500	0	mg/m ³
CO ₂ range	0	20	0	% vol
HCl range	0	5	0	mg/m ³
H ₂ O range	0	20	0	% vol
Voltage	93	121	110	V

Performance characteristic	Uncertainty	Value of uncertainty quantity	mg/m ³
Standard deviation of repeatability at zero	u ₀	for mean	0.02
Standard deviation of repeatability at span level	u _{sp}	for mean	use rep at zero
Lack of fit	u _{lf}		0.23
Drift	u _{dr}		0.20
volume or pressure flow dependence	u _{flow}		0.03
atmospheric pressure dependence	u _{press}		0.04
ambient temperature dependence	u _{temp}		0.00
O ₂	u _{o2}		0.11
SO ₂ (mg/m ³)	u _{so2}		0.13
NO (mg/m ³)	u _{no}		0.08
NO ₂ (mg/m ³)	u _{no2}		0.04
CO (mg/m ³)	u _{co}		0.13
CO ₂ (% vol)	u _{co2}		0.13
HCl (mg/m ³)	u _{hcl}		0.01
H ₂ O (% vol)	u _{h2o}		0.12
Dependence on voltage	u _v		0.14
losses in the line (leak)	u _{leak}		0.48
Uncertainty of calibration gas	u _{calib}		0.62
control gas	u _{control}		4.84
Uncertainty in factor	uf		0.89

Use largest of sum of all positive or all negative influences		
0.17 all +ves	Criteria	
0.00 all -ves	sum < 1 mg/m ³	
0.17 largest	1.67624129	
Value to use for interference uncertainty		
u _{int}	0.17	

Measurement uncertainty			
Combined uncertainty		4.92	mg/m ³
Expanded uncertainty	k = 2	9.83	mg/m ³
Uncertainty corrected to std conds			
Expanded uncertainty	expressed with a level of confidence of 95%	10.00	mg/m ³
Expanded uncertainty	expressed with a level of confidence of 95%	19.99	% ELV
Expanded uncertainty	expressed with a level of confidence of 95%	10.00	mg.m ⁻³
Expanded uncertainty	expressed with a level of confidence of 95%	11.93	% value

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *mb*

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Continuation Sheet

Uncertainty calculation for Gaseous Measurement of TOC to BS EN 12619

Spray Booth Two

Limit value	50 mg/m ³ (corrected) TOC	Cal gas conc	98.87 mg.m ⁻³ TOC
Measured concentration	98.7 mg/m ³	Full Scale	160.5 mg/m ³
Measured concentration	98.7 mg/m ³ (Corrected)		

Correction for reference conditions				
	O ₂ , %	Moisture, %	Pressure, KPa	Temperature, K
ref	20.95	0.00	101.30	273.00
measured	20.95	0.00	101.30	273.00
Uncert	0.00	1.00	0.00	1.00
Factors	1.00	1.00	1.00	1.00
Uncertainty in factor	0.00	0.01	0.00	0.00
Correction Factor	1.00	uf	0.01	

Performance characteristics	Value	units	specification
Response time	15	seconds	60.000
Logger sampling interval	60	seconds	
Measurement period	31	minutes	
Number of readings in measurement	31		
Repeatability at zero	0.133	mg/m ³	0.133 mg/m ³
Repeatability at span level	0.15	mg/m ³	0.2 mg/m ³
Deviation from linearity (lack of fit)	0.4	mg/m ³	< 0.4 mg/m ³
Zero drift	0	mg/m ³	0.4 mg/m ³ (long term)
Span drift	0.42	mg/m ³	0.7 mg/m ³ (long term)
volume or pressure flow dependence	0.02	% of full scale/3 kPa	< 2 % / 3 kPa
atmospheric pressure dependence	0.8	% of full scale/2 kPa	< 3% / 2 kPa
ambient temperature dependence	0.01	mg/m ³	0.5 mg/m ³ /10K (at span)
O ₂ (% vol)	20	0.2	0.8 mg/m ³
SO ₂ (mg/m ³)	260	0.2	
NO (mg/m ³)	860	0.2	
NO ₂ (mg/m ³)	150	0.2	
CO (mg/m ³)	430	0.2	
CO ₂ (% vol)	18	0.2	
HCl (mg/m ³)	40	0.2	
H ₂ O (% vol)	20	0.2	
dependence on voltage	0.1	% full scale/10V	< 2% range
Control gas reading difference	10	% of value	within 15% of test gas value (5 mg/m ³)
losses in the line (leak)	1	% of value	< 0.1%vol /10 volt
Uncertainty of calibration gas	2.00	% of value	< 2% of value

Effect of drift	
0.42 mg/m ³	
0.26 % full scale	

	ranges	min	max	value at calib
flow		95.00	105	100 kPa
pressure		100.76	100.92	100.88 kPa
temp		287	288.5	287.5 K
O ₂ range		6	16	20 % vol
SO ₂ range		0	300	0 mg/m ³
NO range		0	600	0 mg/m ³
NO ₂ range		0	50	0 mg/m ³
CO range		0	500	0 mg/m ³
CO ₂ range		0	20	0 % vol
HCl range		0	5	0 mg/m ³
H ₂ O range		0	20	0 % vol
Voltage		93	121	110 V

Performance characteristic	Uncertainty	Value of uncertainty quantity	mg/m ³
Standard deviation of repeatability at zero	u ₀	for mean	0.02
Standard deviation of repeatability at span level	u _{span}	for mean	use rep at zero
Lack of fit	u _{lof}		0.23
Drift	u _{drift}		0.24
volume or pressure flow dependence	u _{vol/res}		0.03
atmospheric pressure dependence	u _{atmos}		0.04
ambient temperature dependence	u _{temp}		0.00
O ₂	u _{o2ref}		0.11
SO ₂ (mg/m ³)	u _{so2ref}		0.13
NO (mg/m ³)	u _{no2ref}		0.08
NO ₂ (mg/m ³)	u _{no2ref}		0.04
CO (mg/m ³)	u _{co2ref}		0.13
CO ₂ (% vol)	u _{co2ref}		0.13
HCl (mg/m ³)	u _{hclref}		0.01
H ₂ O (% vol)	u _{h2oref}		0.12
Dependence on voltage	u _{volt}		0.14
losses in the line (leak)	u _{leak}		0.57
Uncertainty of calibration gas	u _{calib}		1.14
control gas	u _{control}		5.70
Uncertainty in factor	uf		1.05

Use largest of sum of all positive or all negative influences		
0.17 all +ves	Criteria	
0.00 all -ves	sum < 1 mg/m ³	
0.17 largest	1.973839355	
Value to use for interference uncertainty		
u _{int}	0.17	

Measurement uncertainty			
Combined uncertainty		5.85	mg/m ³
Expanded uncertainty	k = 2	11.71	mg/m ³
Uncertainty corrected to std conds			
Expanded uncertainty	expressed with a level of confidence of 95%	23.79	% ELV
Expanded uncertainty	expressed with a level of confidence of 95%	11.89	mg.m ⁻³
Expanded uncertainty	expressed with a level of confidence of 95%	12.05	% value

Reference: B0102/PAXFORD/PAXFORD/MAR2015/SBs/PPC01

Checked by: *ub*

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NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Uncertainty calculation for dust to BS EN 13284, Manual Gravimetric Method

v15

Spray Booth One - Run One

Limit value (ELV)	50	mg.m ⁻³	Reference oxygen	20.95	% by volume
Measured concentration	26.98	mg.m ⁻³ (at reference conditions)			

Measurement Equation

$$c = \frac{m}{V} f_c$$

Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv	Requirement of std
Sampled Volume	V _m	0.25	uV _m	0.001 m ³	0.40		<=2%
Sampled gas Temperature	T _m	295	uT _m	2 K	0.68		<=1%
Sampled gas Pressure	p _m	102.41	up _m	1 kPa	0.98		<=1%
Sampled gas Humidity	H _m	0	uH _m	1 % by volume	1.00		<=1%
Mass particulate	m	6.0	um	0.23 mg	3.90	2.10	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas meter							
Leak	L	2		%	2.00		<=2%
Uncollected Mass (Instack filter - no rinse)	UCM	0		mg	0		<=10%

Intermediate calculations

Factor for std conds	fs	0.93				
uncertainty components	symbol	sensitivity coeff	u (in units of fs)			
	p _m	0.009	0.009			
	H _m	0.009	0.009			
	T _m	0.003	0.006			
	ufs		0.015			1.55
Corrected volume	V	0.23	uV	0.004 m ³	V = V _m f _s	1.61

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{p_m}{101.3}$$

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard)	V	0.23 m ³	115.02	0.43 mg.m ⁻³	1.61 %
Mass	m	5.99 mg	4.51	1.05 mg.m ⁻³	3.90 %
Leak	L	0.31 mg.m ⁻³	1.00	0.31 mg.m ⁻³	1.15 %
Uncollected mass	UCM	0.00 mg	4.51	0.00 mg.m ⁻³	0.00 %
Combined measurement uncertainty				1.19 mg.m ⁻³	

Expanded uncertainty as percentage of measured value	8.81	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	2.38	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	4.76	% ELV	

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Uncertainty calculation for dust to BS EN 13284, Manual Gravimetric Method

v15

Spray Booth Two - Run One

Limit value (ELV)	50 mg.m ⁻³	Reference oxygen	20.95 % by volume
Measured concentration	13.46 mg.m ⁻³ (at reference conditions)		

Measurement Equation

$$c = \frac{m}{V} f_c$$

Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv	Requirement of std
Sampled Volume	V _m	0.44	uV _m	0.001 m ³	0.23		<=2%
Sampled gas Temperature	T _m	294	uT _m	2 K	0.68		<=1%
Sampled gas Pressure	p _m	102.41	up _m	1 kPa	0.98		<=1%
Sampled gas Humidity	H _m	0	uH _m	1 % by volume	1.00		<=1%
Mass particulate	m	5.28	um	0.23 mg	4.40	1.18	<5% of limit value
Note - Sampled gas humidity, temperature and pressure are values at the gas meter							
Leak	L	2		%	2.00		<=2%
Uncollected Mass (Instack filter - no rinse)	UCM	0		mg	0		<=10%

Intermediate calculations

Factor for std conds	fs	0.94				
uncertainty components	symbol	sensitivity coeff	u (in units of fs)			
	p _m	0.009	0.009			
	H _m	0.009	0.009			
	T _m	0.003	0.006			
	ufs		0.015			1.55
Corrected volume	V	0.42	uV	0.007 m ³	V = V _m f _s	1.57

$$f_s = \frac{(100 - H_m) 273}{100 T_m} \frac{p_m}{101.3}$$

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standar	V	0.42 m ³	32.31	0.21 mg.m ⁻³	1.57 %
Mass	m	5.28 mg	2.55	0.59 mg.m ⁻³	4.40 %
Leak	L	0.16 mg.m ⁻³	1.00	0.16 mg.m ⁻³	1.15 %
Uncollected mass	UCM	0.00 mg	2.55	0.00 mg.m ⁻³	0.00 %
Combined measurement uncertainty				0.65 mg.m ⁻³	

Expanded uncertainty as percentage of measured value	9.68	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	1.30	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	2.61	% ELV	

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2.2.9 Analytical Laboratory Details

	Isocyanates
Analytical Laboratory	RPS Laboratories
UKAS Lab Number	0605
Analytical Method	HPLC
Accreditation	UKAS
Date of Analysis	30/03/2015

2.2.10 - Calculations Used in Reporting Results

Nozzle Selection

For isokinetic sampling, the pressure difference of the orifice meter must equal the pressure difference of the Pitot tube pressure multiplied by the K-factor. Where:

$$K = \text{Constant} \times C_p^2 \times D_n^4 \times DH_{@} \times \left(\frac{M_d}{M_s} \right) \left(\frac{1 - B_{wm}}{1 - B_{ws}} \right)^2 \left(\frac{T_m + 273}{T_s + 273} \right) \left(\frac{P_s}{P_m} \right)$$

$$DH = K \times Dp$$

Where:-

Constant: is a constant dependent on the units used to measure the nozzle (8.038×10^{-5} for mm)

D_n the nozzle diameter mm

$DH_{@}$ a constant dependent on the sampler control box orifice and gas meter

B_{ws} the percent water vapour in the emission as a fraction i.e. 12% = 0.12

B_{wm} the percentage water vapour in the air around the meter box often assumed to be zero

C_p Pitot tube coefficient dependent on the Pitot tube type

T_m the meter temperature in °C

T_s the stack temperature in °C

P_s the stack pressure

P_m the meter pressure

M_d dry gas molecular weight

M_s apparent stack gas molecular weight

DH pressure drop across the orifice (mm water)

DP differential Pitot pressure (mm water)

From this the correct nozzle size can be determined.

$$D_n = \sqrt{\left(\frac{\text{Constant} \cdot Q_m \cdot P_m}{(T_m + 273) C_p} \right) \left(\frac{1 - B_{wm}}{1 - B_{ws}} \right) \sqrt{\frac{(T_s + 273) M_s}{(P_s \cdot (\Delta P)_{avg})}}}$$

Where the Constant = 0.6071 Metric

Q_m = Orifice flow rate normally 21.2 actual lmin⁻¹

$$= K_m \sqrt{\frac{(T_m + 273) \Delta H}{P_m M_m}}$$

Where K_m = Orifice meter coefficient

$$K_m = Q_m \sqrt{\frac{P_m M_m}{\Delta H (T_m + 273)}} = \text{Const} \sqrt{\frac{1}{\Delta H_{@}}}$$

Where Const = 183.7 metric

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Moisture Determination Calculations

These calculations are based at 273K and 101.325kPa

To calculate moisture the following equation is used:

$$B_{ws} = \frac{0.001245 \times W_I \times 100}{(0.001245 \times W_I) + 0.359V_m \left(\frac{P_b + \frac{\Delta H_{avg}}{13.6}}{(T_m + 273)} \right)}$$

Particulate Concentration C_s in stack Gases
At 273K and 101.325kPa and dry gas

$$C_s = \frac{W_t}{V_m} \times \frac{T_m + 273}{273} \times \frac{760}{\left(P_b + \frac{\Delta H_{avg}}{13.6} \right)} \times 1000 \quad \text{mg/Nm}^3$$

Oxygen Concentration Correction C_{oxy} to Particulate concentration

$$C_{oxy} = C \times \frac{(20.9 - \%O_2 \text{ ref})}{(20.9 - \%O_2 \text{ Meas})} \quad \text{mg/Nm}^3$$

Dry Molecular Weight of gases

$$M_D = 0.44(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO + \%N)$$

Stack Molecular Weight of gases

$$M_s = 0.18(B_{ws}) + \frac{M_d}{100}(100 - B_{ws})$$

Stack Gas Velocity

$$(V_s)_{avg} = 34.96 \times C_p \times \sqrt{(\Delta P)_{avg}} \sqrt{\frac{T_s + 273}{P_s M_s}} \quad \text{m/s}$$

Mass Emission Rate M_R

$$M_R = \frac{C_m \times (V_s)_{avg} \times A \times 3600}{10^6} \quad \text{kg/hr}$$

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IsoKinicity

$$I = \frac{2.12 \times 10^8 \times V_m \times Y \times \left(P_b + \left(\frac{\Delta H_{avg}}{13.6} \right) \right) \left(\frac{273 + T_s}{273 + T_m} \right)}{\Theta P_s \pi D_n^2 (Vs)_{avg} (100 - B_{ws})} \%$$

- W_i = the weight change of the impingers during sampling in g
- V_m = volume of dry gas sample in litres at temperature of the meter box
- B_{ws} = the percent water vapour in the emission
- Q = length of time sampling in minutes
- Y = Gas Meter Calibration correction factor
- V_s = Velocity of stack gas m/s
- C_M = measured concentration of particulate matter (mg/m³)
- T_m = average temperature at dry gas meter (°C)
- P_b = atmospheric pressure (mmHg)
- $\%O_{2ref}$ = % oxygen at standard temperature & pressure
- $\%O_{2Meas}$ = % oxygen measured on site
- C_p = Pitot tube coefficient
- DP = mean differential Pitot pressure drop (mm H₂O)
- DH = mean orifice pressure drop (mm H₂O)
- D_s = diameter of stack (m)
- D_n = Nozzle diameter (mm)
- T_s = stack temperature (°C)
- M_d = molecular weight of dry stack gas
- B_w = moisture fraction
- P_s = stack pressure (mmHg)
- A = duct c.s.a. (m²)
- M_s = molecular weight of wet stack gas
- M_d = molecular weight of dry stack gas
- W_t = total weight of particulate matter (g)