

2.2.6 - Sample Sheets

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Test no	SB1 Particulates Test 1		Site: Paxford Composites		Stack Description:		SB1		
	Date	6-3-14	dd/mm/yy	Filter No:	13TF184	Absorber No(s):	T01/A-D		
	nozzle diameter	5.74	mm	Blank I.D.:	13TF185				
	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	309.199	m ³				Control Box I.D. No:	AS0240		
start volume reading	308.645	m ³	end time	14:45	hh:mm	Stack Thermocouple I.D. No.	AS0057a		
volume sampled	0.55	m ³	start time	14:15	hh:mm	Probe I.D. No.	AS0057		
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.	AS0300		
			stop time	00:00	hh:mm	Pitot I.D. No.	AS0261		
Stack pressure	756.25	mmHg	Diagram of Sample Location: 						
Gas Meter Calibration Factor Y	1.0214								
Ref oxygen Value	21	%							
Moisture content	0.3	%							
CO	0	ppm							
CO ₂	0	%							
N ₂	79.05	%							
O ₂	20.95	%							
dry molecular wt	28.84								
stack molecular wt	28.80								
Orifice ΔH@ Factor	41.70	mmH ₂ O							
area of stack	0.47	m ²	LEAK CHECK						
Pbar	1008	mbar	Pre Vac (in Hg):			10	Post Vac (in Hg):		5.0
Pbar	756.2	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 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:	14:15	308.6450	A1	5	11.00	27.5	21	160	N/A	17	N/A	20	20	1.0
2:	14:20	308.7300	A1	5	11.00	27.5	21	159	N/A	20	N/A	21	21	1.0
3:	14:25	308.8120	A2	5	14.00	35.0	21	159	N/A	22	N/A	21	21	1.0
4:	14:30	308.9050	A2	5	13.80	34.5	21	158	N/A	23	N/A	21	21	1.0
5:	14:35	309.0000	A3	5	14.80	37.0	21	158	N/A	24	N/A	22	22	1.0
6:	14:40	309.0980	A3	5	14.60	36.5	21	160	N/A	24	N/A	23	23	1.0
7:	14:45	309.1990	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
Summary values		309.20		30		33.00	21.0	159.0	#DIV/0!	21.7	n/a		21.3	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		12.23	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		5.75	m ³ s ⁻¹
Stack flow @ stack gas T & P and on a dry gas basis		5.73	m ³ s ⁻¹
Stack flow @ STP and on a wet gas basis		5.31	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		0.52	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		0.53	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

Test no	SB1 Isocyanates		Site: Paxford Composites		Stack Description:		Spray Booth 1				
	Date	6-3-14	dd/mm/yy	Filter No:	N/A		Absorber No(s):		T01/A-D		
	nozzle diameter	5.74	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	309.744	m ³				Control Box I.D. No:		AS0240			
start volume reading	309.204	m ³	end time	15:25	hh:mm	Stack Thermocouple I.D. No.		AS0057a			
volume sampled	0.54	m ³	start time	14:55	hh:mm	Probe I.D. No.		AS0057			
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.		AS0300			
			stop time	00:00	hh:mm	Pitot I.D. No.		AS0261			
Stack pressure	756.25	mmHg	Diagram of Sample Location: 								
Gas Meter Calibration Factor Y	1.0214										
Ref oxygen Value	21	%									
Moisture content	0.7	%									
CO	0	ppm									
CO ₂	0	%									
N ₂	79.05	%									
O ₂	20.95	%									
dry molecular wt	28.84										
stack molecular wt	28.76										
Orifice ΔH@ Factor	41.70	mmH ₂ O									
area of stack	0.47	m ²	LEAK CHECK								
Pbar	1008	mbar	Pre Vac (in Hg):					Post Vac (in Hg): 1.0			
Pbar	756.2	mmHg									
pitot tube coeft	0.83		Leak rate (m ³ /l) or (%):					Leak rate (m ³ /l) or (%):			
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:	14:55	309.2040	A1	5	14.20	35.5	20	161	N/A	15	N/A	23	23	1.0
2:	15:00	309.3020	A1	5	13.40	33.5	21	161	N/A	16	N/A	23	23	1.0
3:	15:05	309.4000	A2	5	15.20	38.0	21	160	N/A	19	N/A	24	24	1.0
4:	15:10	309.4990	A2	5	14.60	36.5	21	160	N/A	19	N/A	25	25	1.0
5:	15:15	309.5930	A3	5	9.80	24.5	21	160	N/A	20	N/A	26	26	1.0
6:	15:20	309.6970	A3	5	10.20	25.5	21	160	N/A	21	N/A	26	26	1.0
7:	15:25	309.7440	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
Summary values		309.74		30		32.25	20.8	160.3	#DIV/0!	18.3	n/a		24.5	1.0

Duct / Stack Flow Characteristics:	Spray Booth 1		Units
Test No	SB1 Isocyanates		
Stack Velocity at stack gas T & P and a wet gas basis		12.07	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		5.67	m ³ s ⁻¹
Stack flow @ stack gas T & P and on a dry gas basis		5.63	m ³ s ⁻¹
Stack flow @ STP and on a wet gas basis		5.25	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		0.51	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		0.51	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	SB2 Particulates Test 1		Site: Paxford Composites		Stack Description:		SB2		
	Date	6-3-14	dd/mm/yy	Filter No:	13TF183	Absorber No(s):	T01/A-D		
	nozzle diameter	5.74	mm	Blank I.D.:	13TF182				
	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	307.678	m ³				Control Box I.D. No:		AS0240	
start volume reading	306.844	m ³	end time	11:45	hh:mm	Stack Thermocouple I.D. No.		AS0057a	
volume sampled	0.83	m ³	start time	11:15	hh:mm	Probe I.D. No.		AS0057	
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.		AS0300	
			stop time	00:00	hh:mm	Pitot I.D. No.		AS0261	
Stack pressure	756.25	mmHg	Diagram of Sample Location: 						
Gas Meter Calibration Factor Y	1.0214								
Ref oxygen Value	21	%							
Moisture content	0.6	%							
CO	0	ppm							
CO ₂	0	%							
N ₂	79.05	%							
O ₂	20.95	%							
dry molecular wt	28.84								
stack molecular wt	28.78								
Orifice ΔH@ Factor	41.70	mmH ₂ O							
area of stack	0.64	m ²	LEAK CHECK						
Pbar	1008	mbar	Pre Vac (in Hg):			10	Post Vac (in Hg):		3.5
Pbar	756.2	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 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:	11:15	306.8440	A1	5	48.00	120.0	23	160	N/A	14	N/A	17	17	3.0
2:	11:20	307.0120	A1	5	52.00	130.0	22	160	N/A	15	N/A	18	18	3.5
3:	11:25	307.1870	A2	5	30.00	75.0	22	160	N/A	16	N/A	19	19	2.0
4:	11:30	307.3240	A2	5	28.00	70.0	22	160	N/A	17	N/A	20	20	2.0
5:	11:35	307.4610	A3	5	18.00	45.0	23	159	N/A	18	N/A	21	21	1.0
6:	11:40	307.5820	A3	5	19.00	47.5	23	159	N/A	19	N/A	21	21	1.0
7:	11:45	307.6780	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
Summary values		307.68		30		81.25	22.5	159.7	#DIV/0!	16.5	n/a		19.3	2.1

Duct / Stack Flow Characteristics:	SB2		Units
Test No	SB2 Particulates Test 1		
Stack Velocity at stack gas T & P and a wet gas basis		18.89	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		12.09	m ³ s ⁻¹
Stack flow @ stack gas T & P and on a dry gas basis		12.02	m ³ s ⁻¹
Stack flow @ STP and on a wet gas basis		11.11	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		0.80	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		0.80	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 Date nozzle diameter Stack Pres (with +/- above barometric if unknown enter zero)	SB2 Isocyanates T1		Site: Paxford Composites		Stack Description:		SB2	
	6-3-14	dd/mm/yy	Filter No:		N/A		Absorber No(s):	
	5.74	mm	Blank I.D.:		N/A			
	0	mmH ₂ O	SITE TEAM:		KCB/MRE			
			COMMENTS:		Spray Booth Two Isocyanates Test 1 of 1			
end volume reading	308.632	m ³				Control Box I.D. No:	AS0240	
start volume reading	307.691	m ³	end time	12:40	hh:mm	Stack Thermocouple I.D. No.	AS0057a	
volume sampled	0.94	m ³	start time	12:10	hh:mm	Probe I.D. No.	AS0057	
Conditions	Value	Units	total time	00:30	hh:mm	Barometer I.D. No.	AS0300	
			stop time	00:00	hh:mm	Pitot I.D. No.	AS0261	
Stack pressure	756.25	mmHg	Diagram of Sample Location: 					
Gas Meter Calibration Factor Y	1.0214							
Ref oxygen Value	21	%						
Moisture content	0.5	%						
CO	0	ppm						
CO₂	0	%						
N₂	79.05	%						
O₂	20.95	%						
dry molecular wt	28.84							
stack molecular wt	28.79							
Orifice ΔH@ Factor	41.70	mmH ₂ O						
area of stack	0.64	m ²	LEAK CHECK					
Pbar	1008	mbar	Pre Vac (in Hg):			10	Post Vac (in Hg):	3.0
Pbar	756.2	mmHg	Leak rate (m³/l) or (%):			<2%	Leak rate (m³/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 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:	12:10	307.6910	A1	5	52.00	130.0	23	160	N/A	12	N/A	22	22	2.0
2:	12:15	307.8620	A1	5	48.00	120.0	23	160	N/A	14	N/A	22	22	3.0
3:	12:20	308.0300	A2	5	36.00	90.0	23	160	N/A	16	N/A	22	22	2.0
4:	12:25	308.1850	A2	5	34.00	85.0	22	160	N/A	18	N/A	23	23	2.0
5:	12:30	308.3240	A3	5	28.00	70.0	23	159	N/A	20	N/A	24	24	1.0
6:	12:35	308.4930	A3	5	26.00	65.0	23	159	N/A	22	N/A	24	24	1.0
7:	12:40	308.6320	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
Summary values		308.63	30		93.33	22.8	159.7	#DIV/0!	17.0	n/a		22.8	1.8

Duct / Stack Flow Characteristics:	SB2		Units
Test No	SB2 Isocyanates T1		
Stack Velocity at stack gas T & P and a wet gas basis	20.50	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	13.12	m ³ s ⁻¹	
Stack flow @ stack gas T & P and on a dry gas basis	13.06	m ³ s ⁻¹	
Stack flow @ STP and on a wet gas basis	12.05	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	0.89	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	0.89	m ³	
Gas vol. samp. @ STP, O ₂ (ref) and on a wet gas basis	N/A	m ³	
Percentage Isokinicity	102	%	

2.2.7 - Moisture Calculations

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test RecordForm

Test No:	SB1 Particulates
Date:	6-3-14
pbar (mbar):	1008
pbar (mmHg):	756
nozzle diameter (mm):	5.74
Temp of Meter (in)/(out) °C:	21
ΔH_{ave} (mmH ₂ O):	33.0
Filter No (if app):	13TF184

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

End Volume Reading	309.20	m ³
Start Volume reading	308.65	m ³
Volume Sampled	0.55	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)	583.5	598.3	454.5	714.4				MRE
Weight of Jars plus absorber (g)	589.0	599.5	454.5	706.3				MRE
Weight of Jars (g)	440.5	423.1	452.5	416.2				MRE
Weight Gain (g)	-5.5	-1.2	0.0	8.1				

Total Weight Gain (1+2+3+4) (g)	1.4
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Gas Volume of water at 0°C (l)	1.74
Gas Meter volume at 0°C (l)	512.95

Moisture content of Gases (%)	0.3
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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 = $\frac{\text{wt of water collected (g)} \times 100}{\text{wt of water collected (g)} + (\text{m}^3 \text{ of gas on meter} \times 1200)}$

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test Record Form

Test No:	SB1 Isocyanates
Date:	6-3-14
pbar (mbar):	1008
pbar (mmHg):	756
nozzle diameter (mm):	5.74
Temp of Meter (in)/(out) °C:	25
ΔH_{ave} (mmH ₂ O):	32.3
Filter No (if app):	N/A

Site:	Paxford Composites
Stack:	Spray Booth 1
Site Team:	KCB/MRE
Data Entered By:	

End Volume Reading	309.74	m ³
Start Volume reading	309.20	m ³
Volume Sampled	0.54	m ³

end time	15:25	hr:min
start time	14:55	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)	743.4	802.2	608.8	851.8				MRE
Weight of Jars plus absorber (g)	746.6	802.9	608.9	844.8				MRE
Weight of Jars (g)	591.5	607.2	606.9	611.5				MRE
Weight Gain (g)	-3.2	-0.7	-0.1	7.0				

Total Weight Gain (1+2+3+4) (g)	3
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Gas Volume of water at 0°C (l)	3.74
Gas Meter volume at 0°C (l)	494.63

Moisture content of Gases (%)	0.7
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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 $V_{mc} = 359.2 \times \text{gas meter reading (m}^3) \times (P_{bar} + \Delta H/13.6) / (\text{meter temp} + 273)$

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

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

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

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

National Physical Laboratory
Absorber Test RecordForm

Test No:	SB2 Particulates Test 1
Date:	6-3-14
pbar (mbar):	1008
pbar (mmHg):	756
nozzle diameter (mm):	5.74
Temp of Meter (in)/(out) °C:	19
ΔH_{ave} (mmH ₂ O):	81.3
Filter No (if app):	13TF183

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

End Volume Reading	307.68	m ³
Start Volume reading	306.84	m ³
Volume Sampled	0.83	m ³

end time	11:45	hr:min
start time	11:15	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)	746.6	802.9	608.9	844.8				MRE
Weight of Jars plus absorber (g)	766.5	797.5	606.9	828.8				MRE
Weight of Jars (g)	591.5	607.2	606.9	611.5				MRE
Weight Gain (g)	-19.9	5.4	2.0	16.0				

Total Weight Gain (1+2+3+4) (g)	3.5
---------------------------------	-----

Gas Volume of water at 0°C (l)	4.36
Gas Meter volume at 0°C (l)	781.12

Moisture content of Gases (%)	0.6
-------------------------------	-----

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 RecordForm

Test No:	SB2
Date:	Isocyanates T1 6-3-14
pbar (mbar):	1008
pbar (mmHg):	756
nozzle diameter (mm):	5.74
Temp of Meter (in)/(out) °C:	23
ΔH_{ave} (mmH ₂ O):	93.3
Filter No (If app):	N/A

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

End Volume Reading	308.63	m ³
Start Volume reading	307.69	m ³
Volume Sampled	0.94	m ³

end time	12:40	hr:min
start time	12:10	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)	589.0	599.5	454.5	706.3				MRE
Weight of Jars plus absorber (g)	612.2	594.4	452.5	686.8				MRE
Weight of Jars (g)	440.5	423.1	452.5	416.2				MRE
Weight Gain (g)	-23.2	5.1	2.0	19.5				

Total Weight Gain (1+2+3+4) (g)	3.4
---------------------------------	-----

Gas Volume of water at 0°C (l)	4.23
Gas Meter volume at 0°C (l)	871.93

Moisture content of Gases (%)	0.5
-------------------------------	-----

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

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

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

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

2.2.8 - Uncertainty Calculations

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

v15

SB1 - Run One

Measurement Equation

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

Limit value (ELV)	50	mg.m ⁻³	Reference oxygen	20.95	% by volume
Measured concentration	4.56	mg.m ⁻³ (at reference conditions)			

Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv	Requirement of std
Sampled Volume	V _m	0.55	uV _m	0.001 m ³	0.18		<=2%
Sampled gas Temperature	T _m	294	uT _m	2 K	0.68		<=1%
Sampled gas Pressure	p _m	100.8	up _m	1 kPa	0.99		<=1%
Sampled gas Humidity	H _m	0	uH _m	1 % by volume	1.00		<=1%
Mass particulate	m	2.4	um	0.2 mg	9.59	0.87	<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	UCM	0		mg	0		<=10%
(Instack filter - no rinse)							

Intermediate calculations

Factor for std conds	fs	0.92				
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		0.014			1.56
Corrected volume	V	0.51	uV	0.008 m ³	V = V _m f _s	1.58

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

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard)	V	0.51 m ³	8.92	0.07 mg.m ⁻³	1.58 %
Mass	m	2.40 mg	1.90	0.44 mg.m ⁻³	9.59 %
Leak	L	0.05 mg.m ⁻³	1.00	0.05 mg.m ⁻³	1.15 %
Uncollected mass	UCM	0.00 mg	1.90	0.00 mg.m ⁻³	0.00 %
Combined measurement uncertainty				0.45 mg.m ⁻³	

Expanded uncertainty as percentage of measured value	19.60	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	0.89	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	1.79	% ELV	

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

v15

SB2 - Run One

Measurement Equation

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

Limit value (ELV)	50	mg.m ⁻³	Reference oxygen	20.95	% by volume
Measured concentration	2.68	mg.m ⁻³ (at reference conditions)			

Measured Quantities	Symbol	Value	Standard uncertainty	Units	Uncertainty as percentage	Uncertainty at lv	Requirement of std
Sampled Volume	V _m	0.83	uV _m	0.001 m ³	0.12		<=2%
Sampled gas Temperature	T _m	292	uT _m	2 K	0.68		<=1%
Sampled gas Pressure	p _m	100.8	up _m	1 kPa	0.99		<=1%
Sampled gas Humidity	H _m	0	uH _m	1 % by volume	1.00		<=1%
Mass particulate	m	2.15	um	0.23 mg	10.69	0.57	<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	UCM	0		mg	0		<=10%
(Instack filter - no rinse)							

Intermediate calculations

Factor for std cond	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			1.57
Corrected volume	V	0.77	uV	0.012 m ³	V = V _m f _s	1.57

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

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standar	V	0.77 m ³	3.46	0.04 mg.m ⁻³	1.57 %
Mass	m	2.15 mg	1.25	0.29 mg.m ⁻³	10.69 %
Leak	L	0.03 mg.m ⁻³	1.00	0.03 mg.m ⁻³	1.15 %
Uncollected mass	UCM	0.00 mg	1.25	0.00 mg.m ⁻³	0.00 %
Combined measurement uncertainty				0.29 mg.m ⁻³	

Expanded uncertainty as percentage of measured value	21.76	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)
Expanded uncertainty in units of measurement	0.58	mg.m ⁻³	
Expanded uncertainty as percentage of limit value	1.17	% ELV	

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Uncertainty calculation for Gaseous Measurement of TOC to BS EN 12619

Limit value	50 mg/m ³ (corrected) TOC	Cal gas conc	85.07 mg.m ⁻³ TOC
Measured concentration	64.7 mg/m ³	Full Scale	160.5 mg/m ³
Measured concentration	64.7 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	1.00	0.01	0.01

Effect of drift
0.60 mg/m ³
0.37 % full scale

Performance characteristics	Value		specification
Response time	40	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	0.48	mg/m ³	0.4 mg/m ³ (long term)
Span drift	0.16	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	mg/m ³	0.8 mg/m ³
SO ₂ (mg/m ³)	260	mg/m ³	
NO (mg/m ³)	860	mg/m ³	
NO ₂ (mg/m ³)	150	mg/m ³	sum of all effects of these interferents when taking all positive or all negative effects shall be less than 1 mg/m ³
CO (mg/m ³)	430	mg/m ³	
CO ₂ (% vol)	18	mg/m ³	
HCl (mg/m ³)	40	mg/m ³	
H ₂ O (% vol)	20	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)	2	% of value	< 0.1%vol /10 volt
Uncertainty of calibration gas	2.00	% 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 ₁₅	for mean	use rep at zero
Lack of fit	U _{fit}		0.23
Drift	U _{dr}		0.35
volume or pressure flow dependence	U _{spres}		0.03
atmospheric pressure dependence	U _{spres}		0.04
ambient temperature dependence	U _{temp}		0.00
O ₂	U _{inter}		0.11
SO ₂ (mg/m ³)	U _{inter}		0.13
NO (mg/m ³)	U _{inter}		0.08
NO ₂ (mg/m ³)	U _{inter}		0.04
CO (mg/m ³)	U _{inter}		0.13
CO ₂ (% vol)	U _{inter}		0.13
HCl (mg/m ³)	U _{inter}		0.01
H ₂ O (% vol)	U _{inter}		0.12
Dependence on voltage	U _{vol}		0.14
losses in the line (leak)	U _{leak}		0.75
Uncertainty of calibration gas	U _{calib}		0.75
control gas	U _{control}		3.74
Uncertainty in factor	U _f		0.69

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	1.294303065	
Value to use for interference uncertainty	U _{int}	0.17

Measurement uncertainty			
Combined uncertainty		3.91	mg/m ³
Expanded uncertainty	k = 2	7.82	mg/m ³
Uncertainty corrected to std conds			
Expanded uncertainty	expressed with a level of confidence of 95%	7.94	mg/m ³
Expanded uncertainty	expressed with a level of confidence of 95%	15.89	% ELV
Expanded uncertainty	expressed with a level of confidence of 95%	7.94	mg.m ⁻³
Expanded uncertainty	expressed with a level of confidence of 95%	12.28	% value

NATIONAL PHYSICAL LABORATORY
Continuation Sheet

Uncertainty calculation for Gaseous Measurement of TOC to BS EN 12619

Limit value	50 mg/m ³ (corrected) TOC	Cal gas conc	85.07 mg.m ⁻³ TOC
Measured concentration	39.5 mg/m ³	Full Scale	160.5 mg/m ³
Measured concentration	39.5 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	

Effect of drift	4.39 mg/m ³
	2.74 % full scale
CORRECT FOR DRIFT	

Performance characteristics	Value		specification
Response time	30	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	3.05	mg/m ³	0.4 mg/m ³ (long term)
Span drift	2.89	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	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

	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 _{re}	for mean	0.02
Standard deviation of repeatability at span level	U _{rs}	for mean	use rep at zero
Lack of fit	U _{lf}		0.23
Drift	U _{dr}		2.54
volume or pressure flow dependence	U _{agp}		0.03
atmospheric pressure dependence	U _{agp}		0.04
ambient temperature dependence	U _{temp}		0.00
O ₂	U _{interf}		0.11
SO ₂ (mg/m ³)	U _{interf}		0.13
NO (mg/m ³)	U _{interf}		0.08
NO ₂ (mg/m ³)	U _{interf}		0.04
CO (mg/m ³)	U _{interf}		0.13
CO ₂ (% vol)	U _{interf}		0.13
HCl (mg/m ³)	U _{interf}		0.01
H ₂ O (% vol)	U _{interf}		0.12
Dependence on voltage	U _{int}		0.14
losses in the line (leak)	U _{leak}		0.23
Uncertainty of calibration gas	U _{calib}		0.29
control gas	U _{control}		2.28
Uncertainty in factor	uf		0.42

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	0.78944054	
Value to use for interference uncertainty		
U _{int}	0.17	

Measurement uncertainty			
Combined uncertainty		3.4	mg/m ³
Expanded uncertainty	k = 2	6.9	mg/m ³
Uncertainty corrected to std conds			
Expanded uncertainty	expressed with a level of confidence of 95%	13.9	% ELV
Expanded uncertainty	expressed with a level of confidence of 95%	6.9	mg.m ⁻³
Expanded uncertainty	expressed with a level of confidence of 95%	17.6	% value

2.2.9 Analytical Laboratory Details

	Isocyanates
Analytical Laboratory	RPS Laboratories
UKAS Lab Number	0605
Analytical Method	HPLC
Accreditation	UKAS
Date of Analysis	25/03/2014

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

Moisture Determination Calculations

These calculations are based at 273K and 101.325kPa

To calculate moisture the following equation is used:

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

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

$$C_{oxy} = C \times \frac{(20.9 - \%O_{2ref})}{(20.9 - \%O_{2Meas})} \quad \text{mg/Nm}^3$$

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

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

IsoKinicity

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

- 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/m^3)
 T_m = average temperature at dry gas meter ($^{\circ}C$)
 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 H_2O)
 DH = mean orifice pressure drop (mm H_2O)
 D_s = diameter of stack (m)
 D_n = Nozzle diameter (mm)
 T_s = stack temperature ($^{\circ}C$)
 M_d = molecular weight of dry stack gas
 B_w = moisture fraction
 P_s = stack pressure (mmHg)
 A = duct c.s.a. (m^2)
 M_s = molecular weight of wet stack gas
 M_d = molecular weight of dry stack gas
 W_t = total weight of particulate matter (g)