

REC

Resource & Environmental Consultants Ltd



MONITORING OF EMISSIONS FROM THE FACI BOILER STACK

6 March, 2014

Prepared for Piping Hot Cookers Ltd

REC Report 71753p3r0

Issued: 20 March, 2014





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Analyses identified as UKAS accredited were conducted by REC or approved sub-contractors in accordance with their SOPs

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EXECUTIVE SUMMARY

Resource & Environmental Consultants (REC) Ltd was commissioned by Piping Hot Cookers Ltd to monitor emissions of pollutants released from the Faci Boiler process stack at the Michton Ltd site in Port Talbot. The Faci boiler was fuelled by wood pellets during the sampling campaign.

In accordance with the requirements of an RHI Certificate, monitoring has been undertaken for the following pollutants:-

- Combustion Gases including O₂ and NO_x
- Total Particulate Matter

The following results were obtained from the emission monitoring survey and are compared with the current RHI limit:-

Faci Boiler – Pellet Fuel

Species	UKAS Status	Emission Concentration (mg/m ³)		Emission Factor (g/GJ)		RHI Limit (g/GJ)
Oxides of Nitrogen	A	Run 1	168.2	Run 1	81.3	150
		Run 2	162.6	Run 2	78.5	
		Run 3	169.5	Run 3	81.9	
		Run 4	165.7	Run 4	80.0	
		Run 5	163.8	Run 5	79.1	
		Average	166.0	Average	80.2	
		Best 3	164.0	Best 3	79.2	
Particulate Matter	B	Run 1	38.7	Run 1	18.7	30
		Run 2	37.9	Run 2	18.3	
		Run 3	57.0	Run 3	27.5	
		Run 4	47.8	Run 4	23.1	
		Run 5	62.5	Run 5	30.2	
		Average	48.7	Average	23.56	
		Best 3	41.5	Best 3	20.0	

NOTE 1: All emission concentration data are expressed in mg/Nm³ at 273K, 101.3kPa, dry gas and referenced to 10% O₂ content, unless otherwise stated.

NOTE: UKAS Status:- (A) REC Ltd accredited for sampling and analysis. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd.

INTRODUCTION

1.1 Background

Piping Hot Cookers Ltd commissioned REC Ltd to conduct an emission monitoring survey on the Faci boiler process stack at the Michton Ltd site in Port Talbot.

The boiler provides heat to the factory.

1.2 Scope of the Survey

An emission monitoring survey was required to determine the release concentrations of various pollutants from the boiler process. Concentrations of the following pollutants were quantified during the survey:

- Combustion Gases including O₂ and NO_x
- Total Particulate Matter

Ancillary measurements of stack dimensions, temperature and velocity were also made.

Sampling for combustion gases was carried out on a continuous basis with measured concentrations being data-logged at 1 minute intervals over the sampling period. All other pollutants were sampled over five separate periods.

All results were to be reported at 273K, 101.3kPa, dry gas and corrected to 10% oxygen content. Results were also to be reported expressed in gram per gigajoule (g/GJ).

Additional analysis of each fuel type for moisture content was carried out by a sub-contracted laboratory, SAL Ltd.

1.3 Sampling Personnel

Monitoring was conducted by the following REC Ltd permanent staff:-

- Dave Burns - Team Leader, MM05 579, MCERTS Level 2, TE1-4
- Rachel Powis - Assistant, MM12 1203, MCERTS Level 1

2. METHODOLOGY

2.1 Species & Techniques

The following table shows the reference methods used for the emission monitoring survey:

Species	UKAS Status	Method	Uncertainty (±%)	Limit of Detection
Moisture	A	In house method MM0010 based on BS EN 14790	20	0.1%vol
Particulate Matter	B	In house method MM0004 based on BS EN 13284	10	1 mg/m ³
Oxides of Nitrogen (as NO ₂)	A	In house method MM0002 based on BS EN 14792	10	1 mg/m ³
Oxygen	A	In house method MM0002 based on BS EN 14789	10	0.1%vol

NOTE: UKAS Status:- (A) REC Ltd accredited for sampling and analysis. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd.

Additional analysis of each fuel type for moisture content was carried out by a sub-contracted laboratory, SAL Ltd.

2.2 Sampling & Analytical Methodology

Total Particulate Matter

To determine the concentration of particulate matter in emissions, isokinetic stack sampling equipment satisfying the requirements of BS EN 13284 was utilised and in-house method MM0004 followed.

The Standard describes the methodology for measuring particulate matter under defined conditions and at discrete locations in the duct. Sampling is carried out under isokinetic sampling conditions i.e. the flowrate through the sampling nozzle is adjusted to equal the flowrate in the duct at the sampling positions. Velocity pressures were recorded throughout the monitoring period by means of an 'S' type pitot integral to the sampling probe and nozzle assembly.

A sample of the exhaust stream was removed from the stack via a titanium nozzle and titanium lined heated probe. It was then passed through a quartz fibre filter contained in a heated oven compartment. The temperature of the probe and filter box were maintained at 160°C i.e. above the dew point of the stack gases, to ensure moisture did not condense on the filter. Each filter used complied with the requirements of Section 6.2.7 of BS EN 13284-1:2001 in that the efficiency was better than 99.5% for particles of 0.3µm diameter (or 99.9% for particles of 0.6µm diameter).

The impinger train was seated in a water bath to cool the gas stream and condense out less volatile gases and water vapour.

The first two impingers encountered by the gas stream contained deionised water. The third impinger was left empty and the fourth contained anhydrous silica gel which was used to dry the gas stream before passing it through a dry gas meter (DGM) to measure the volume of gas sampled.

All the impingers were weighed before and after the sampling run in order to determine the mass of water condensed by the impinger train (in house Method MM0010).

The sample volume collected was in excess of the minimum requirement stated in MM0004. The minimum sample volume ensures the results would be representative of normal plant operating conditions.

Upon completion of sampling, the filter was removed to a clean petri dish, labelled and sealed. The probe and filter housing were rinsed with acetone and water. The washings were collected in a container and submitted for analysis along with the filter.

Combustion Gases

To determine the concentration of combustion gases (NO_x and O_2) in emissions, a Horiba PG250 Model multigas analyser was used. The analyser uses a separate gas conditioner to enable the gas stream to be presented to the detection cells on a dry gas basis. In house method MM0002 was followed.

The analyser satisfies the requirements of the following Standards:-

NO_x	-	BE EN 14792
O_2	-	BS EN 14789

The measured value and uncertainty associated with this analyser is 0.5% to 1.0% of full scale deflection.

The monitoring ranges of the Horiba PG250 are:

NO_x chemiluminescence sensor ranges: 0, 25, 50, 100, 250 ... 2500

O_2 Zirconia sensor ranges: 0...5, 10, 25%

The analyser was calibrated against traceable test gases prior to, during and on completion of the sampling survey.

The Standards describe the methodology for measuring the combustion gases listed above under defined conditions in the duct. Sampling is carried out under anisokinetic sampling conditions as it is assumed that the gas is homogenous across the sample plane.

Stack Temperature and Velocity

To determine the stack temperature, a calibrated thermocouple and digital indicator were employed. The exhaust gas velocity was investigated using a pitot static probe (to MM0004) and digital manometer.

Fuel Moisture Content

A sample of each fuel type was taken and submitted to a sub-contracted company, SAL Ltd for analysis of Total Moisture Content.

2.3 Laboratory Analysis

An approved UKAS accredited sub-contractor, SAL Ltd, undertook the sample analysis for Particulate Matter.

A copy of their Certificate of Analysis is enclosed in Appendix 1.

3. SAMPLING AND OPERATIONAL DETAILS

3.1 Process Description

The Faci boiler at Piping Hot Cookers Ltd, Port Talbot is seeking compliance with the Renewable Heat Incentive (RHI) emissions criteria.

The following guidance document applies:-

Renewable Heat Incentive - Emission Limits for Total Particulate matter and Oxides of Nitrogen- August 2011.

In accordance with the requirements of RHI the boilers were operating at $\geq 85\%$ of the boilers nominal heat output for the duration of the monitoring periods.

Details of the Faci boiler monitored are outlined below:

Model Number	16
Registration Number	-
Fuel Type	Wood Pellets
Fuel Feed Rate	20 – 24 kg/hr
Loading During Testing	180 kW
Fuel Moisture Content (from previous SAL analysis)	7.1%

3.2 Sampling Positions

On the boiler stack, 1 x 4" sampling hole was provided. The sampling plane on the Faci Boiler was less than five hydraulic diameters downstream from flow disturbances but greater than two upstream.

The sampling points do not fully satisfy the requirements of BS EN 13284 and EA Guidance M1, in terms of location and port size. However, due to the size of the stack single point sampling was conducted as required by the Standard.

A photographs detailing the sampling positions and taken from Site Worksheets is provided in Appendix 2.

3.3 Uncertainty

All standard methods were fully complied with, consequently the standard uncertainties apply for these tests.

REC has calculated uncertainty budgets for all of the pollutants listed in the Method Details Table in Section 2.1 above in accordance with calculations and methodology supplied by the Source Testing Association (STA). These uncertainties are quoted in the Tables section of this report.

3.4 Emission Monitoring Survey Details

The emission monitoring survey was carried out on the boiler on 6 March 2014. The table below summarises the actual sampling periods.

SAMPLING PERIODS

Stack Ref.	Parameter	Sample Time (& Date)
Faci Boiler – Pellet Fuel	Particulates, Run 1	09:59 – 10:29 (06/03/14)
	Particulates, Run 2	10:39 – 11:09 (06/03/14)
	Particulates, Run 3	11:19 – 11:49 (06/03/14)
	Particulates, Run 4	11:59 – 12:29 (06/03/14)
	Particulates, Run 5	12:39 – 13:09 (06/03/14)
	NO _x & O ₂	Continuous during Particulate Runs 1-5

4. RESULTS AND DISCUSSION

4.1 Initial Velocity and Temperature Traverse

An initial pitot-static pressure and temperature traverse was carried out. From these data stack velocity, expressed in metres per second (m/s), and volumetric flowrates expressed in cubic metre per hour (m³/hr) have been calculated.

The results are reported at actual stack conditions and the volumetric flowrate is further expressed at the standard reference conditions of 273K, 101.3kPa i.e. standard temperature and pressure (STP). The results are summarised in Table 1.

4.2 Particulate Matter

The results of the particulate sampling runs are summarised in Tables 2 - 6. From the mass of particulate matter on the filter and in the acetone/water wash residue and volume sampled an emission concentration was calculated.

The results are expressed in mg/m³ at 273K, 101.3kPa, dry gas and referenced to 10% O₂ content and also expressed in gram per gigajoule (g/GJ).

4.3 Combustion Gases

The results of the combustion gas monitoring tests are summarised in Tables 7 - 11 and Figures 1 - 5. The table presents the average of concentrations measured throughout each of the sample periods.

Concentrations are expressed in mg/m³ at the standard reference conditions of 273K, 101.3kPa, dry gas and referenced to 10% O₂ content and also expressed in g/GJ.

===== End of Report Text =====

FIGURES

Fig 1: Combustion Gas Emission Data, piping Hot Cookers, Port Talbot, Faci 16 - Wood Pellet Fuel, Run 1 (06/03/14)

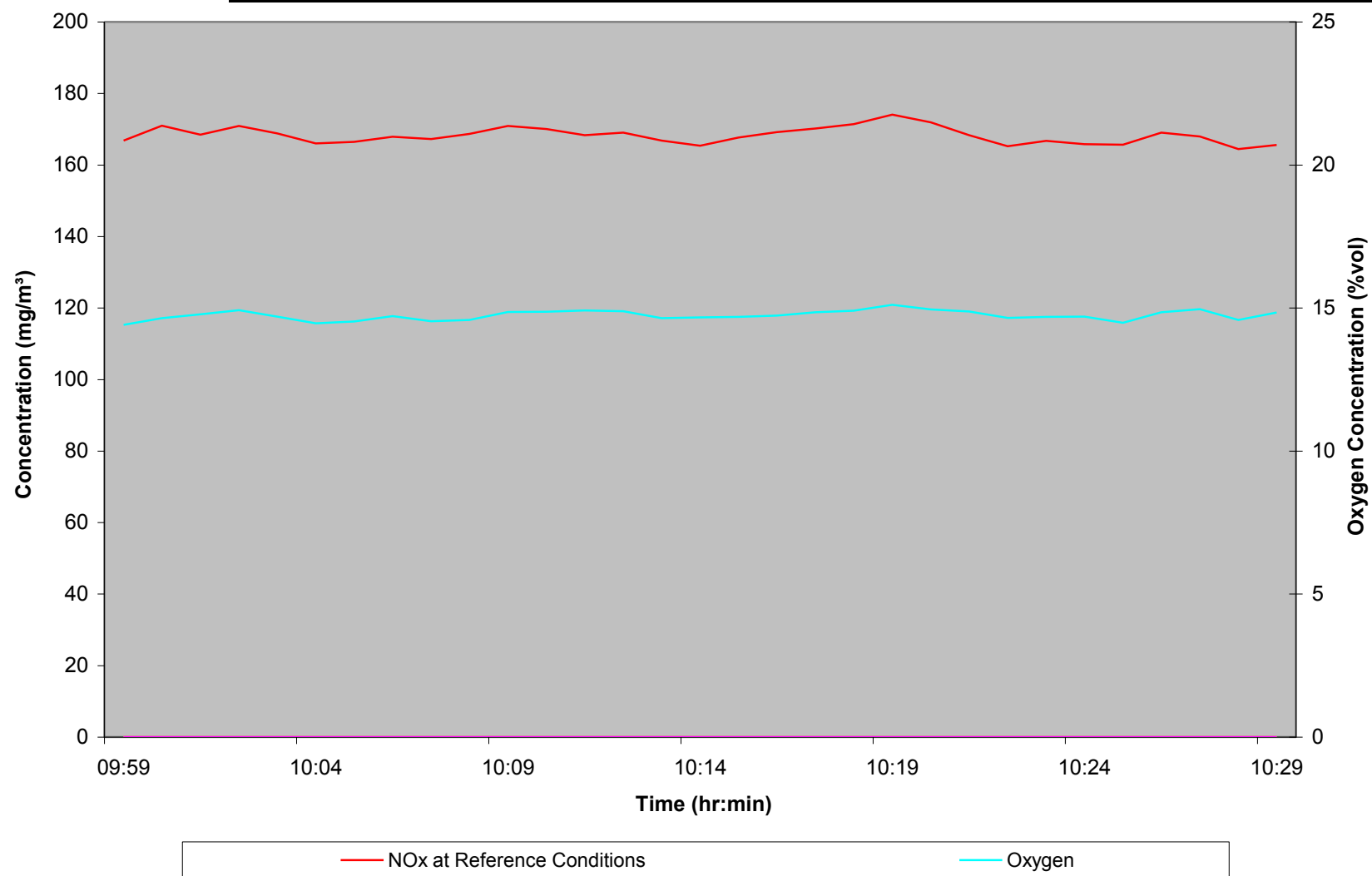


Fig 2: Combustion Gas Emission Data, piping Hot Cookers, Port Talbot, Faci 16 - Wood Pellet Fuel, Run 2 (06/03/14)

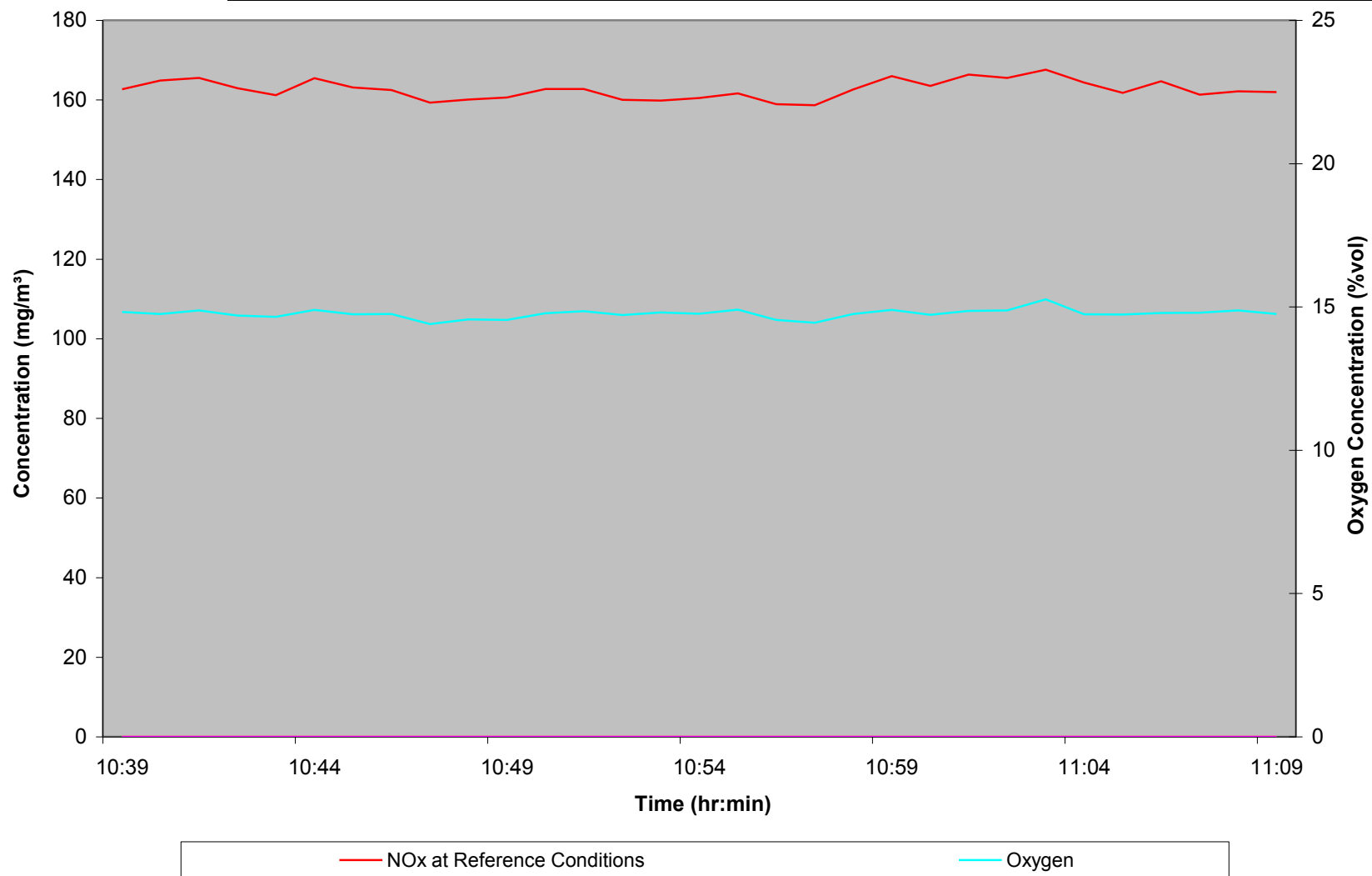


Fig 3: Combustion Gas Emission Data, piping Hot Cookers, Port Talbot, Faci 16 - Wood Pellet Fuel, Run 3 (06/03/14)

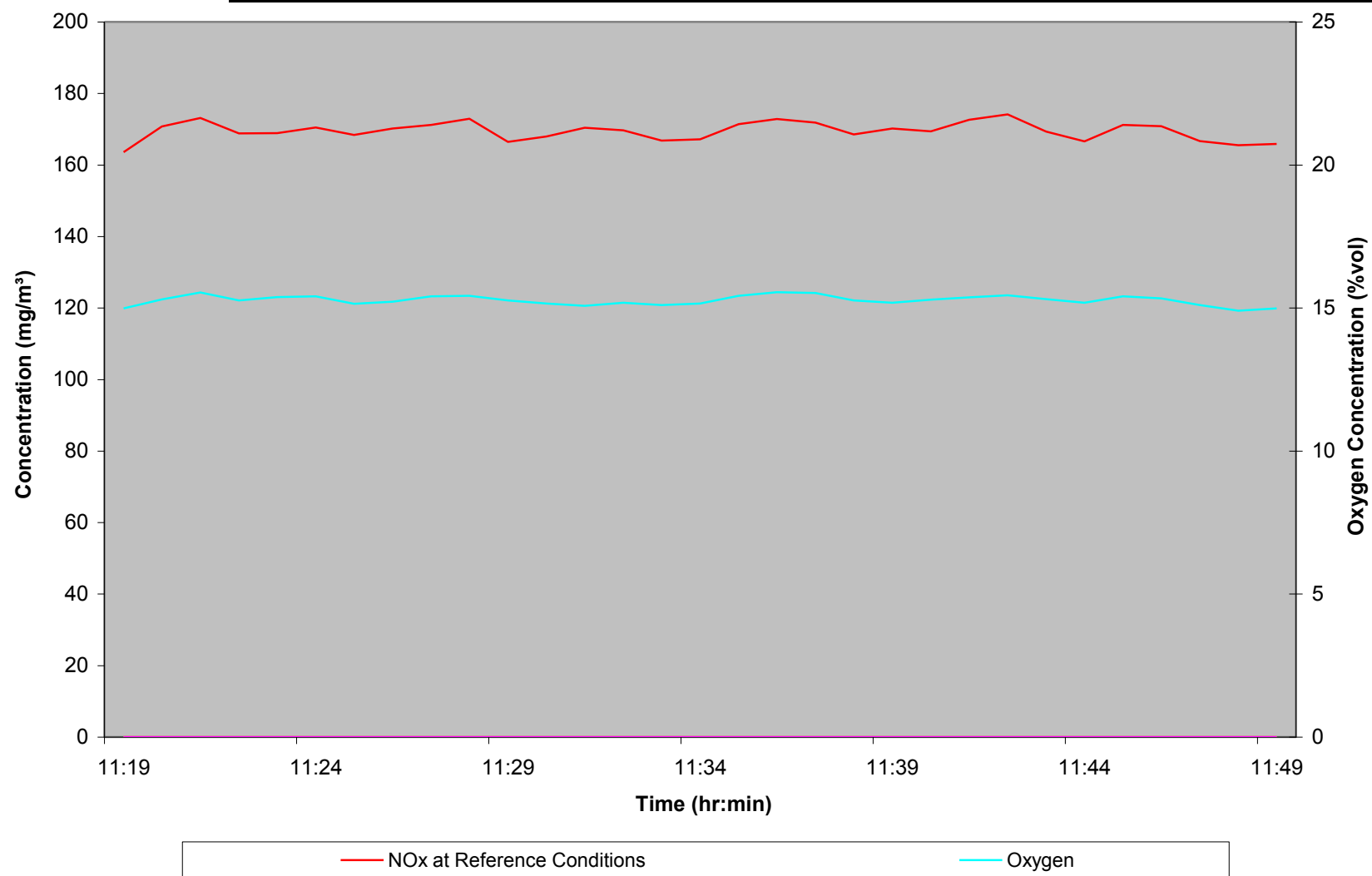


Fig 4: Combustion Gas Emission Data, piping Hot Cookers, Port Talbot, Faci 16 - Wood Pellet Fuel, Run 4 (06/03/14)

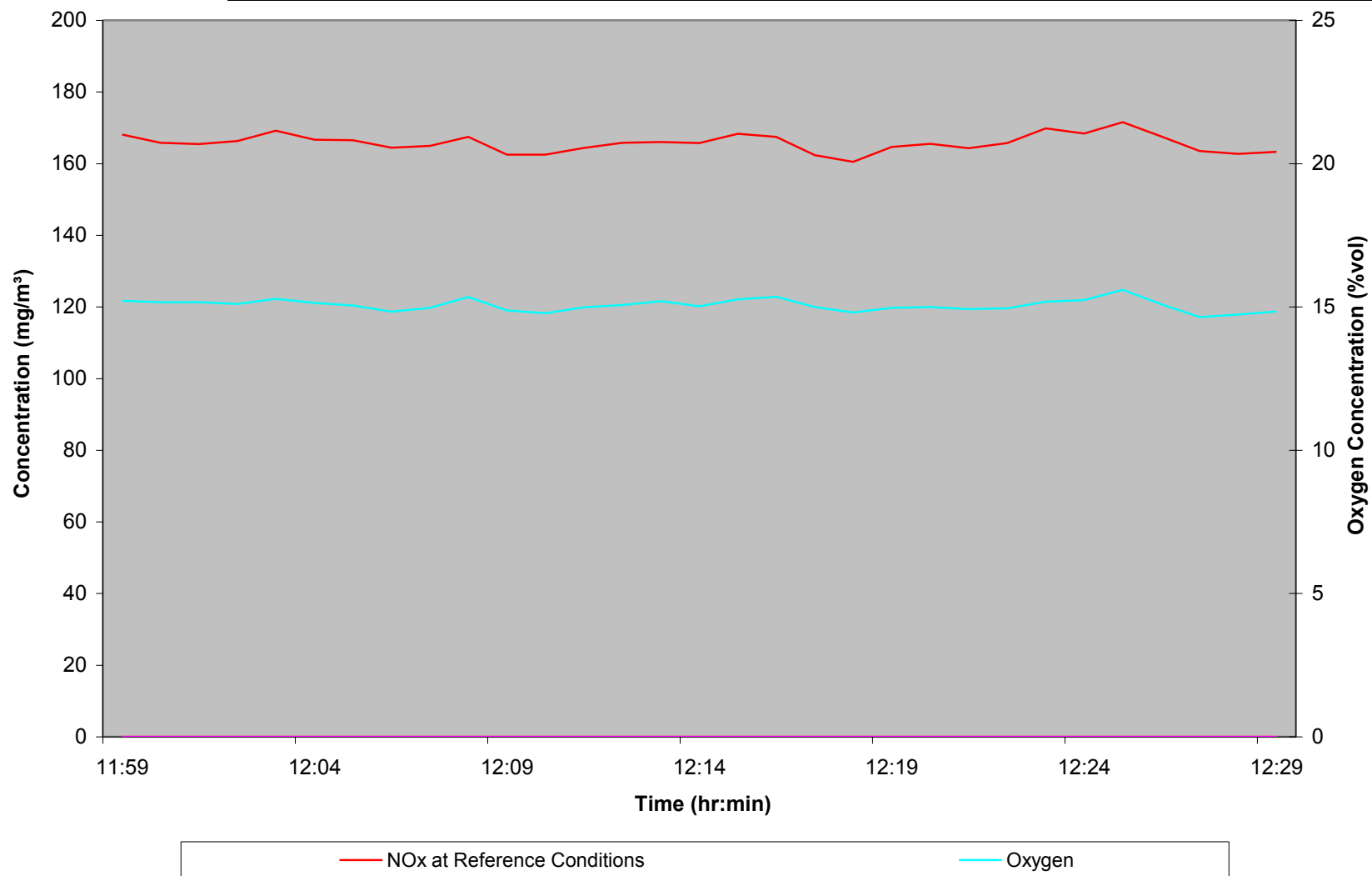
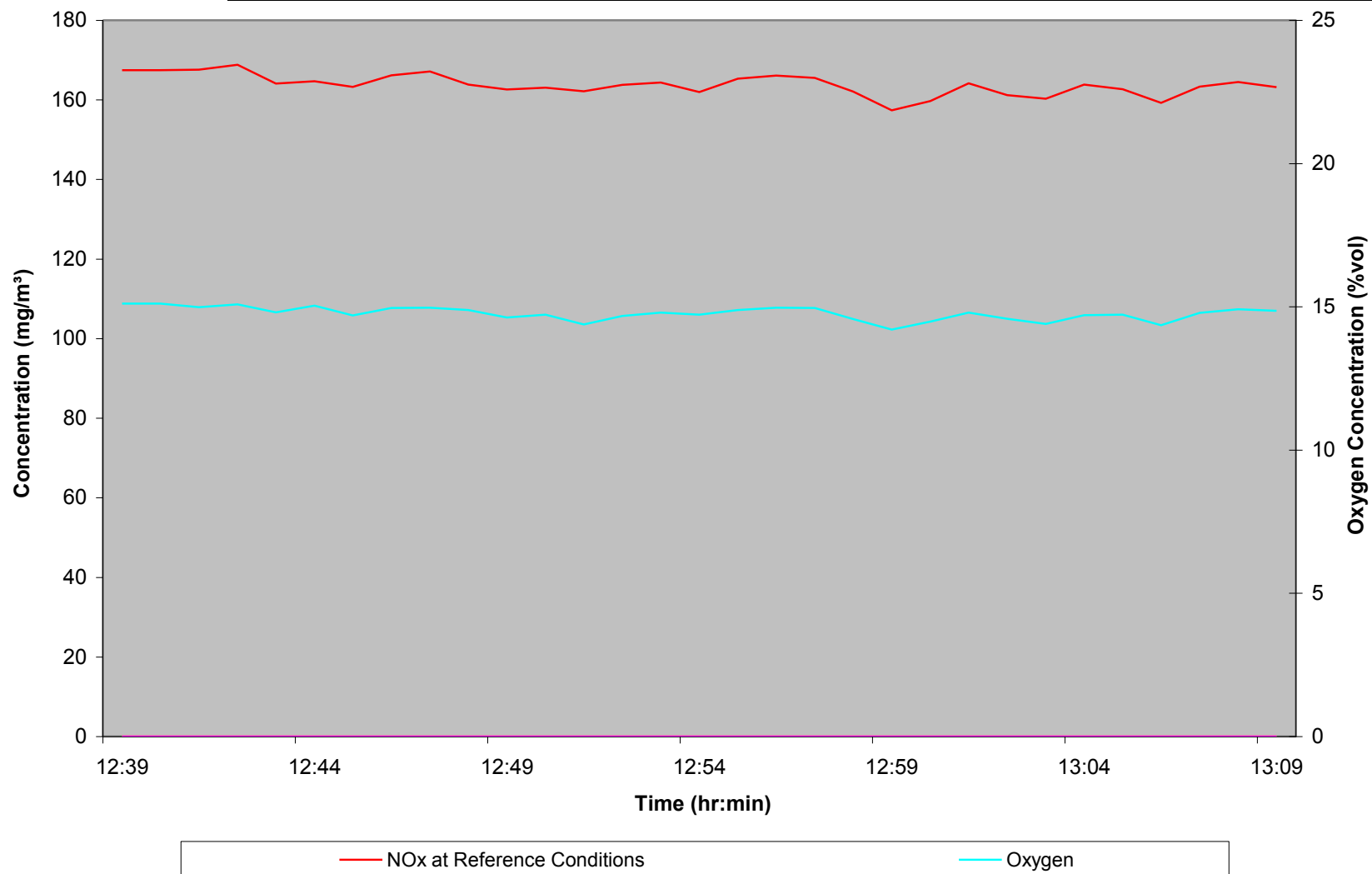


Fig 5: Combustion Gas Emission Data, piping Hot Cookers, Port Talbot, Faci 16 - Wood Pellet Fuel, Run 5 (06/03/14)



TABLES

TABLE 1
FLOW DATA

Stack Ref.	Stack Temp	Av Pitot ΔP	Duct Diam	X-Sect. Area	Velocity (actual)	Volume Flow (m ³ /hr)	
	(°C)	(Pa)	(cm)	(m ²)	(m/s)	(actual)	(@ ntp)
Faci 16	78	2	20	0.031	1.8	204	158

TABLE 2

PARTICULATE EMISSION DATA SUMMARY – FACI BOILER PELLET FUEL – RUN 1

DATE: 06/03/14

09:59 - 10:29

Sampling Data	
Run Time (min)	30
Total mass H ₂ O collected (g)	6.7
Pitot tube constant, C _p	0.84
Dry gas meter (DGM) volume (m ³)	0.184
Temperature DGM (°C)	15
Temperature stack (°C)	69
Mean pitot tube pressure drop, delta P (mm H ₂ O)	0.2
Orifice meter pressure drop, delta H (mm H ₂ O)	3.4
Barometric Pressure (kPa)	102.1
X-sectional area of stack (m ²)	0.031
Nozzle size (mm)	9.93
Flow Data	
Velocity, actual (m/s)	1.6
Velocity, ntp (m/s)	1.3
Vol. Flow, actual (m ³ /hr)	186
Vol. Flow, ntp (m ³ /hr)	149
Volume sampled, ntp, dry gas (m ³)	0.173
Volume sampled, ntp, wet gas (m ³)	0.181
Analytical Data	
Filter Weight Gain (mg)	3.1
Acetone Wash Residue Weight (mg)	0.7
Total Particulates (mg)	3.8
Partics Field Blank (mg)	0.7
Blank % of ELV	6.5
Emission Data	
O ₂ (%vol)	14.7
H ₂ O (% vol)	4.6
Percentage Isokinetic	98.5
Particulates (mg/m ³ at ref O ₂)	38.7
Uncertainty (± mg/m ³)	10.8
Particulates (g/GJ at 10% O ₂)	18.7

TABLE 3

PARTICULATE EMISSION DATA SUMMARY – FACI BOILER PELLET FUEL – RUN 2

DATE: 06/03/14

10:39 - 11:09

Sampling Data	
Run Time (min)	30
Total mass H ₂ O collected (g)	6.2
Pitot tube constant, C _p	0.84
Dry gas meter (DGM) volume (m ³)	0.178
Temperature DGM (°C)	18
Temperature stack (°C)	66
Mean pitot tube pressure drop, delta P (mm H ₂ O)	0.2
Orifice meter pressure drop, delta H (mm H ₂ O)	3.4
Barometric Pressure (kPa)	102.1
X-sectional area of stack (m ²)	0.031
Nozzle size (mm)	9.93
Flow Data	
Velocity, actual (m/s)	1.6
Velocity, ntp (m/s)	1.3
Vol. Flow, actual (m ³ /hr)	185
Vol. Flow, ntp (m ³ /hr)	150
Volume sampled, ntp, dry gas (m ³)	0.165
Volume sampled, ntp, wet gas (m ³)	0.173
Analytical Data	
Filter Weight Gain (mg)	2.6
Acetone Wash Residue Weight (mg)	0.9
Total Particulates (mg)	3.5
Partics Field Blank (mg)	0.7
Blank % of ELV	6.8
Emission Data	
O ₂ (%vol)	14.8
H ₂ O (% vol)	4.5
Percentage Isokinetic	93.6
Particulates (mg/m ³ at ref O ₂)	37.9
Uncertainty (± mg/m ³)	11.5
Particulates (g/GJ at 10% O ₂)	18.3

TABLE 4

PARTICULATE EMISSION DATA SUMMARY – FACI BOILER PELLET FUEL – RUN 3

DATE: 06/03/14

11:19 - 11:49

Sampling Data	
Run Time (min)	30
Total mass H ₂ O collected (g)	6.6
Pitot tube constant, C _p	0.84
Dry gas meter (DGM) volume (m ³)	0.189
Temperature DGM (°C)	20
Temperature stack (°C)	65
Mean pitot tube pressure drop, delta P (mm H ₂ O)	0.2
Orifice meter pressure drop, delta H (mm H ₂ O)	3.4
Barometric Pressure (kPa)	102.1
X-sectional area of stack (m ²)	0.031
Nozzle size (mm)	9.93
Flow Data	
Velocity, actual (m/s)	1.6
Velocity, ntp (m/s)	1.3
Vol. Flow, actual (m ³ /hr)	185
Vol. Flow, ntp (m ³ /hr)	150
Volume sampled, ntp, dry gas (m ³)	0.174
Volume sampled, ntp, wet gas (m ³)	0.182
Analytical Data	
Filter Weight Gain (mg)	3.8
Acetone Wash Residue Weight (mg)	1.3
Total Particulates (mg)	5.1
Partics Field Blank (mg)	0.7
Blank % of ELV	6.5
Emission Data	
O ₂ (%vol)	15.3
H ₂ O (% vol)	4.5
Percentage Isokinetic	98.6
Particulates (mg/m ³ at ref O ₂)	57.0
Uncertainty (± mg/m ³)	12.1
Particulates (g/GJ at 10% O ₂)	27.5

TABLE 5

PARTICULATE EMISSION DATA SUMMARY – FACI BOILER PELLET FUEL – RUN 4

DATE: 06/03/14

11:59 - 12:29

Sampling Data	
Run Time (min)	30
Total mass H ₂ O collected (g)	6.5
Pitot tube constant, C _p	0.84
Dry gas meter (DGM) volume (m ³)	0.189
Temperature DGM (°C)	21
Temperature stack (°C)	67
Mean pitot tube pressure drop, delta P (mm H ₂ O)	0.2
Orifice meter pressure drop, delta H (mm H ₂ O)	3.4
Barometric Pressure (kPa)	102.0
X-sectional area of stack (m ²)	0.031
Nozzle size (mm)	9.93
Flow Data	
Velocity, actual (m/s)	1.6
Velocity, ntp (m/s)	1.3
Vol. Flow, actual (m ³ /hr)	186
Vol. Flow, ntp (m ³ /hr)	150
Volume sampled, ntp, dry gas (m ³)	0.173
Volume sampled, ntp, wet gas (m ³)	0.181
Analytical Data	
Filter Weight Gain (mg)	3.2
Acetone Wash Residue Weight (mg)	1.2
Total Particulates (mg)	4.4
Partics Field Blank (mg)	0.7
Blank % of ELV	6.5
Emission Data	
O ₂ (%vol)	15.1
H ₂ O (% vol)	4.5
Percentage Isokinetic	98.3
Particulates (mg/m ³ at ref O ₂)	47.8
Uncertainty (± mg/m ³)	11.6
Particulates (g/GJ at 10% O ₂)	23.1

TABLE 6

PARTICULATE EMISSION DATA SUMMARY – FACI BOILER PELLET FUEL – RUN 5

DATE: 06/03/14

12:39 - 13:09

Sampling Data	
Run Time (min)	30
Total mass H ₂ O collected (g)	8.4
Pitot tube constant, C _p	0.84
Dry gas meter (DGM) volume (m ³)	0.184
Temperature DGM (°C)	21
Temperature stack (°C)	66
Mean pitot tube pressure drop, delta P (mm H ₂ O)	0.2
Orifice meter pressure drop, delta H (mm H ₂ O)	3.4
Barometric Pressure (kPa)	102.0
X-sectional area of stack (m ²)	0.031
Nozzle size (mm)	9.93
Flow Data	
Velocity, actual (m/s)	1.6
Velocity, ntp (m/s)	1.3
Vol. Flow, actual (m ³ /hr)	186
Vol. Flow, ntp (m ³ /hr)	150
Volume sampled, ntp, dry gas (m ³)	0.169
Volume sampled, ntp, wet gas (m ³)	0.179
Analytical Data	
Filter Weight Gain (mg)	4.4
Acetone Wash Residue Weight (mg)	1.5
Total Particulates (mg)	5.9
Partics Field Blank (mg)	0.7
Blank % of ELV	6.7
Emission Data	
O ₂ (%vol)	14.8
H ₂ O (% vol)	5.8
Percentage Isokinetic	96.8
Particulates (mg/m ³ at ref O ₂)	62.5
Uncertainty (± mg/m ³)	11.5
Particulates (g/GJ at 10% O ₂)	30.2

TABLE 7**COMBUSTION GAS EMISSION DATA SUMMARY - FACI BOILER - PELLETS RUN 1**

Stack Ref	O ₂	NOx (as NO ₂)		g/GJ @ 10% O ₂
	(%vol)	ppm	mg/m ³ @ ref O ₂	
Faci	14.7	46.3	168.2	81.3
Uncertainty (±)	0.9		28.9	

TABLE 8**COMBUSTION GAS EMISSION DATA SUMMARY - FACI BOILER - PELLETS RUN 2**

Stack Ref	O ₂	NOx (as NO ₂)		g/GJ @ 10% O ₂
	(%vol)	ppm	mg/m ³ @ ref O ₂	
Faci	14.8	44.6	162.6	78.5
Uncertainty (±)	0.9		28.9	

TABLE 9**COMBUSTION GAS EMISSION DATA SUMMARY - FACI BOILER - PELLETS RUN 3**

Stack Ref	O ₂	NOx (as NO ₂)		g/GJ @ 10% O ₂
	(%vol)	ppm	mg/m ³ @ ref O ₂	
Faci	15.3	42.6	169.5	81.9
Uncertainty (±)	0.9		31.5	

TABLE 10**COMBUSTION GAS EMISSION DATA SUMMARY - FACI BOILER - PELLETS RUN 4**

Stack Ref	O ₂	NOx (as NO ₂)		g/GJ @ 10% O ₂
	(%vol)	ppm	mg/m ³ @ ref O ₂	
Faci	15.1	43.3	165.7	80.0
Uncertainty (±)	0.9		30.4	

TABLE 11**COMBUSTION GAS EMISSION DATA SUMMARY - FACI BOILER - PELLETS RUN 5**

Stack Ref	O ₂	NO _x (as NO ₂)		
	(%vol)	ppm	mg/m ³ @ ref O ₂	g/GJ @ 10% O ₂
Faci	14.8	44.8	163.8	79.1
Uncertainty (±)	0.9		29.0	

APPENDIX 1

Certificate of Analysis



Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
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Tel : 0161 874 2400
Fax : 0161 874 2404

Report Number: 381580-1 Interim

Date of Report: 14-Mar-2014

Customer: Resource Environmental Consultants Ltd
Unit 19
Bordesley Trading Estate
Bordesley Green Road
Birmingham
B8 1BZ

Customer Contact: Mr David Burns

Customer Job Reference: 71753 MARCH

Customer Site Reference: Date Collected: 6/3/14

Date Job Received at SAL: 10-Mar-2014

Date Analysis Started: 11-Mar-2014

Date Analysis Completed:

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with QP22



1549

Report checked
and authorised by :

Issued by :
James Allan
Project Manager

SAL Reference: 381580 Project Site: Date Collected: 6/3/14 Customer Reference: 71753 MARCH Bulk Product Analysed as Bulk Product Miscellaneous					
SAL Reference					381580 013
Customer Sample Reference					71753/13
Test Sample					AR
Determinand	Method	LOD	Units	Symbol	
Moisture @ 105 C	Grav (1 Dec) (105 C)	0.1	%	N	-

SAL Reference: 381580 Project Site: Date Collected: 6/3/14 Customer Reference: 71753 MARCH									
Wash(Acetone)		Analysed as Wash(Acetone)							
Miscellaneous									
SAL Reference					381580 002	381580 004	381580 006	381580 008	381580 010
Customer Sample Reference					71753/2	71753/4	71753/6	71753/8	71753/10
Test Sample					AR	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol					
Particulates (Total)	Grav	0.3	mg	U	0.7	0.7	0.9	1.3	1.2

SAL Reference: 381580 Project Site: Date Collected: 6/3/14 Customer Reference: 71753 MARCH Wash(Acetone) Analysed as Wash(Acetone) Miscellaneous					
SAL Reference					381580 012
Customer Sample Reference					71753/12
Test Sample					AR
Determinand	Method	LOD	Units	Symbol	
Particulates (Total)	Grav	0.3	mg	U	1.5

SAL Reference: 381580									
Project Site: Date Collected: 6/3/14									
Customer Reference: 71753 MARCH									
Filter Quartz 110mm Analysed as Filter Quartz 110mm									
Miscellaneous									
SAL Reference					381580 001	381580 003	381580 005	381580 007	381580 009
Customer Sample Reference					71753/1	71753/3	71753/5	71753/7	71753/9
Test Sample					AR	AR	AR	AR	AR
Filter Reference					74	63	72	58	52
Determinand	Method	LOD	Units	Symbol					
Particulates (Total)	Grav (5 Dec)	0.10	mg	U	<0.10	3.1	2.6	3.8	3.2

SAL Reference: 381580 Project Site: Date Collected: 6/3/14 Customer Reference: 71753 MARCH Filter Quartz 110mm Analysed as Filter Quartz 110mm Miscellaneous					
SAL Reference					381580 011
Customer Sample Reference					71753/11
Test Sample					AR
Filter Reference					51
Determinand	Method	LOD	Units	Symbol	
Particulates (Total)	Grav (5 Dec)	0.10	mg	U	4.4

Index to symbols used in 381580-1 Interim

Value	Description
AR	As Received
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

APPENDIX 2

Diagram of Sampling Points

Faci Boiler



APPENDIX 3

Calculations

Conversion Factors

ppm @ mg/Nm³ (at 273K, 101.3kPa: STP)

CO	x	1.25	
SO ₂	x	2.86	
VOC's	x	1.61	(ppm as C ₃ H ₈ to mg/Nm ³ as C)
NO _x	x	2.05	(ppm NO + NO ₂ to mg/m ³ as NO ₂)

Oxygen Correction to Reference Value

Concentration at (STP) -> Concentration at 273K, 101.3kPa, reference O₂ and Dry Gas, i.e.

Concentration X ((20.9-O₂ ref)/(20.9-O₂ measured)) = Concentration at ref Oxygen state.

Example Calculation

SO ₂ concentration at STP	=	170.7 mg/Nm ³
Oxygen percentage in gas stream	=	13.8%
Reference Oxygen	=	11%
SO ₂ concentration at reference O ₂ conditions	=	170.7 ((20.9-11)/(20.9-13.8))
	=	238 mg/Nm ³ at 273K, 101.3kPa, 11% O ₂ and Dry Gas

Moisture Correction (Wet to Dry)

Concentration of Gas Dry = Concentration of x 100/100-Bws Gas Wet

Concentration of Gas Wet = Concentration of x 100-Bws/100 Gas Dry

Where Bws = moisture content of gas stream in percent (Vol/Vol).

Example

VOC concentration	=	25 mg/Nm ³ (Wet)
Moisture Content	=	27.1%
Concentration of VOC	=	25 (100/(100-27.1))

Conversion of emission concentration data (mg/m³) to emission factor (g/GJ)

Emission Factor in g/GJ = Concentration (mg/m³) x SDFGV / 1000

SDFGV (specific dry flue gas volume factor) for wood @ 10% O₂ at 273K, 101.3kPa = 483