2499

EMISSIONS MONITORING SURVEY

Prepared for:

Western Bio-Energy Ltd
Longlands Lane
Margam
Port Talbot
SA13 2NR

Permit Number	**: EPR/ZP3939GL**
Variation Number	**: V005**
Installation	**: Biomass Plant**
Visit Details	**: Compliance – May 2022**
Job Number	**: P5200**
Report Number	**: R002**
Report Issue Date	**: 13th July 2022**
Survey Dates	**: 10th to 12th & 19th to 20th May 2022**

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Report Issue:		**FINAL**	
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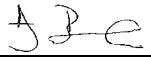
		Signature:	
Date:	7th July 2022	***Date:***	13th July 2022

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PART 1 - EXECUTIVE SUMMARY

1 Monitoring Objectives

Environmental Compliance Ltd (ECL) was commissioned by **Western Bio-Energy Ltd** to undertake an emission monitoring survey at their **Margam, Port Talbot** facility. This report presents the findings of the study.

The monitoring at this installation was carried out in accordance with our quotation reference **DHFB/P5200/Q001,** for compliance check monitoring of emissions to air. The substances requested for monitoring at each emissions point are listed below:

Substances to be monitored	Emission Point Identification
	Biomass Plant (Main Stack)
Particulates	• U
Velocity / Flowrate	• U
Oxides of Nitrogen (as NO_2)	• U
Sulphur Dioxide	• U
Carbon Monoxide	• U
Oxygen	• U
Total Organic Carbon (TVOC)	• U
Hydrogen Chloride	• U
Dioxins / Furans	• U
Heavy Metals (Cd, Tl, Sb, As, Pb, Cr, Co, Cu, Mn, Ni & V)	• U
Mercury	• U
Nitrous Oxide (N_2O)	• U
Ammonia	• U

• Denotes the substances to be monitored.

U **Denotes UKAS accreditation is held for monitoring that substance, but does not mean that it has been claimed which will depend on whether the testing could be completed in accordance with the Standard Reference Method.**

Special Requirements: *During Normal Operation.*

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

1.1 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Units	Uncertainty %	Reference Conditions 273 K, 101.3 kPa	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation Claimed For Test Result	Tick if non-conforming test (see Section 2)	Operating Status
Biomass Plant (Main Stack)	Volumetric Flowrate	...	42.19252	m^3/sec	4	Stack Conditions	10/05/2022	11:06 – 11:45	BS EN 16911-1:2013 & MID	UKAS / MCERTS		Normal
	Volumetric Flowrate	...	16.16126	m^3/sec	7	Dry & 6% O2	10/05/2022	11:06 – 11:45	BS EN 16911-1:2013 & MID	UKAS / MCERTS		Normal
	Particulates $	15	0.84	mg/m^3	53	Dry & 6% O2	19/05/2022	11:20 – 12:24	BS EN 13284-1:2017 & MID	UKAS / MCERTS		Normal
	Dioxin & Furans $	...	0.0032	ng/m^3	12	Dry & 6% O2	11/05/2022	09:15 – 15:20	BS EN 1948-1:2006 & MID	UKAS / MCERTS		Normal
	Heavy Metals* $	...	0.053	mg/m^3	5	Dry & 6% O2	19/05/2022	13:00 – 14:04	BS EN 14385:2004 & MID	UKAS / MCERTS		Normal
	Cadmium / Thallium $	...	0.0010	mg/m^3	5	Dry & 6% O2	19/05/2022	13:00 – 14:04	BS EN 14385:2004 & MID	UKAS / MCERTS		Normal
	Mercury $	...	0.00035	mg/m^3	10	Dry & 6% O2	19/05/2022	14:35 – 15:39	BS EN 13211:2001	UKAS / MCERTS		Normal
	Hydrogen Chloride $	...	0.10	mg/m^3	14	Dry & 6% O2	19/05/2022	11:20 – 12:24	BS EN 1911:2010	UKAS / MCERTS		Normal
	Ammonia $	10	0.10	mg/m^3	14	Dry & 6% O2	20/05/2022	11:35 – 12:35	BS EN ISO 21877:2019	UKAS / MCERTS		Normal
	Sulphur Dioxide $	...	19.41	mg/m^3	14	Dry & 6% O2	10/05/2022	12:00 – 16:00	BS EN 14791:2017	UKAS / MCERTS		Normal
	TVOC as Carbon	...	1.85	mgC/m^3	2	Dry & 6% O2	10/05/2022	13:40 – 14:40	BS EN 12619:2013	UKAS / MCERTS		Normal
	Oxides of Nitrogen (as NO_2)	300	270.12	mg/m^3	3	Dry & 6% O2	10/05/2022	12:00 – 13:00	BS EN 14792: 2017	UKAS / MCERTS		Normal
	Carbon Monoxide	250	216.05	mg/m^3	4	Dry & 6% O2	10/05/2022	12:00 – 13:00	BS EN 15058: 2017	UKAS / MCERTS	✓	Normal
	Oxygen (Paramagnetic)	...	10.31	%	2	Dry	10/05/2022	12:00 – 13:00	BS EN 14789: 2017	UKAS / MCERTS		
	Nitrous Oxide (N_2O)	...	0.27	mg/m^3	9	Dry & 6% O2	20/05/2022	11:35 – 12:35	PD CEN/TS 17337:2019	UKAS / MCERTS		Normal
	Oxygen (Zirconia Cell)	...	7.58	%	6	Dry	20/05/2022	11:35 – 12:35	BS EN 14789: 2017	UKAS / MCERTS		Normal

The volumetric flowrate shown above is that from the initial pitot traverse.
Any other flow measurements made during isokinetic sampling and/ or repeat traverses are shown later in the tables section.

(* Sum of Sb, As, Pb, Cr, Co, Cu, Mn, Ni & V)

Notes

The uncertainty figures presented in Table 1.1 for NO_x, CO, N_2O, O_2 & TVOC are "measurement uncertainty" figures, which do not take into account the variability of the measured sample values. The "uncertainty of measurement results" figures, which do include this contribution, are presented in the appendices of the report for these determinands.

Emission Limit Value	The emission limit value is that stated in the permit and will be expressed as a concentration or a mass emission.
Periodic Monitoring Result	The result given is expressed in the same terms and units as the emission limit value.
Uncertainty	The uncertainty associated with the quoted result is at the 95% confidence interval. The Uncertainty results **DO NOT** take into account the effect of the sample location limitations.
Reference Conditions	All results are expressed at 273 K and 101.3kPa. The oxygen and moisture corrections are stated.
Monitoring Method Reference	The method stated is in accordance with the Environment Agency Technical Guidance Note M2, or other method approved by the Environment Agency.
Accreditation for use of Method	**The details indicate the accreditation for the use of the complete monitoring method, e.g. MCERTs, UKAS. If use of the method is not accredited " NA" is stated.**
Operating Status	The details indicate the feedstock and the loading rate of the plant during monitoring.
$	Chemical Analysis on sample reagents was performed by an External Laboratory as detailed in Section 4
NU	UKAS Accreditation Held but UKAS Accreditation cannot be claimed for the test as sampling did not comply with the Standard Reference Method (SRM), see section 2 & 5
NA	**Method is NOT UKAS Accredited.**

1.2 Operating Information

Any operating information and CEMS data below has been supplied by the client.

Emission Point Reference	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results					
							Parameter	Date	Time	CEMS Results	Periodic Monitoring Results	Units
Biomass Plant	Continuous	Continuous	Wood Chip & Natural Gas	…	Bag Filters	Normal	…	…	…	NP	…	…

Notes:

Process Type	State whether the process is a continuous or batch process.
Process Duration	If a batch process, state the duration, frequency and details of the portion of the batch sampled. If continuous state "NA"
Fuel	If applicable, state the fuel type If not applicable state "NA"
Feedstock	State the feedstock type
Abatement	State the type and whether operational during monitoring. If not applicable state "NA"
Load	State the normal load, throughput or rating of the plant
CEMS Data	Enter this data for each CEM installed if it is has been provided by operator otherwise state “NP” (NOT PROVIDED)

2 Monitoring Deviations

The objective of the survey was to measure the concentrations of pollutants from the processes / locations as detailed in Section 1. This survey meets the requirements of the site's **PPC Permit Number: EPR/ZP3939GL** where UKAS and MCERTS accreditation has and could be claimed for the testing in the monitoring results table.

There were modifications to the sampling procedures (TPDs) listed in section 4, these are as follows:

The concentration of the span check gas used for FTIR sampling of N_2O has not been verified by analysis accredited to ISO 17025 with uncertainty <2%. Such analysis is not currently available. A gravimetrically prepared mixture was used instead. This deviation from the procedure has been sanctioned by the Environment Agency, until 17025 accredited gas does become available.

Due to high duct gas velocity, in order to maintain isokinetic sampling, it was necessary to use a nozzle with diameter smaller than the recommended minimum of 8mm minimum stated in BS EN 13284-1:2017. Note that there is no absolute minimum nozzle size stated in the standard, as long as the uncertainty of the nozzle area is <5%. **So this does not need to be described as a non-conforming test.**

There were no substance deviations from the original and agreed emissions monitoring schedule.

There were non-conforming tests, as follows.

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of non-conformities or sample location limitations.

During the sampling of Carbon Monoxide, some of the measured readings exceeded the selected range (100ppm) for a short period (12:17 – 12:31). The analyser is able to continue recording values during this period, but the range has not been linearised above 100ppm.

The following tests appeared to fail efficiency checks (>5% in final impinger): **HCl & NH3.** For **HCl**, the concentration in the final impinger was very low (at or below the analytical LOD / blank value, so the efficiency check is not required). For **NH3**, the efficiency check is not required, as, according to MCERTS requirements, this efficiency check requirement is only applicable where the concentration is above 30% of the ELV.

Homogeneity tests have not been completed for pollutants at the following locations: **Biomass Plant (Main Stack):** Such tests were not requested by the client.

PART 2 – SUPPORTING INFORMATION

3 SAMPLING STAFF DETAILS

Site Sampling Team

Names of Site Team	Dates on Site	MCERTS No.	LEVEL	Technical Endorsements
Peter Brockway	10th - 12th & 20th May 2022	MM 17 1459	2	TE1, TE2, TE3, TE4
Harry Round	19th & 20th May 2022	MM 14 1278	2	TE1, TE2, TE3, TE4
Llion Preskett Hughes	10th - 12th & 19th May 2022	MM 22 1689	Trainee	…

Report Reviewer

Name	MCERTS No.	LEVEL	Technical Endorsements
Andy Barnes	MM 03 235	2	TE1, TE2, TE3, TE4

Technical Endorsement Key:-

TE1 – **Isokinetic** Particulates, Temperature & Velocity Profiles, Oxygen.
TE2 – **Isokinetic** Extractive Pollutants:- Metals, Dioxin & Furans, PAHs, PCBs, HCl, HF.
TE3 – **Non-Isokinetic** Extractive Pollutants:- Speciated VOCs, HF, HCl, Cyanide.
TE4 – **Continuous Analysers** (Combustion Gases):- TVOC, CO, NOx, SO2.

4 SAMPLING PROTOCOLS / METHODOLOGIES

Details of the substances monitored, the standard methods used and the Environmental Compliance Limited Technical Procedures used during this survey are shown in the table below. Detailed sampling protocols are included in a separate document which will be sent with the report.

In all cases, where analysis of collected samples was required, the analysis was by a subcontract laboratory. Details of the sub-contract laboratory are shown on the analysis certificates in this report. The UKAS/MCERTs accreditation status of the analysis is also indicated on the certificates.

Any required modifications to the Technical Procedure Documents (TPDs) specified below will be detailed in section 2 of this report.

Determinand	External Reference Method	ECL Technical Procedure Number
Velocity and Flowrate	BS EN 16911-1:2013 & MID	ECL/ TPD/ 022A
Particulates (MST)	BS EN 13284-1:2017 &	ECL / TPD / 027
Metals (without mercury)	BS EN 14385:2004 & MID	ECL / TPD / 028
Mercury (without other metals)	BS EN 13211:2001	ECL / TPD / 030
Dioxins & Furans	BS EN 1948-1:2006	ECL / TPD / 031
TVOC (Signal 3030PM)	BS EN 12619: 2013	ECL / TPD / 032A
Oxygen (PG350E)	BS EN 14789: 2017	ECL / TPD / 033D
Carbon Monoxide (PG350E)	BS EN 15058: 2017	ECL / TPD / 033D
Oxides of Nitrogen (PG350E)	BS EN 14792: 2017	ECL / TPD / 033D
Hydrogen Chloride	BS EN 1911:2010	ECL / TPD / 081
Ammonia	BS EN ISO 21877:2019	ECL / TPD / 034
Sulphur Dioxide	BS EN 14791:2017	ECL / TPD / 039
Moisture	BS EN 14790: 2017	ECL / TPD / 082
Nitrous Oxide (N_2O) (FTIR 204M)	PD CEN/TS 17337:2019	ECL / TPD / 097
Oxygen (Protea 204M)	BS EN 14789: 2017	ECL / TPD / 097

5 SAMPLE POINT DESCRIPTIONS

The homogeneity test is applicable to combustion processes, but may also be requested by the regulator for non-combustion processes.

Homogeneity testing has not been completed at this location.

The test is not usually required for stacks with sampling plane areas of <1m^2 (below 1.13m in diameter for circular ducts).

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of non-conformities or sample location limitations.

The sample location that was monitored is detailed below:

Biomass Plant – Main Stack

The stack diameter is 1.60m and the sample platform width back from the sample ports is 3.0m.

Two sample ports are located on the stack at 90 degrees to each other and are located on the same plane.

These sample ports are located at a height of approximately 0.7m from the working sample platform.

Sampling for Particulates was carried out using an out-of-stack filter system.

Access to the sample platform was attained by means of hooped ladder accessed on the outside of the chimney.

EQUIPMENT IDs
(Pre site checklist from SSP)

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

(Completed before departure to site and when on site in full)

Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001	U005							
MST Nozzle set		1267							
MST "S" Type Pitot		666							
MST Probe		017							
MST Hot Box		192							
MST Impinger Arm		980							
		…							
Barometer		1220							
Site Balance		1069							
Site Check weights		190							
		191							
Horiba	E002	1266							
Heated Probe / Filter		1089							
Chiller		970							
MFC		…							
Heated Line		1090	1091						
FID	E003	301							
Heated Line		567	569						
Heated Probe / Filter		1190							
Testo	E004								
FTIR	E005	566							
Heated Probe / Filter		1089							
Heated Line		567	569						
Stackmite	E006								
"L" Type Pitot									
Digital Manometer									
Stack Thermocouple		018							
Thermocouple Reader									
Nozzle Set									
Workhorse Pumps	E007								
Stack Thermocouple									
Tube Thermocouple									
Meter Thermocouple									
High Vac Gauge									
Dioxin Thermocouple		424							

Quantity of Ice Required / Used for Survey	15	Bags (2kg bags)

FIGURES

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Figure 1 – TVOC

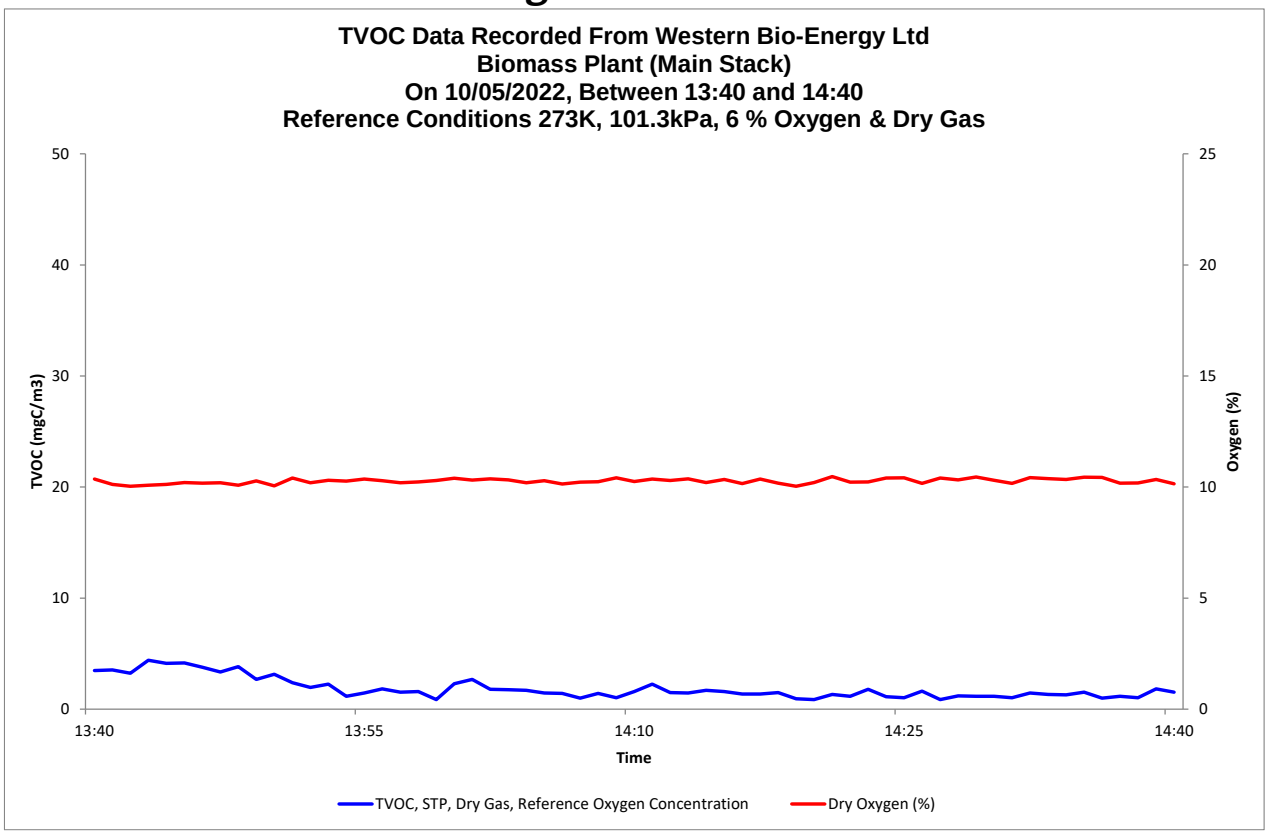


Figure 2 – NO_x, CO & O_2

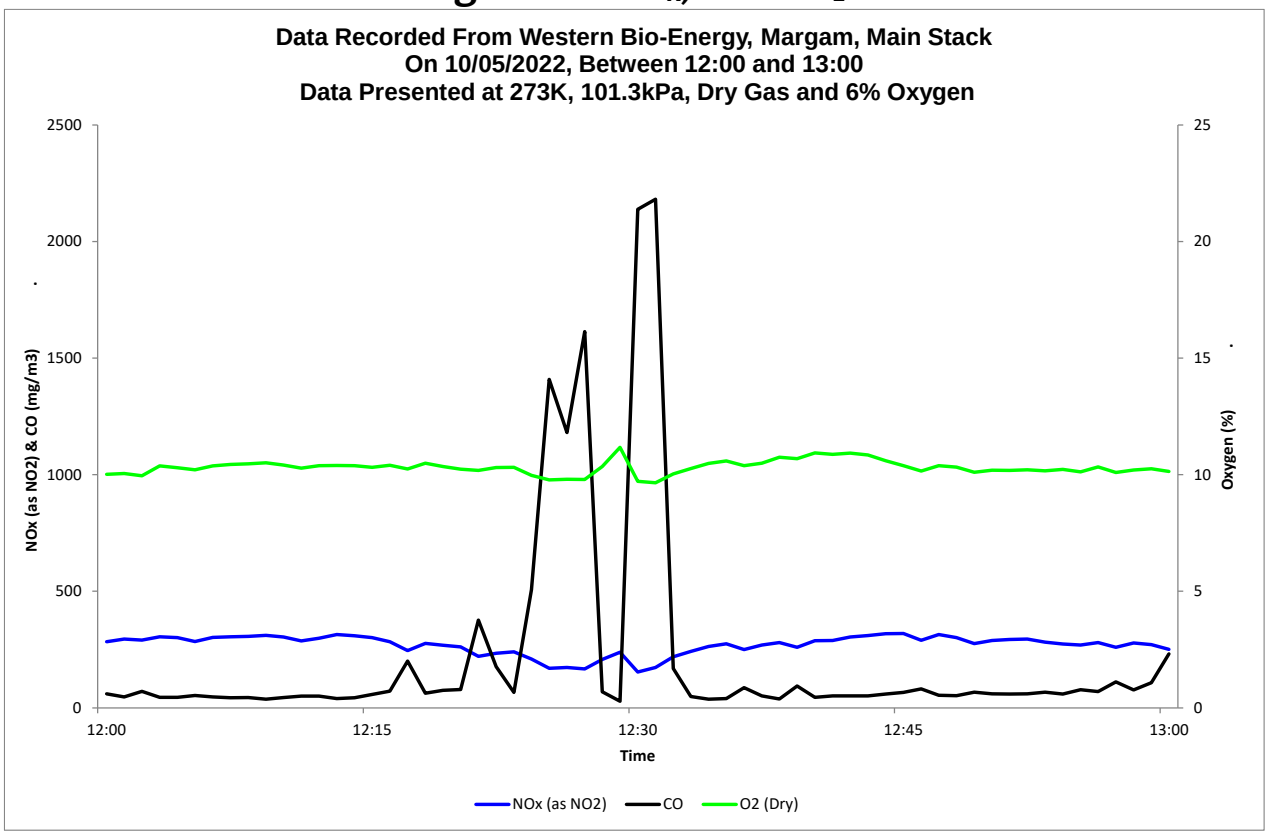
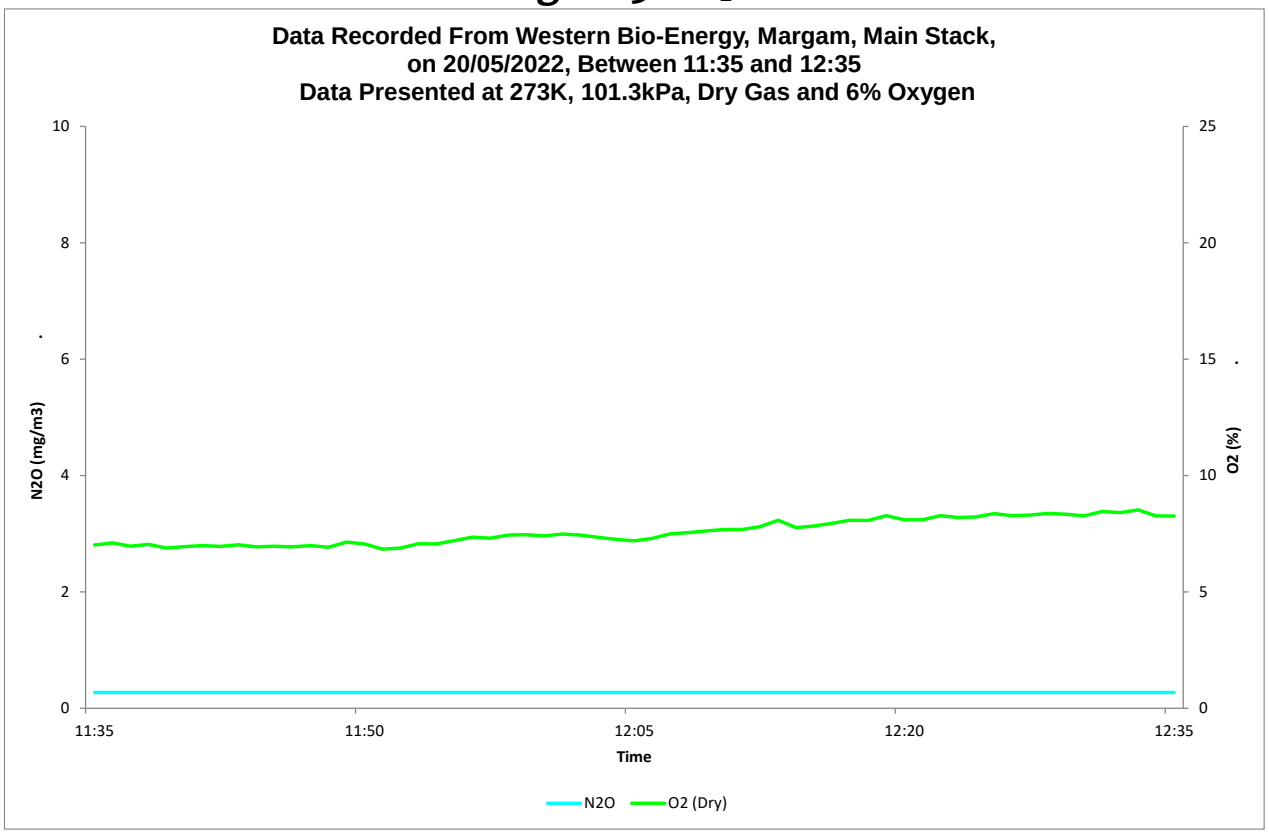


Figure 3 – N_2O


Data Recorded From Western Bio-Energy, Margam, Main Stack,
on 20/05/2022, Between 11:35 and 12:35
Data Presented at 273K, 101.3kPa, Dry Gas and 6% Oxygen
N2O (mg/m3)
O2 (%)
0
2
4
6
8
10
0
5
10
15
20
25
11:35
11:50
12:05
12:20
12:35
Time
N2O
O2 (Dry)

TABLES

Table 1 – TVOC

Data Recorded from Biomass Plant (Main Stack)

Sample Period: 13:40 – 14:40 on the 10th May 2022

Volumetric Flowrate (Reference Conditions) = 16.16126 m³/sec *

	Average	Emission Rate
	mg/m³	Kg/hr
TVOC (as carbon)*	1.85	0.1076

*** Reference Conditions (273K, 101.3 kPa, 6% Oxygen & Dry Gas)**

Table 2 – Nitrous Oxide

Data Recorded from Biomass Plant (Main Stack)

Sample Period: 11:35 – 12:35 on the 20th May 2022

Volumetric Flowrate (Reference Conditions) = 16.16126 m³/sec *

	Average	Emission Rate
	mg/m³	Kg/hr
Nitrous Oxide (N_2O)	0.27	0.0157

*** Reference Conditions (273K, 101.3 kPa, 6% Oxygen & Dry Gas)**

Table 3 – Combustion Gases

Data Recorded from Biomass Plant (Main Stack)

Sample Period: 12:00 – 13:00 on the 10th May 2022

Volumetric Flowrate (Reference Conditions) = 16.16126 m³/sec *

	Average	Emission Rate
	mg/m³	Kg/hr
Oxides of Nitrogen (as NO_2) *	270.12	15.7157
Carbon Monoxide *	216.05	12.5699
Oxygen (%)	10.31	…

*** Reference Conditions (273K, 101.3 kPa, 6% Oxygen & Dry Gas)**

Table 4 – Particulates & Hydrogen Chloride

Data Recorded from Main Stack - Biomass Plant

Emission Parameter	Units	TPM & HCl	Blank
Stack Diameter	metres	1.60	…
Area of Sample Plane	m^2	2.011	…
Moisture Content	%	16.48	…
Oxygen Content	%	7.16	…
Stack Temperature	^oC	132	…
Gas Velocity (as Measured. Adjusted for Smooth Walls)	m/sec	20.4935	…
Gas Velocity (Reference Conditions)	m/sec*	10.7427	…
Volumetric Flowrate (as Measured)	m^3/sec	41.2045	…
Volumetric Flowrate (Reference Conditions)	m^3/sec*	21.5994	…
Dry Gas Molecular Weight	g/gmole	30.4542	
Sample Date	…	19/05/2022	…
Sample Period	…	11:20 - 12:24	…
Sample Volume (reference Conditions)	m^3*	1.146	1.146
Isokinetic Sampling Rate	%	105.31	…
Sample Reference (ECL ID)	ECL/22/	2647 & 2648	2651 & 2652
Mass of Particulate Matter Collected	mg	0.96	0.60
Concentration of Particulate Matter	mg/m^3*	**0.84**	0.52
Emission Rate of Particulate Matter	g/hr	65.11	...
Expanded Uncertainty (% Relative)	%	53	...
Emission Limit Value (ELV)	mg/m^3*	15	…
Blank Concentration as Percentage of ELV	%	…	3.49
Sample Reference (ECL ID)	ECL/22/	2653/2654	2655
Mass of Hydrogen Chloride Collected	mg	0.12	0.02
Concentration of Hydrogen Chloride	mg/m^3*	**0.10**	0.02
Emission Rate of Hydrogen Chloride	g/hr	8.13	...
Expanded Uncertainty (% Relative)	%	14	...
Impinger Collection Efficiency	%	92	...

***Reference Conditions (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Table 5 – Dioxins & Furans

Data Recorded from Biomass Plant - Stack Main Stack

Emission Parameter	Units	Test Dioxins & Furans
Stack Diameter	**metres**	1.6
-	**-**	-
Area of sample plane	**m^2**	2.011
Moisture Content	**%**	20.62
Moisture Expanded Uncertainty	%(Relative)	5.21
Stack Temperature	**°C**	131
Oxygen Concentration	**%**	10.62
Gas velocity (as Measured)	**m/sec**	20.8876
Gas velocity (Reference Conditions)	**m/sec***	7.8003
Volumetric Flowrate (as Measured)	**m^3/sec**	41.9969
Volumetric Flowrate (Reference	**m^3/sec***	15.6833
Sample Date	11/05/2022	
Sample Period	09:15 - 15:20	
Sample Reference	ECL/22/2681 - 2683	
Sample Volume (Reference Conditions)	**m^3 ***	4.71
Isokinetic Sampling Rate	**%**	**99.28**

Species	Sample Reference: ECL/22/2681 - 2683		Blank Reference: ECL/22/2684 - 2686	
	Conc. ng/m³*	TEQ ng/m³*	Conc. ng/m³*	TEQ ng/m³*
Dioxins 2,3,7,8 Isomers	**0.059**	**0.0020**	**0.00051**	**0.000049**
Total Dioxins Non – Targeted	**0.00**	**…**	**0.00**	**…**
Furans 2,3,7,8 Isomers	**0.0085**	**0.0012**	**0.00042**	***0.000027***
Total Furans Non – Targeted Isomers	**0.00**	**…**	**0.00**	**…**
TOTAL	**…**	**0.0032**	**…**	**0.00008**
Range	**…**	**0.003 - 0.0032**	**Blank <10% of ELV?**	**NO**
% Uncertainty	**…**	**12**		

***Reference Conditions 273K, 101.3kPa, 6% Oxygen, Dry Gas. NB: For each congener, where the blank concentration exceeds or equals the measured concentration, the blank value has been substituted. Refer to the table of individual congeners for more detailed information.**

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
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Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Table 5b – Dioxins & Furans

Data Recorded from Biomass Plant - Stack Main Stack on the 11/05/22, 09:15 - 15:20

Species	Blank Reference: ECL/22/2684 - 2686 TEQ ng/m³*	EEC Toxic Equivalent Factor (TEF)	Sample Ref.: ECL/22/2681 - 2683 Concentration ng/m³*	Sample Ref.: ECL/22/2681 - 2683 TEQ ng/m³*	WHO Humans & Mammals (TEF)	Humans & Mammals TEQ ng/m³*	WHO Fish (TEF)	Fish TEQ ng/m³*	WHO Birds (TEF)	Birds TEQ ng/m³*
Dioxins - 2,3,7,8 Isomers										
2,3,7,8 - TCDD	0.000021	1	*0.00015*	*0.00015*	1	*0.00015*	1	*0.00015*	1	*0.00015*
1,2,3,7,8 - PeCDD	0.000021	0.5	**0.0011**	**0.00055**	1	**0.0011**	1	**0.0011**	1	**0.0011**
1,2,3,4,7,8 - HxCDD	0.000002	0.1	**0.0023**	**0.00023**	0.1	**0.00023**	0.5	**0.0011**	0.05	**0.00011**
1,2,3,6,7,8 - HxCDD	0.000002	0.1	**0.0048**	**0.00048**	0.1	**0.00048**	0.01	**0.000048**	0.01	**0.000048**
1,2,3,7,8,9 - HxCDD	0.000002	0.1	**0.0033**	**0.00033**	0.1	**0.00033**	0.01	**0.000033**	0.1	**0.00033**
1,2,3,4,6,7,8 - HpCDD	0.000000	0.01	**0.024**	**0.00024**	0.01	**0.00024**	0.001	**0.000024**	0.001	**0.000024**
OCDD	0.000000	0.001	**0.023**	**0.000023**	0.0001	**0.000002**	0	**…**	0	**…**
Total Dioxins - Non - Targeted Isomers										
TCDD	…	0	0.000000	…	0	…	0	…	0	…
PeCDD	…	0	0.000000	…	0	…	0	…	0	…
HxCDD	…	0	0.000000	…	0	…	0	…	0	…
HpCDD	…	0	0.000000	…	0	…	0	…	0	…
Furans - 2,3,7,8 Isomers										
2,3,7,8 - TCDF	0.000004	0.1	**0.0021**	**0.00021**	0.1	**0.00021**	0.05	**0.00011**	1	**0.0021**
1,2,3,7,8 - PeCDF	0.000001	0.05	**0.0013**	**0.000063**	0.05	**0.000063**	0.05	**0.000063**	0.1	**0.00013**
2,3,4,7,8 - PeCDF	0.000011	0.5	**0.0016**	**0.00082**	0.5	**0.00082**	0.5	**0.00082**	1	**0.0016**
1,2,3,4,7,8 - HxCDF	0.000002	0.1	*0.000085*	*0.000008*	0.1	*0.000008*	0.1	*0.000008*	0.1	*0.000008*
1,2,3,6,7,8 - HxCDF	0.000002	0.1	*0.000085*	*0.000008*	0.1	*0.000008*	0.1	*0.000008*	0.1	*0.000008*
2,3,4,6,7,8 - HxCDF	0.000002	0.1	*0.000085*	*0.000008*	0.1	*0.000008*	0.1	*0.000008*	0.1	*0.000008*
1,2,3,7,8,9 - HxCDF	0.000002	0.1	*0.00011*	*0.000011*	0.1	*0.000011*	0.1	*0.000011*	0.1	*0.000011*
1,2,3,4,6,7,8 - HpCDF	0.000002	0.01	**0.0020**	**0.000020**	0.01	**0.000020**	0.01	**0.000020**	0.01	**0.000020**
1,2,3,4,7,8,9 - HpCDF	0.000000	0.01	**0.00028**	**0.000003**	0.01	**0.000003**	0.01	**0.000003**	0.01	**0.000003**
OCDF	0.000000	0.001	**0.00087**	**0.000001**	0.0001	**0.000000**	0.0001	**0.000000**	0.0001	**0.000000**
Total Furans - Non - Targeted Isomers										
TCDF	…	0	0.000000	…	0	…	0	…	0	…
PeCDF	…	0	0.000000	…	0	…	0	…	0	…
HxCDF	…	0	0.000000	…	0	…	0	…	0	…
HpCDF	…	0	0.000000	…	0	…	0	…	0	…
TOTAL	**0.000076**	**…**	**…**	**0.0032**	**…**	**0.0037**	**…**	**0.0036**	**…**	**0.0057**
Range	**…**	**…**	**…**	**0.003 - 0.0032**	**…**	**0.0035 - 0.0037**	**…**	**0.0034 - 0.0036**	**…**	**0.0055 - 0.0057**
% Uncertainty	**…**	**…**	**…**	**12**	**…**	**13**	**…**	**16**	**…**	**16**

***Reference Conditions 273K, 101.3kPa, 6% Oxygen, Dry Gas. NB: For each congener, where the blank concentration exceeds or equals the measured concentration, the blank value has been substituted.This is presented as shaded cells. Where the Limit of Detection applies, concentrations are presented in italics.**

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Table 6 – Heavy Metals

Sampling Location: Biomass Plant Main Stack

Test Heavy Metals					
Stack Profile:	Circular	Units	Gas velocity (as Measured. Adjusted for Smooth Walls):	20.5437	m/sec
Diameter:	1.60	m	Gas velocity (Reference Conditions):	10.9620	m/sec *
			Volumetric Flowrate (as Measured):	41.3056	m^3/sec
Area of sample plane:	2.011	m^2	Volumetric Flowrate (Reference Conditions):	22.0403	m^3/sec *
Moisture Content:	16.71	%	Sample Date:	19/05/2022	
Stack Temperature:	132	°C	Sample Period:	13:00 - 14:04	
Barometric Pressure:	1020	mbar	Sample Volume:	1.166	m^3
Measured Oxygen:	6.86	%	Isokinetic Rate (95% < ISOKx > 115%):	105.03	%

***Reference Conditions: (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Trace Element	Symbol	Mass (mg)			ECL/22/2665 - 2668 Concentration (mg/m^3)*			Emission Rate (g/hr)*	Uncertainty (%)	ECL/22/2669 - 2672 Blank	
		Particulate Phase	Vapour Phase	Total Element Phase	Particulate Phase	Vapour Phase	Total Element Phase		Total Element Phase	Mass (mg)	Conc. (mg/m^3)
Antimony	Sb	0.00060	0.00015	0.00075	0.00051	0.00012	**0.00064**	**0.051**	13	0.00072	0.00062
Arsenic	As	0.0012	0.00022	0.0014	0.0010	0.00019	**0.0012**	**0.096**	11	0.00068	0.00058
Cadmium	Cd	0.00050	0.00015	0.00065	0.00043	0.00012	**0.00055**	**0.044**	11	0.00062	0.00053
Chromium	Cr	0.0077	0.00083	0.0085	0.0066	0.00071	**0.0073**	**0.58**	12	0.0040	0.0034
Cobalt	Co	0.00050	0.00015	0.00065	0.00043	0.00012	**0.00055**	**0.044**	11	0.00062	0.00053
Copper	Cu	0.0042	0.00029	0.0045	0.0036	0.00025	**0.0039**	**0.31**	12	0.00084	0.00072
Lead	Pb	0.012	0.00015	0.012	0.010	0.00012	**0.010**	**0.81**	14	0.00072	0.00062
Manganese	Mn	0.0046	0.00056	0.0052	0.0039	0.00048	**0.0044**	**0.35**	15	0.0013	0.0011
Nickel	Ni	0.028	0.00022	0.028	0.024	0.00019	**0.024**	**1.91**	13	0.020	0.017
Thallium	Tl	0.00040	0.00015	0.00055	0.00034	0.00012	**0.00047**	**0.037**	12	0.00052	0.00045
Vanadium	V	0.00060	0.000073	0.00067	0.00051	0.000062	**0.00058**	**0.046**	12	0.00046	0.00039
Cadmium & Thallium		0.00090	0.00029	0.0012	0.00077	0.00025	**0.0010**	**0.081**	5	0.0011	0.00098
Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel & Vanadium		0.059	0.0026	0.062	0.051	0.0022	**0.053**	**4.19**	5	0.029	0.025

No ELV Entered!

No ELV Entered!

Note: Uncertainty for each metals group is based on the summation in quadrature of the individual standard uncertainties (in mg/m^3) of each contributing metal. Combined standard uncertainty of each group is converted to 95% confidence (multiplication by k = 2) before being expressed as a percentage of the combined group concentration.

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Table 6b – Heavy Metals Efficiencies

Metals groups have been selected. Efficiencies will only be displayed for individual elements if the group total concentration is greater than 30% of the associated ELV.

Recovery in the final impinger must be <10% of the total combined element mass (i.e. filter, probe rinse & impingers) to pass - ONLY if the element makes up >1% of the total mass of all metals collected

Trace Element	Symbol	Final Impinger (%)	<10%?	<1% of Total?
Antimony	Sb	5.66	PASS	NO
Arsenic	As	4.46	PASS	NO
Cadmium	Cd	6.54	PASS	NO
Chromium	Cr	2.47	PASS	NO
Cobalt	Co	6.54	PASS	NO
Copper	Cu	1.88	PASS	NO
Lead	Pb	0.36	PASS	NO
Manganese	Mn	0.82	PASS	NO
Nickel	Ni	0.23	PASS	NO
Thallium	Tl	7.74	PASS	NO
Vanadium	V	3.14	PASS	NO

Combined Groups	ELV mg/m^3	Result <30% ELV?
Cadmium & Thallium	0	NO
Antimony, Arsenic, Chromium, Cobalt, Copper, Lead, Manganese, Nickel & Vanadium	0	NO

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Table 7 – Mercury

Sampling Location: Biomass Plant Main Stack

Test Mercury					
Stack Profile:	Circular	Units	Gas velocity (as Measured. Adjusted for Smooth Walls):	20.5262	m/sec
Diameter:	1.60	m	Gas velocity (Reference Conditions):	10.8381	m/sec *
			Volumetric Flowrate (as Measured):	41.2704	m^3/sec
Area of sample plane:	2.011	m^2	Volumetric Flowrate (Reference Conditions):	21.7912	m^3/sec *
Moisture Content:	16.52	%	Sample Date:	19/05/2022	
Stack Temperature:	134	°C	Sample Period:	14:35 - 15:39	
Barometric Pressure:	1020	mbar	Sample Volume:	1.148	m^3
Measured Oxygen:	6.97	%	Isokinetic Rate (95% < ISOKx > 115%):	104.60	%

***Reference Conditions: (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Trace Element	Symbol	Mass (mg)			ECL/22/2673 - 2676 Concentration (mg/m^3)*			Emission Rate (g/hr)*	Uncertainty (%)	ECL/22/2677 - 2680 Blank	
		Particulate Phase	Vapour Phase	Total Element Phase	Particulate Phase	Vapour Phase	Total Element Phase		Total Element Phase	Mass (mg)	Conc. (mg/m^3)
Mercury	Hg	0.00011	0.00029	0.00041	0.000098	0.00026	**0.00035**	**0.028**	10	0.00037	0.00032

No ELV Entered!

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Table 7b – Mercury Efficiencies

Groups have been selected. Efficiencies will only be displayed for mercury if the concentration is greater than 30% of the associated ELV.

Recovery in the final impinger must be <5% of the total combined element mass in both impingers to pass - ONLY if the final impinger has a concentration greated than 2µg/m^3

Trace Element	Symbol	Final Impinger (%)	<5%?	Final Impinger <2 µg/m^3?
Mercury	Hg	N/A	N/A	YES

Combined Groups	ELV mg/m^3	Result <30% ELV?
Mercury	0	NO

Table 8 – Ammonia

Data Recorded from Main Stack - Biomass Plant

Emission Parameter	Units	Ammonia	Blank	
Stack Diameter	metres	1.60		
Area of Sample Plane	m^2	2.011		
Moisture Content	%	16.81		
Oxygen Content	%	7.58		
Stack Temperature	°C	136		
Gas Velocity (as Measured)	m/sec	20.98		
Gas Velocity (Reference Conditions)	m/sec*	10.59		
Volumetric Flowrate (as Measured)	m^3/sec	42.19		
Volumetric Flowrate (Reference Conditions)	m^3/sec*	21.30		
Dry Gas Molecular Weight	g/gmole	30.47133616		
Sample Date	…	20/05/2022		
Sample Period	…	11:35 - 12:35		
Sample Volume (reference Conditions)	m^3*	0.775	0.775	
Sample Reference (ECL ID)	ECL/22/	2657/2658	2659	
Mass of Ammonia Collected	mg	0.08	0.04	
Concentration of Ammonia	mg/m^3*	**0.10**	0.05	
Emission Rate of Ammonia	g/hr	7.42	...	
Expanded Uncertainty (% Relative)	%	14	...	
Emission Limit Value (ELV)	mg/m^3*	10	…	
Impinger Collection Efficiency	%	73	...	(Conc < 30% ELV)
Blank Concentration as Percentage of ELV	%	…	<1.00%	

***Reference Conditions (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

Table 9 – Sulphur Dioxide

Data Recorded from Main Stack - Biomass Plant

Emission Parameter	Units	SO2	Blank
Stack Diameter	metres	1.60	
Area of Sample Plane	m^2	2.011	
Moisture Content	%	15.24	
Oxygen Content	%	10.28	
Stack Temperature	°C	131	
Gas Velocity (as Measured)	m/sec	20.98	
Gas Velocity (Reference Conditions)	m/sec*	8.61	
Volumetric Flowrate (as Measured)	m^3/sec	42.19	
Volumetric Flowrate (Reference Conditions)	m^3/sec*	17.30	
Dry Gas Molecular Weight	g/gmole	30.57923183	
Sample Date	…	10/05/2022	
Sample Period	…	12:00 - 16:00	
Sample Volume (reference Conditions)	m^3*	1.497	1.497
Sample Reference	ECL/22/	2661/2662	2663
Mass of Sulphur Dioxide Collected	mg	29.06	0.21
Concentration of Sulphur Dioxide	mg/m^3*	**19.41**	0.14
Emission Rate of Sulphur Dioxide	g/hr	1209.16	...
Expanded Uncertainty (% Relative)	%	14	...
Impinger Collection Efficiency	%	99	...

***Reference Conditions (273K, 101.3kPa, 6% Oxygen, Dry Gas)**

VELOCITY TRAVERSE PROFILES

Environmental Compliance Limited

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Environmental Compliance Limited	Traverse Data Profoma	Date of Measurement	10/05/2022

Company	Western Bio-Energy Ltd	Stack Diameter Port A (mm)	1600	Average Stack Diameter (mm)	1600	Pitot tube coefficient	0.84
Site	Margam	Stack Diameter Port B (mm)	1600	Port Length (mm)	210	Pitot Id	666
Location	Biomass Plant	Duct Length Port A (mm)		Average Duct Length (mm) L		Stack Thermocouple ID	018
Stack	Main Stack	Duct Length Port B (mm)		Duct width (mm) B		Stack Temp Reader ID	318
Job No	P5200	Duct Length Port C (mm)		Barometric Pressure. (mb)	1018	Manometer ID	316
Operators	PB & LPH	Duct Length Port D (mm)		Ave Static Press. (mm H_2O)	18.30	Barometer ID	1220

Pre - Traverse Checks Carried Out	Time	Pass/ Fail
Pre - Traverse PITOT Visual Inspection	11:06:00	Pass
Pre - Traverse PITOT Leak Check	11:08:00	Pass

Smooth Walls

Static Pressure Readings (mm H_2O)			
Port A	Port B	Port C	Port D
17.40	19.20		

Port/ Point	Distance to Point (mm)	Time	Temperature Readings (^oC)			(ΔP) Pitot Readings (mm H_2O)			Average Temp. (^oC)	Average (ΔP) (mm H_2O)	Swirl Test ^{o} From Reference
			1	2	3	1	2	3			
A1	70	11:12:00	130.0	130.0	130.0	24.20	23.80	23.60	130.0	23.87	10
A2	234	11:14:00	132.0	130.0	130.0	24.00	24.40	24.40	130.7	24.27	10
A3	473	11:16:00	130.0	132.0	132.0	26.00	26.00	26.00	131.3	26.00	8
A4	1127	11:18:00	131.0	131.0	132.0	30.00	30.00	30.00	131.3	30.00	8
A5	1366	11:20:00	134.0	132.0	132.0	30.00	30.00	30.00	132.7	30.00	8
A6	1530	11:22:00	134.0	132.0	132.0	32.00	32.00	32.00	132.7	32.00	9
B1	70	11:25:00	132.0	132.0	132.0	23.40	23.40	24.00	132.0	23.60	9
B2	234	11:27:00	130.0	131.0	131.0	24.60	24.60	24.40	130.7	24.53	9
B3	473	11:29:00	132.0	132.0	132.0	25.80	26.00	26.00	132.0	25.93	10
B4	1127	11:31:00	133.0	133.0	133.0	26.00	26.00	26.00	133.0	26.00	10
B4	1366	11:33:00	134.0	134.0	132.0	30.00	30.00	30.00	133.3	30.00	10
B6	1530	11:35:00	132.0	132.0	132.0	32.00	32.00	32.00	132.0	32.00	11
Blockage Check @ A1 (L-Type Pitot Only)									1581.7	328.2	Total
			Mean			Mean			133.3	32.0	Max
			Difference <5% from Initial ?			Difference <5% from Initial ?			130.0	23.6	Min
									131.8	27.4	Average

Stagnation Check (S-type Pitot Only)	Time	Reading
Static Pressure Via Positive Leg (mm H_2O)	11:38:00	19.20
Static Pressure Via Negative Leg (mm H_2O)	11:40:00	18.40
Difference (Pa) < 1 mm H_20 ?		-0.80

Post - Traverse Checks Carried Out	Time	Pass/ Fail
Post - Traverse PITOT Visual Inspection	11:43:00	Pass
Post - Traverse PITOT Leak Check	11:45:00	Pass

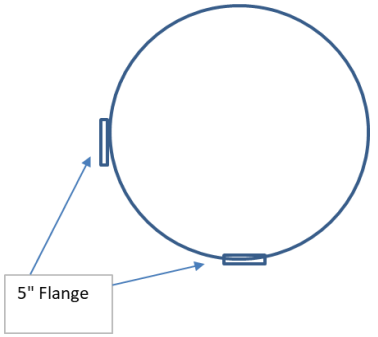
Average temp (K)	404.806

Suitability of Sampling Position	Actual Stack Conditions
Highest:lowest flow pressure ratio < 9:1?	1.37:1
Maximum deviation of flow from axis <15^o ?	11
X-sectional area for stacks= πr2	2.01 m^2
X-sectional area for ducts = L x B	m^2
Suitability of Position for Sampling	OK

Stack Moisture	20.62	%	Gas Velocity (as Measured) Adjusted for Smooth Walls	20.98484	m/sec
Measured Oxygen	10.31	%	Gas Velocity (Reference Conditions) Adjusted for Smooth Walls	8.03795	m/sec*
Measured Carbon Dioxide	13.55	%	Volumetric Flowrate (as Measured) Adjusted for Smooth Walls	42.19252	m^3/sec
Dry Gas Molecular Weight	30.58040	g/g mole	Volumetric Flowrate (Ref Cond) Adjusted for Smooth Walls	16.16126	m^3/sec*

*Reference Conditions: 273K, 101.3kPa, 6% Oxygen, Dry Gas NOTE: Velocity / volume flowrate calculations exclude contributions from the measurement point(s) where swirl >15°

Diagram/ Description of Cross Section of Stack/Duct



Notes

Including expected or actual deviations from procedures / non-conformities

Compliance With Positional Requirements?

Height of sample ports from Platform	0.70m
Number of sample ports	2
Width of platform (port back to handrail)	3.0m

Nearest downstream disturbance	Exit	15m
Nearest upstream disturbance	Bend	>5m

Disturbances are classed as bends, fans or diameter variations

FIELD CALIBRATION AND SAMPLING DATA

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

TVOC Calibration Site Log

TVOC - FIELD DATA SHEET

Client	Western Bio-Energy			Barometric Pressure mb	1018		
Site	Margam			Barometer ID	ECL/ID/ 1220		
Date	10/05/2022			Analyser ID	ECL/ID/ 301		
Location	Biomass Plant			Sonimix/ MFC ID	ECL/ID/		
Stack ID	Main Stack			Heated Line/ Controller ID	ECL/ID/ 567 / 569		
Stack Temp °C	135			Heated Line Set Temp °C	180	YES	
Ambient Temp (sampling)	1= 16	2= 16	3= 16	Heated Line Length	20	m	
Ambient Temp (sampling)	4= 16	5= 16	6= 16	Heated Probe Filter ID	ECL/ID/ 1190		
Job No	P5200			Heated Filter Set Temp °C	180	YES	
Operators	PB / LPH			Logger ID	928		

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)
Zero Gas (Synthetic Air)	Gas/ 2603	…	…
Hydrogen / Helium	Gas/ 2587	…	…
Propane (In Air)	Gas/ 2724	93.24 ppm	0.9324

	Analyser Range	Span Gas value used
Propane	100 ppm	93.24 ppm

Analyser Range should be not less than the expected peak emissions.

Span Gas Values should be **either** *approximately the half-hourly ELV* **OR** ***50%*** *to* ***90%*** *of the Selected Analyser Range.*

	Direct Calibration (Rear of Analyser)					
	Zero Cal		Span Gas Cal		Zero Check	
	Start Time	End Time	Start Time	End Time	Start Time	End Time
ZERO /SPAN/ ZERO	12:40	12:42	12:47	12:49	12:52	12:54

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

Pre-Cal Ambient Temp °C		PRE System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
16	16	Start Time	End Time	Start Time	End Time
ZERO / SPAN		12:57	13:00	13:05	13:07

Response Time SYSTEM Span Gas Cal		
Start Time	90% Time	less than 200s (Y/N)
13:01:20	13:02:05	Y

	Start Time	End Time	Location	Production Details
Sample Period	13:40	14:40	Main Stack	Normal
Sample Period				
Sample Period				
Sample Period				
Sample Period				
Sample Period				

Post-Cal Ambient Temp °C		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
16	16	Start Time	End Time	Start Time	End Time
ZERO / SPAN		14:45	14:47	14:50	14:52

Process Details / Comments

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

TVOC Calibration Summary

		TVOC ppm
Analyser Range		100
Repeatability at Zero		2
Span Gas Concentration Applied		93.24
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	93.2
	Zero	0.23
Difference (Zero)		0.2282
<2×Repeatability @ Zero?		YES
Pre Test (System)	Zero	0.12
	Span	92.4
Difference (Zero)		0.1247
<2% Relative to Direct Span		YES
Difference (Span)		0.8862
<2% Relative to Direct Span		YES
Post Test (System)	Zero	-0.15
	Span	93.4
Difference (Zero)		0.2786
Zero Drift <2% of Applied Span?		YES
Difference (Span)		1.0188
Span Drift <2% of Applied Span?		YES
Zero and Span Drift <5% of Applied Span?		YES

Western Bio-Energy Ltd			Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL		Visit Details	: Compliance – May 2022
Variation No	: V005		Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200	: R002	Report Issue Date	: 13th July 2022

Combustion Gases Calibration Summary (NO_x, CO, & O_2) 10/05/2022

	Horiba PG 350 Measurement Ranges:		
	NO as NO_2	CO	O_2
	512.5	125	25
Units	mg/m^3	mg/m^3	%Vol
	Zero Values (Direct)		
Mean Initial Direct Zero	0.02	0.78	0.01
Mean Confirmation Direct Zero	0.03	-0.13	-0.02
Difference in Direct Zero	0.01	0.91	0.03
Repeatability at Zero	4.10	1.25	0.20
<2 x Repeatability at Zero?	YES	YES	YES
	Pre Zero Values (System)		
Mean Pre Test Zero	0.06	-0.22	0.04
% of Measurement Range?	0.01%	-0.18%	0.17%
Detection Limit (LOD)	0.15	0.68	0.20
	Applied Span:		
	NO	CO	O_2
Actual Applied Span Concentration	316.52	75.14	15.02
	Pre Test System Zero Values		
Mean Pre Test System Zero	0.06	-0.22	0.04
Difference ≤ ± 2% of Span Value?	0.02%	0.30%	0.29%
	Post Test Direct Zero Values		
Mean Post Test Direct Zero	0.14	-0.33	0.08
% of Certified Range?	0.03%	-0.26%	0.34%
Zero Drift ≤ ± 5% of Applied Span?	0.04%	1.47%	0.49%
	Pre Test System Span Values		
Mean Pre Test System Span	313.39	74.78	14.97
Difference ≤ ± 2% of Span Value ?	0.99%	0.48%	0.32%
	Post Test Direct Span Values		
Mean Post Test Direct Span	313.21	75.35	15.03
Span Drift ≤ ± 5% Span Value?	1.05%	0.29%	0.04%

Western Bio-Energy Ltd			Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL		Visit Details	: Compliance – May 2022
Variation No	: V005		Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200	: R002	Report Issue Date	: 13th July 2022

Oxygen Calibration Summary
11/05/2022

	Horiba PG 350 Measurement Ranges:
	O_2
Units	25 %Vol
	Zero Values (Direct)
Mean Initial Direct Zero	0.01
Mean Confirmation Direct Zero	-0.02
Difference in Direct Zero	0.03
Repeatability at Zero	0.20
<2 x Repeatability at Zero?	YES
	Pre Zero Values (System)
Mean Pre Test Zero	0.12
% of Measurement Range?	0.48%
Detection Limit (LOD)	0.20
	Applied Span:
	O_2
Actual Applied Span Concentration	15.02
	Pre Test System Zero Values
Mean Pre Test System Zero	0.12
Difference ≤ ± 2% of Span Value?	0.80%
	Post Test Direct Zero Values
Mean Post Test Direct Zero	0.04
% of Certified Range?	0.16%
Zero Drift ≤ ± 5% of Applied Span?	0.19%
	Pre Test System Span Values
Mean Pre Test System Span	15.00
Difference ≤ ± 2% of Span Value ?	0.11%
	Post Test Direct Span Values
Mean Post Test Direct Span	15.11
Span Drift ≤ ± 5% Span Value?	0.60%

Western Bio-Energy Ltd			Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL		Visit Details	: Compliance – May 2022
Variation No	: V005		Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200	: R002	Report Issue Date	: 13th July 2022

Oxygen Calibration Summary
19/05/2022

	Horiba PG 350 Measurement Ranges:
	O_2
Units	25 %Vol
	Zero Values (Direct)
Mean Initial Direct Zero	0.07
Mean Confirmation Direct Zero	0.03
Difference in Direct Zero	0.04
Repeatability at Zero	0.20
<2 x Repeatability at Zero?	YES
	Pre Zero Values (System)
Mean Pre Test Zero	0.08
% of Measurement Range?	0.33%
Detection Limit (LOD)	0.20
	Applied Span:
	O_2
Actual Applied Span Concentration	15.02
	Pre Test System Zero Values
Mean Pre Test System Zero	0.08
Difference ≤ ± 2% of Span Value?	0.54%
	Post Test Direct Zero Values
Mean Post Test Direct Zero	-0.11
% of Certified Range?	-0.46%
Zero Drift ≤ ± 5% of Applied Span?	1.21%
	Pre Test System Span Values
Mean Pre Test System Span	14.89
Difference ≤ ± 2% of Span Value ?	0.84%
	Post Test Direct Span Values
Mean Post Test Direct Span	14.86
Span Drift ≤ ± 5% Span Value?	1.04%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Combustion Gases Calibration Summary (N_2O & O_2) 20/05/2022

	4M FTIR Certified	
	N_2O	O_2
Upper Limit of Certified Range	**39**	**20.9**
Units	**mg/m^3**	**%Vol**
	e System Zero Valu	
Mean Pre Test Zero	0.46	-0.27
% of Certified Range?	1.18%	-1.29%
Detection Limit (LOD)	0.57	0.20
LOD as % of Range (Maximum Allowed 2%)	1.47	0.96
	st System Zero Val	
Mean Post Test Zero	0.34	-0.08
% of Certified Range?	0.86%	-0.37%
Zero Drift ≤ ± 5% of Applied Span?	0.33%	0.51%

	Applied Span:	
	N_2O	O_2
Actual Applied Span Concentration	36.65	15.02
	Direct Span Values	
Mean Span Direct to Analyser		15.02
Deviation ≤ ± 5% Applied Concentration?	n/a	0.00%
	e System Span Valu	
Mean Pre Test Span	35.79	14.96
Difference ≤ ± 5% Applied Concentration?	2.34%	0.41%
Losses Due to Sampling System ≤ 5%?	n/a	0.41%
	t System Span Val	
Mean Post Test Span	36.06	14.79
Span Drift ≤ ± 5% Pre Span?	0.76%	1.50%

Particulates & Hydrogen Chloride

Environmental Compliance Limited	PARTICULATE DATA SAMPLING PROFORMA	Date of Measurement	19/05/2022
ECL/TPD/ 027 & 081	Time taken to change Ports? 4	Start Time 11:20	End Time 12:24
		Test Duration 60 mins	

Client	Weston Bio-Energy Ltd	Stack Profile	Circular	Console id	U005	Barometer id	1220	Impinger 1	DiH2O
Site	Margam	Stack Area (m^2)	2.01	Pump id	U005	Nozzle Id	1267	SOL/	4624
Location	Biomass Plant	Barometric Pressure (mb)	1020	Probe id	017	Nozzle size	5.97	Start Weight (g)	639.8
Stack ID	Main Stack	Static Pres. (mm $H_2$0)	18.3	DGM Yd	0.9635	Filter Id	3556-240572	End Weight (g)	761.5
Test No.	TPM & HCl	Pitot coefficient	0.84	ΔH@	47.33	Pitot ID	666	Total weight (g)	121.7
Job No	P5200	Probe Heater Setting (°C)	160	Impinger Id	980	Hot Box ID	192		
ECL Site Staff	HR / LPH	Hot Box Setting (°C)	160	Balance Id	1069			Impinger 2	DiH2O

IF SAMPLING FOR PARTICULATES NO LEAK CHECKS ARE ALLOWED AFTER SAMPLING HAS STARTED (NOT EVEN IF TRAIN IS BROKEN DOWN)
FOR OTHER SAMPLING (WITHOUT PARTICULATES) LEAK CHECKS ARE ALLOWED AFTER SAMPLING HAS STARTED (BUT ARE NOT MANDATORY)

Silica <50% Spent at End of Test? YES

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	3865313.0						
Final Volume	3866707.0						
Total Volume	1394.0	0.0	0.0	0.0	0.0	0.0	1394.0
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	-13						
Time of Check	11:10						
Set Rate l/min	20						
Leak <2%?	YES						

Original K Factor Settings	
Meter Temp.	25
Stack Temp	130
%Moisture	20.00
Dry O_2 (Atmospheric)	7.16
Dry Carbon Dioxide %	13.55
K factor	1.9
Reference Oxygen Percentage	6

Smooth Walls

Traverse Point	A1	A2	A3	A4	A5	A6	B6	B5	Total
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (mm H20)	22.20	23.00	24.40	30.00	30.00	32.00	30.00	30.00	27.70
K factor	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	
ΔH (Orifice)	42.18	43.70	46.36	57.00	57.00	60.80	57.00	57.00	52.63
Meter (Tm in)	21.00	22.00	23.00	24.00	25.00	26.00	26.00	26.00	24.13
Meter (Tm out)	21.00	22.00	23.00	24.00	25.00	26.00	26.00	26.00	24.13
Stack Temp (Ts)	131.00	131.00	131.00	131.00	131.00	132.00	132.00	132.00	131.38
Impinger T Outlet	6.00	6.00	6.00	7.00	7.00	7.00	8.00	8.00	6.88
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00

Traverse Point	B4	B3	B2	B1					Total
Time/Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔP (mm H20)	25.20	24.80	23.00	22.80					23.95
K factor	1.90	1.90	1.90	1.90					
ΔH (Orifice)	47.88	47.12	43.70	43.32					45.51
Meter (Tm in)	27.00	28.00	29.00	30.00					28.50
Meter (Tm out)	27.00	28.00	29.00	30.00					28.50
Stack Temp (Ts)	132.00	132.00	132.00	132.00					132.00
Impinger T Outlet	8.00	8.00	8.00	9.00					8.25
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00					-3.00

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Impinger 2	DiH2O
SOL/	4624
Start Weight (g)	660.2
End Weight (g)	714.1
Total weight (g)	53.9
Impinger3	DiH2O
SOL/	4624
Start Weight (g)	669.9
End Weight (g)	679.1
Total weight (g)	9.2
Impinger 4	Empty
SOL/	...
Start Weight (g)	531.6
End Weight (g)	534.9
Total weight (g)	3.3
Impinger 5	Silica
SOL/	...
Start Weight (g)	726.9
End Weight (g)	735.8
Total weight (g)	8.9
Impinger 6	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 7	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 8	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Total (g)	197.00

Rinse Solutions used	
Solution	SOL NO
DI Water	4624
Acetone	4540

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

Additional Moisture Weighings	
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

PRE-Sample PITOT Visual Inspection	
Time	11:03
Pass ? (Y/N)	Y
PRE-Sample PITOT Leak Check	
Time	11:05
Pass ? (Y/N)	Y

Post-Sample Blockage Check (L-type)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	
POST-Sample PITOT Visual Inspection	
Time	12:28
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	12:30
Pass ? (Y/N)	Y

Dioxins & Furans

	DIOXIN & FURANS DATA SAMPLING PROFORMA	Date of Measurement	11/05/2022
ECL/TPD/ 031	Time taken to change Ports? 5	Start Time 09:15	End Time 15:20
		Sample Time (mins) 360	

Client	Weston Bio-Energy Ltd	Stack Profile	Circular	Console ID	U005	Barometer ID	1220	Impinger 1	XAD
Site	Margam	Stack Area (m^2)	2.011	Pump ID	U005	Nozzle ID	1267	TRAP ID	213
Location	Biomass Plant	Barometric Pressure (mb)	1017	Probe ID	017	Nozzle size	5.97	Start Weight (g)	267.4
Stack ID	Main Stack	Static Pres. (mm $H_2$0)	18.30	DGM Yd	0.9635	Filter ID	GFA	End Weight (g)	269.8
Test No.	Dioxins & Furans	Pitot coefficient	0.84	DH@	47.33	Pitot ID	666	Total weight (g)	2.4
Job No	P5200	Probe Heater Setting (°C)	120	Impinger ID	980	Hot Box ID	192		
Operators	PB / LPH	Hot Box Setting (°C)	120	Balance ID	1069	XAD Therm ID	424	Impinger 2	Condenser

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	3855702.4	3859514.0					
Final Volume	3863465.2	3859526.8					
Total Volume	7762.8	12.8	0.0	0.0	0.0	0.0	7750.0
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.4	0.4	0.4				
Vaccum "Hg	10	8	8				
Time of Check	09:05	12:18	15:23				
Set Rate l/min	22	21.78	21.56				
Leak <4%?	YES	YES	YES				

Original K Factor Settings	
Meter Temp.	25
Stack Temp	130
%Moisture	20.00
Silica <50% Spent at End of Test?	Yes
Dry O_2 (Atmospheric)	10.62
Dry Carbon Dioxide %	13.55
K factor	1.9
Reference Oxygen Percentage	6

Smooth Walls

Leak check ALWAYS needs to be performed when moving between sample ports.
Leak check IS ALWAYS required on completion of the sample.

Traverse Point	A1	A1	A2	A2	A3	A3	A4	A4	Total
Time/Point(mins)	0 - 15	15 - 30	30 - 45	45 - 60	60 - 75	75 - 90	90 - 105	105 - 120	
DP (mm H20)	24.0	23.8	23.8	24.2	24.2	24.2	30.0	30.0	25.5
K factor	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	
DH (Orifice)	45.60	45.22	45.22	45.98	45.98	45.98	57.00	57.00	48.5
Meter (Tm in)	25.00	26.00	26.00	27.00	27.00	27.00	28.00	28.00	26.8
Meter (Tm out)	25.00	26.00	26.00	27.00	27.00	27.00	28.00	28.00	26.8
Stack Temp (Ts)	130.00	130.00	129.00	130.00	132.00	131.00	133.00	131.00	130.8
Impinger T Outlet	7.00	9.00	12.00	15.00	6.00	8.00	12.00	14.00	10.4
Vaccum (" Hg)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.0
XAD Temperature (°C)	4.00	7.00	9.00	11.00	5.00	8.00	9.00	10.00	7.9
Traverse Point	A5	A5	A6	A6	B1	B1	B2	B2	Total
Time/Point(mins)	120 - 135	135 - 150	150 - 165	165 - 180	180 - 195	195 - 210	210 - 225	225 - 240	
DP (mm H20)	30.0	30.0	30.0	32.0	23.2	23.2	24.4	24.6	27.2
K factor	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	
DH (Orifice)	57.00	57.00	57.00	60.80	44.08	44.08	46.36	46.74	51.6
Meter (Tm in)	29.0	29.0	29.0	30.0	30.0	30.0	30.0	31.0	29.8
Meter (Tm out)	29.0	29.0	29.0	30.0	30.0	30.0	30.0	31.0	29.8
Stack Temp (Ts)	130.0	130.0	129.0	130.0	130.0	131.0	132.0	131.0	130.4
Impinger T Outlet	7.0	9.0	12.0	16.0	7.0	8.0	11.0	14.0	10.5
Vaccum (" Hg)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
XAD Temperature (°C)	5.00	7.00	9.00	12.00	7.00	6.00	9.00	11.00	8.3
Traverse Point	B3	B3	B4	B4	B5	B5	B6	B6	Total
Time/Point(mins)	240 - 255	255 - 270	270 - 285	285 - 300	300 - 315	315 - 330	330 - 345	345 - 360	
DP (mm H20)	26.0	26.0	26.0	26.0	30.0	30.0	32.0	32.0	28.5
K factor	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	
DH (Orifice)	49.40	49.40	49.40	49.40	57.00	57.00	60.80	60.80	54.2
Meter (Tm in)	31.0	31.0	31.0	31.0	31.0	32.0	32.0	32.0	31.4
Meter (Tm out)	31.0	31.0	31.0	31.0	31.0	32.0	32.0	32.0	31.4
Stack Temp (Ts)	131.0	132.0	131.0	130.0	130.0	131.0	131.0	131.0	130.9
Impinger T Outlet	17.0	8.0	10.0	13.0	16.0	18.0	11.0	10.0	12.9
Vaccum (" Hg)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
XAD Temperature (°C)	13.00	6.00	8.00	10.00	11.00	14.00	7.00	9.00	9.8
Traverse Point									Total
Time/Point(mins)									
DP (mm H20)									
K factor									
DH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									
XAD Temperature (°C)									

Impinger 2	Condenser
Start Weight (g)	482.3
End Weight (g)	1311.3
Total weight (g)	829
Impinger3	Empty
Start Weight (g)	523.6
End Weight (g)	1003.2
Total weight (g)	479.6
Impinger 4	Empty
Start Weight (g)	544.8
End Weight (g)	598.7
Total weight (g)	53.9
Impinger 5	Silica
Start Weight (g)	781.4
End Weight (g)	836.5
Total weight (g)	55.1
Impinger 6	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 7	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Impinger 8	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Total (g)	1420

Rinse Solutions used	
Solution	SOL NO
DCM	4140
Acetone	4614
Toluene	4141

Additional Moisture Weighings	
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

PRE-Sample PITOT Visual Inspection	
Time	09:00
Pass ? (Y/N)	Y
PRE-Sample PITOT Leak Check	
Time	09:02
Pass ? (Y/N)	Y

Post-Sample Blockage Check (L-type)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	
POST-Sample PITOT Visual Inspection	
Time	15:26
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	15:28
Pass ? (Y/N)	Y

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Heavy Metals

METALS DATA SAMPLING PROFORMA — Date of Measurement: 19/05/2022

ECL/TPD/: 028 — Time taken to change Ports?: 4 — Start Time: 13:00 — Test Duration: 60 mins — End Time: 14:04

Client	Weston Bio-Energy Ltd	Stack Profile	Circular	Console id	U005	Barometer id	1220
Site	Margam	Stack Area (m²)	2.01	Pump id	U005	Nozzle Id	1267
Location	Biomass Plant	Barometric Pressure (mb)	1020	Probe id	017	Nozzle size	5.97
Stack ID	Main Stack	Static Pres. (mm H²0)	18.3	DGM Yd	0.9635	Filter Id	85mm QMA
Test No.	Heavy Metals	Pitot coefficient	0.84	ΔH@	47.33	Pitot ID	666
Job No	P5200	Probe Heater Setting (°C)	180	Impinger Id	980	Hot Box ID	192
ECL Site Staff	HR / LPH	Hot Box Setting (°C)	180	Balance Id	1069		

Rinse Solutions used

Solution	SOL NO
5% HNO3	4592

NB: Leak Check - Record Actual leak rate or '0' but not 'less than' values

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	3867525.0						
Final Volume	3868934.0						
Total Volume	1409.0	0.0	0.0	0.0	0.0	0.0	1409.0
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	-12						
Time of Check	12:55						
Set Rate l/min	20						
Leak <2%?	YES						

Smooth Walls

Original K Factor Settings

Meter Temp.	25
Stack Temp	130
%Moisture	20.00
Silica <50% Spent at End of Test?	YES
K factor	1.9
Reference Oxygen Percentage	6

Dry O_2 ☐ Atmospheric: 6.86 — Dry Carbon Dioxide %: 13.55

Leak checks DO NOT NEED to be performed (BUT ARE ALLOWED) at the and of the test or when moving between sample ports, EVEN when disconnections are made.

Traverse Point	A1	A2	A3	A4	A5	A6	B6	B5	Total
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (mm H20)	23.20	23.80	24.40	26.00	30.00	32.00	32.00	30.00	27.7
K factor	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	
ΔH (Orifice)	44.08	45.22	46.36	49.40	57.00	60.80	60.80	57.00	52.6
Meter (Tm in)	31.00	31.00	31.00	32.00	32.00	32.00	31.00	30.00	31.3
Meter (Tm out)	31.00	31.00	31.00	32.00	32.00	32.00	31.00	30.00	31.3
Stack Temp (Ts)	132.00	132.00	132.00	132.00	132.00	132.00	132.00	132.00	132.0
Impinger T Outlet	7.00	7.00	7.00	8.00	8.00	8.00	9.00	9.00	7.9
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3

Traverse Point	B4	B3	B2	B1					Total
Time/Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔP (mm H20)	26.00	24.40	23.40	23.00					24.2
K factor	1.90	1.90	1.90	1.90					
ΔH (Orifice)	49.40	46.36	44.46	43.70					46.0
Meter (Tm in)	29.00	28.00	27.00	26.00					27.5
Meter (Tm out)	29.00	28.00	27.00	26.00					27.5
Stack Temp (Ts)	132.00	132.00	132.00	132.00					132.0
Impinger T Outlet	10.00	10.00	11.00	12.00					10.8
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00					-3

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Impinger 1	HNO3 / H2O2
SOL/	4623
Start Weight (g)	587.7
End Weight (g)	733.2
Total weight (g)	145.5

Impinger 2	HNO3 / H2O2
SOL/	4623
Start Weight (g)	635.7
End Weight (g)	672.8
Total weight (g)	37.1

Impinger3	HNO3 / H2O2
SOL/	4623
Start Weight (g)	634.4
End Weight (g)	640.7
Total weight (g)	6.3

Impinger 4	Empty
SOL/	
Start Weight (g)	531.7
End Weight (g)	533.8
Total weight (g)	2.1

Impinger 5	Silica
SOL/	
Start Weight (g)	735.8
End Weight (g)	744.3
Total weight (g)	8.5

Impinger 6	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Impinger 7	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Total (g)	199.5

Pitot Quality Control Checks

PRE-Sample PITOT Visual Inspection	
Time	12:28
Pass ? (Y/N)	Y
PRE-Sample PITOT Leak Check	
Time	12:30
Pass ? (Y/N)	Y
Post-Sample Blockage Check (L-Type ONLY)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	
POST-Sample PITOT Visual Inspection	
Time	14:08
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	14:10
Pass ? (Y/N)	Y

Additional Moisture Weighings	
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Mercury

METALS DATA SAMPLING PROFORMA — Date of Measurement: 19/05/2022

ECL/TPD/: 030 — Time taken to change Ports?: 4 — Start Time: 14:35 — Test Duration: 60 mins — End Time: 15:39

Client	Weston Bio-Energy Ltd	Stack Profile	Circular	Console id	U005	Barometer id	1220
Site	Margam	Stack Area (m²)	2.01	Pump id	U005	Nozzle Id	1267
Location	Biomass Plant	Barometric Pressure (mb)	1020	Probe id	017	Nozzle size	5.97
Stack ID	Main Stack	Static Pres. (mm H²0)	18.3	DGM Yd	0.9635	Filter Id	85mm QMA
Test No.	Mercury	Pitot coefficient	0.84	ΔH@	47.33	Pitot ID	666
Job No	P5200	Probe Heater Setting (°C)	180	Impinger Id	980	Hot Box ID	192
ECL Site Staff	HR / LPH	Hot Box Setting (°C)	180	Balance Id	1069		

Rinse Solutions used

Solution	SOL NO
25% HNO3	...
5% HNO3	4592

NB: Leak Check - Record Actual leak rate or '0' but not 'less than' values

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	3869832.0						
Final Volume	3871198.0						
Total Volume	1366.0	0.0	0.0	0.0	0.0	0.0	1366.0
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	-11						
Time of Check	14:30						
Set Rate l/min	20						
Leak <2%?	YES						

Smooth Walls

Original K Factor Settings

Meter Temp.	25
Stack Temp	130
%Moisture	20.00
Silica <50% Spent at End of Test?	YES
K factor	1.9
Reference Oxygen Percentage	6

Dry O_2 ☐ Atmospheric: 6.97 — Dry Carbon Dioxide %: 13.55

Leak checks DO NOT NEED to be performed (BUT ARE ALLOWED) at the and of the test or when moving between sample ports, EVEN when disconnections are made.

Traverse Point	A1	A2	A3	A4	A5	A6	B6	B5	Total
Time/Point (mins)	0 - 5	5 - 10	10 - 15	15 - 20	20 - 25	25 - 30	30 - 35	35 - 40	
ΔP (mm H20)	23.60	24.00	24.20	26.00	30.00	30.00	30.00	30.00	27.2
K factor	1.90	1.90	1.90	1.90	1.90	1.90	1.90	1.90	
ΔH (Orifice)	44.84	45.60	45.98	49.40	57.00	57.00	57.00	57.00	51.7
Meter (Tm in)	22.00	22.00	23.00	23.00	23.00	24.00	24.00	23.00	23.0
Meter (Tm out)	22.00	22.00	23.00	23.00	23.00	24.00	24.00	23.00	23.0
Stack Temp (Ts)	134.00	134.00	134.00	134.00	134.00	134.00	134.00	134.00	134.0
Impinger T Outlet	8.00	7.00	7.00	8.00	9.00	10.00	10.00	11.00	8.8
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00	-3

Traverse Point	B4	B3	B2	B1					Total
Time/Point(mins)	40 - 45	45 - 50	50 - 55	55 - 60					
ΔP (mm H20)	26.00	25.00	24.00	23.60					24.7
K factor	1.90	1.90	1.90	1.90					
ΔH (Orifice)	49.40	47.50	45.60	44.84					46.8
Meter (Tm in)	23.00	23.00	23.00	23.00					23.0
Meter (Tm out)	23.00	23.00	23.00	23.00					23.0
Stack Temp (Ts)	134.00	134.00	134.00	134.00					134.0
Impinger T Outlet	11.00	12.00	13.00	13.00					12.3
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00					-3

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)									
K factor									
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Impinger 1	HNO3 / K2Cr2O7
SOL/	4622
Start Weight (g)	614.1
End Weight (g)	749.8
Total weight (g)	135.7

Impinger 2	HNO3 / K2Cr2O7
SOL/	4622
Start Weight (g)	668.7
End Weight (g)	713.8
Total weight (g)	45.1

Impinger3	Empty
SOL/	
Start Weight (g)	532.7
End Weight (g)	537.9
Total weight (g)	5.2

Impinger 4	Silica
SOL/	...
Start Weight (g)	744.3
End Weight (g)	753.6
Total weight (g)	9.3

Impinger 5	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Impinger 6	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Impinger 7	
SOL/	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Total (g)	195.3

Pitot Quality Control Checks

PRE-Sample PITOT Visual Inspection	
Time	14:08
Pass ? (Y/N)	Y
PRE-Sample PITOT Leak Check	
Time	14:10
Pass ? (Y/N)	Y
Post-Sample Blockage Check (L-Type ONLY)	
Time	
Reading (mm H_2O)	
Pass (<5%) ?	
POST-Sample PITOT Visual Inspection	
Time	15:45
Pass ? (Y/N)	Y
POST-Sample PITOT Leak Check	
Time	15:47
Pass ? (Y/N)	Y

Additional Moisture Weighings	
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0
Item Name	
Start Weight (g)	
End Weight (g)	
Total weight (g)	0

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Ammonia

Environmental Compliance Limited	NON ISOKINETIC SAMPLING PROFORMA	Date of Measurement	20/05/2022
ECL/TPD/ 034	Time taken to change Ports? 0	Start Time 11:35	End Time 12:35
		Test Duration	60 mins

If moisture was not measured see detailed notes below.

Client	Weston Bio-Energy Ltd	Stack Profile	Circular	Console id	U005	Barometer id	1220
Site	Margam	Stack Area (m^2)	2.01	Pump id	U005	Nozzle Id	n/a
Location	Biomass Plant	Barometric Pressure (mb)	1018	Probe id	017	Nozzle size	n/a
Stack ID	Main Stack	Static Pres. (mm H_20)	18.30	DGM Yd	0.9635	Filter Id	85mm QMA
Test No.	Ammonia	Pitot coefficient	n/a	ΔH@	47.33	Pitot ID	n/a
Job No	P5200	Probe Heater Setting (^OC)	160	Impinger Id	980	Hot Box ID	192
ECL Site Staff	HR / PB	Hot Box Setting (^OC)	160	Balance Id	1069		

For all parameters a leak check is OPTIONAL at the end of the test.
(and when moving between sample ports if any disconnections are required).

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	3873130.0						
Final Volume	3874087.0						
Total Volume	957.0	0.0	0.0	0.0	0.0	0.0	957.0
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.2						
Vaccum "Hg	-10						
Time of Check	11:25						
Set Rate l/min	15						
Leak <2%?	YES						

Required Sample Flowrate l/min	Suggested ΔH Entered Below
3	1
6	3
10	10
15	25
25	50
Initial ΔH	25
Reference Oxygen Percentage	6

Dry O_2 (Atmospheric)	7.58
Dry Carbon Dioxide %	13.55
Dry Carbon Monoxide ppm	172.84

Traverse Point	B3	B3	B3	B3	B3	B3			Total
Time/Point (mins)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60			
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	25.00	25.00	25.00	25.00	25.00	25.00			25.00
Meter (Tm in)	17.00	18.00	19.00	20.00	21.00	22.00			19.50
Meter (Tm out)	17.00	18.00	19.00	20.00	21.00	22.00			19.50
Stack Temp (Ts)	135.00	135.00	135.00	136.00	136.00	136.00			135.50
Impinger T Outlet	7.00	8.00	8.00	8.00	8.00	9.00			8.00
Vaccum (" Hg)	-3.00	-3.00	-3.00	-3.00	-3.00	-3.00			-3.00

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

	Impinger 1	Impinger 2	Impinger3	Impinger 4	Impinger 5	Impinger 6	Impinger 7	Impinger 8
Contents	0.1N H2SO4	0.1N H2SO4	0.1N H2SO4	Empty	Silica			
SOL/	4619	4619	4619					
Start Weight (g)	761.2	757.8	756.4	494.7	965.3			
End Weight (g)	853.2	785.2	762.3	495.7	979.7			
Total weight (g)	92	27.4	5.9	1	14.4	0	0	0

Total (g)	140.70
Silica <50% used at End of Test? Y/N	YES

Rinse Solutions used	
Solution	SOL NO
DI Water	4624
Acetone	…

Additional Moisture Weighings

	1	2	3	4	5	6	7	8	9	10
Item Name										
Start Weight (g)										
End Weight (g)										
Total weight (g)	0	0	0	0	0	0	0	0	0	0

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

Sulphur Dioxide

Environmental Compliance Limited	NON ISOKINETIC SAMPLING PROFORMA	Date of Measurement	10/05/2022
ECL/TPD/ 039	Time taken to change Ports? 0	Start Time 12:00	End Time 16:00
		Test Duration	240 mins

If moisture was not measured see detailed notes below.

Client	Weston Bio-Energy Ltd	Stack Profile	Circular	Console id	U005	Barometer id	1220
Site	Margam	Stack Area (m^2)	2.01	Pump id	U005	Nozzle Id	n/a
Location	Biomass Plant	Barometric Pressure (mb)	1018	Probe id	017	Nozzle size	n/a
Stack ID	Main Stack	Static Pres. (mm H_20)	18.30	DGM Yd	0.9635	Filter Id	UW QMA
Test No.	SO2	Pitot coefficient	n/a	ΔH@	47.33	Pitot ID	n/a
Job No	P5200	Probe Heater Setting (^OC)	160	Impinger Id	980	Hot Box ID	192
ECL Site Staff	PB / LPH	Hot Box Setting (^OC)	160	Balance Id	1069		

For all parameters a leak check is OPTIONAL at the end of the test.
(and when moving between sample ports if any disconnections are required).

	Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total
Start Volume	3852758.6						
Final Volume	3855126.4						
Total Volume	2367.8	0.0	0.0	0.0	0.0	0.0	2367.8
Leak Check	First	Second	Third	Fourth	Fifth		
Leak rate l/min	0.1						
Vaccum "Hg	10						
Time of Check	11:50						
Set Rate l/min	10						
Leak <2%?	YES						

Required Sample Flowrate l/min	Suggested ΔH Entered Below
3	1
6	3
10	10
15	25
25	50
Initial ΔH	10
Reference Oxygen Percentage	6

Dry O_2 (Atmospheric)	10.28
Dry Carbon Dioxide %	13.55
Dry Carbon Monoxide ppm	172.84

Traverse Point	A4	A4	A4	A4	A4	A4	A4	A4	Total
Time/Point (mins)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)	23.00	23.00	24.00	24.00	24.00	25.00	25.00	25.00	24.13
Meter (Tm out)	23.00	23.00	24.00	24.00	24.00	25.00	25.00	25.00	24.13
Stack Temp (Ts)	132.00	132.00	132.00	132.00	131.00	131.00	130.00	130.00	131.25
Impinger T Outlet	6.00	8.00	9.00	10.00	12.00	14.00	5.00	6.00	8.75
Vaccum (" Hg)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Traverse Point	A4	A4	A4	A4	A4	A4	A4	A4	Total
Time/Point(mins)	80 - 90	90 - 100	100 - 110	110 - 120	120 - 130	130 - 140	140 - 150	150 - 160	
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)	25.00	26.00	26.00	26.00	26.00	26.00	27.00	27.00	26.13
Meter (Tm out)	25.00	26.00	26.00	26.00	26.00	26.00	27.00	27.00	26.13
Stack Temp (Ts)	131.00	132.00	132.00	132.00	131.00	131.00	132.00	132.00	131.63
Impinger T Outlet	7.00	8.00	10.00	12.00	15.00	6.00	7.00	7.00	9.00
Vaccum (" Hg)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Traverse Point	A4	A4	A4	A4	A4	A4	A4	A4	Total
Time/Point(mins)	160 - 170	170 - 180	180 - 190	190 - 200	200 - 210	210 - 220	220 - 230	230 - 240	
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)	27.00	27.00	27.00	27.00	28.00	28.00	28.00	28.00	27.50
Meter (Tm out)	27.00	27.00	27.00	27.00	28.00	28.00	28.00	28.00	27.50
Stack Temp (Ts)	132.00	132.00	132.00	131.00	131.00	131.00	130.00	131.00	131.25
Impinger T Outlet	8.00	10.00	12.00	15.00	6.00	6.00	8.00	10.00	9.38
Vaccum (" Hg)	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00

Traverse Point									Total
Time/Point(mins)									
ΔP (mm H20)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)									
Meter (Tm in)									
Meter (Tm out)									
Stack Temp (Ts)									
Impinger T Outlet									
Vaccum (" Hg)									

	Impinger 1	Impinger 2	Impinger3	Impinger 4	Impinger 5	Impinger 6	Impinger 7	Impinger 8
Contents	3% H2O2	3% H2O2	3% H2O2	Empty	Silica			
SOL/	4625	4625	4625					
Start Weight (g)	591.5	640.2	637.8	531.6	746.2			
End Weight (g)	759.8	695.6	672.2	533.1	789.3			
Total weight (g)	168.3	55.4	34.4	1.5	43.1	0	0	0

Total (g)	302.70
Silica <50% used at End of Test? Y/N	YES

Rinse Solutions used	
Solution	SOL NO
DI Water	4624
Acetone	…

Additional Moisture Weighings

	1	2	3	4	5	6	7	8	9	10
Item Name										
Start Weight (g)										
End Weight (g)										
Total weight (g)	0	0	0	0	0	0	0	0	0	0

If moisture was not measured and gas was dried before entering the gas meter, impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then impinger weights may be included to produce a nominal 0.1% moisture value.

LABORATORY ANALYSIS RESULTS

Laboratory analysis for Particulates, Hydrogen Chloride, Sulphur Dioxide, Ammonia, Heavy Metals & Mercury was subcontracted to RPS laboratories, a UKAS Accredited Testing Laboratory, Number 0605.

RPS DO hold UKAS & MCERTS accreditation for this analysis.

As required by the MCERTS Performance Standard for Organisations, the analysis results are shown below.

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Results Summary
Report No.: 22-06616-1

Customer Reference: Not Supplied
Customer Order No: C4660 P5200

Customer Sample No	ECL/22/2647	ECL/22/2648	ECL/22/2649	ECL/22/2650	ECL/22/2651	ECL/22/2652
Customer Sample ID						
RPS Sample No	111280	111281	111282	111283	111284	111285
Sample Type	**SOLID**	**LIQUID**	**SOLID**	**LIQUID**	**SOLID**	**LIQUID**
Sample Matrix	FILTER	SOLUTION	FILTER	SOLUTION	FILTER	SOLUTION
Sample Depth (m)	-	-	-	-	-	-
Sampling Date	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022	27/05/2022
Sampling Time	16:00	16:00	16:00	16:00	16:00	16:00

Determinand	CAS No	Codes	SOP	RL	Units						
particulates		UM	D9	0.04	mg	0.26		S/C		S/C	
particulates		UM	D9	0.5	mg		0.7		< 0.5		< 0.5

Comments

Report No.: 22-06616-1

Customer Reference: Not Supplied

Customer Order No: C4660 P5200

RPS Sample Number	Customer Number	Sample Comments
111282	ECL/22/2649	<0.1 mg
111284	ECL/22/2651	<0.1 mg

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Results Summary
Report No.: 22-06617-1
Customer Reference: Not Supplied
Customer Order No: C4660 P5200

Customer Sample No				ECL/22/2653	ECL/22/2654	ECL/22/2655	ECL/22/2656
Customer Sample ID							
RPS Sample No				111286	111287	111288	111289
Sample Type				**LIQUID**	**LIQUID**	**LIQUID**	**LIQUID**
Sample Matrix				SOLUTION	SOLUTION	SOLUTION	SOLUTION
Sample Depth (m)				-	-	-	-
Sampling Date				19/05/2022	19/05/2022	19/05/2022	19/05/2022
Sampling Time				16:00	16:00	16:00	16:00
Determinand	**CAS No**	**Codes**	**SOP**	**RL**	**Units**		
volume of sample supplied		U	N/A	n/a	ml	647	198	370	393
hydrogen chloride	7647-01-0	UM	C27	0.05	ug/mL	0.17	< 0.05	< 0.05	< 0.05

Results Summary
Report No.: 22-06621-1
Customer Reference: Not Supplied
Customer Order No: C4660 P5200

Customer Sample No				ECL/22/2661	ECL/22/2662	ECL/22/2663	ECL/22/2664
Customer Sample ID							
RPS Sample No				111326	111327	111328	111329
Sample Type				**LIQUID**	**LIQUID**	**LIQUID**	**LIQUID**
Sample Matrix				SOLUTION	SOLUTION	SOLUTION	SOLUTION
Sample Depth (m)				-	-	-	-
Sampling Date				10/05/2022	10/05/2022	10/05/2022	10/05/2022
Sampling Time				16:00	16:00	16:00	16:00
Determinand	**CAS No**	**Codes**	**SOP**	**RL**	**Units**		
volume of sample supplied		U	N/A	n/a	ml	622	322	347	347
sulphur dioxide	7446-09-5	UM	C27	0.05	ug/mL	46.4	0.63	0.60	0.57

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Results Summary
Report No.: 22-06619-1
Customer Reference: Not Supplied
Customer Order No: C4660 P5200

Customer Sample No	ECL/22/2657	ECL/22/2658	ECL/22/2659	ECL/22/2660
Customer Sample ID				
RPS Sample No	111320	111321	111322	111323
Sample Type	**LIQUID**	**LIQUID**	**LIQUID**	**LIQUID**
Sample Matrix	SOLUTION	SOLUTION	SOLUTION	SOLUTION
Sample Depth (m)	-	-	-	-
Sampling Date	20/05/2022	20/05/2022	20/05/2022	20/05/2022
Sampling Time	16:00	16:00	16:00	16:00

Determinand	CAS No	Codes	SOP	RL	Units				
volume of sample supplied		U	N/A	n/a	ml	550	200	400	395
ammonia	7664-41-7	UM	A6	0.1	ug/mL	< 0.1	< 0.1	< 0.1	< 0.1

Environmental Compliance Limited

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

Results Summary

Report No.: 22-06623-2

Customer Reference: Not Supplied

Customer Order No: C4660 P5200

Customer Sample No						ECL/22/2665	ECL/22/2666	ECL/22/2667	ECL/22/2668	ECL/22/2669	ECL/22/2670	ECL/22/2671	ECL/22/2672
RPS Sample No						111332	111333	111334	111335	111336	111337	111338	111339
Sample Type						SOLID	LIQUID	LIQUID	LIQUID	SOLID	LIQUID	LIQUID	LIQUID
Sample Matrix						FILTER	SOLUTION	SOLUTION	SOLUTION	FILTER	SOLUTION	SOLUTION	SOLUTION
Determinand	CAS No	Code	SOP	RL	Unit	Column1	Column2	Column3	Column4	Column5	Column6	Column7	Column8
antimony	7440-36-0	UM	M31	0.4	ug	< 0.4				< 0.4			
antimony	7440-36-0	UM	M31	0.2	ug		< 0.2				< 0.2		
antimony	7440-36-0	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2
arsenic	7440-38-2	UM	M31	0.2	ug	0.9				< 0.2			
arsenic	7440-38-2	UM	M31	0.3	ug		0.3				< 0.3		
arsenic	7440-38-2	UM	M31	0.3	ug/L			< 0.3	< 0.3			< 0.3	< 0.3
cadmium	7440-43-9	UM	M31	0.2	ug	< 0.2				< 0.2			
cadmium	7440-43-9	UM	M31	0.3	ug		< 0.3				< 0.3		
cadmium	7440-43-9	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2
chromium	7440-47-3	UM	M31	0.3	ug	3.2				3.1			
chromium	7440-47-3	UM	M31	0.3	ug		4.5				< 0.3		
chromium	7440-47-3	UM	M31	0.2	ug/L			1.2	1.0			1.0	0.9
cobalt	7440-48-4	UM	M31	0.2	ug	< 0.2				< 0.2			
cobalt	7440-48-4	UM	M31	0.3	ug		< 0.3				< 0.3		
cobalt	7440-48-4	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2
copper	7440-50-8	UM	M31	0.2	ug	1.0				0.2			
copper	7440-50-8	UM	M31	0.4	ug		3.2				< 0.4		
copper	7440-50-8	UM	M31	0.4	ug/L			< 0.4	< 0.4			< 0.4	< 0.4
lead	7439-92-1	UM	M31	0.3	ug	4.3				0.4			
lead	7439-92-1	UM	M31	0.2	ug		7.4				< 0.2		
lead	7439-92-1	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2
manganese	7439-96-5	UM	M31	0.2	ug	1.5				0.8			
manganese	7439-96-5	UM	M31	0.2	ug		3.1				0.4		
manganese	7439-96-5	UM	M31	0.2	ug/L			1.0	< 0.2			< 0.2	< 0.2
nickel	7440-02-0	UM	M31	0.5	ug	19.5				19.5			
nickel	7440-02-0	UM	M31	0.1	ug		8.4				< 0.1		
nickel	7440-02-0	UM	M31	0.3	ug/L			< 0.3	0.3			< 0.3	< 0.3
thallium	7440-28-0	UM	M31	0.2	ug	< 0.2				< 0.2			
thallium	7440-28-0	UM	M31	0.2	ug		< 0.2				< 0.2		
thallium	7440-28-0	UM	M31	0.2	ug/L			< 0.2	< 0.2			< 0.2	< 0.2
vanadium	7440-62-2	UM	M31	0.2	ug	< 0.2				< 0.2			
vanadium	7440-62-2	UM	M31	0.2	ug		0.4				< 0.2		
vanadium	7440-62-2	UM	M31	0.1	ug/L			< 0.1	< 0.1			< 0.1	< 0.1
volume of sample supplied		U	N/A	n/a	ml		140	515	211		158	400	200

Environmental Compliance Limited

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Results Summary

Report No.: 22-06623-2

Customer Reference: Not Supplied

Customer Order No: C4660 P5200

Customer Sample No		ECL/22/2673	ECL/22/2674	ECL/22/2675	ECL/22/2676	ECL/22/2677	ECL/22/2678	ECL/22/2679	ECL/22/2680
	RPS Sample No	111340	111341	111342	111343	111344	111345	111346	111347
	Sample Type	SOLID	LIQUID	LIQUID	LIQUID	SOLID	LIQUID	LIQUID	LIQUID
	Sample Matrix	FILTER	SOLUTION	SOLUTION	SOLUTION	FILTER	SOLUTION	SOLUTION	SOLUTION
Determinand	**CAS N**	**Code**	**SOI**	**RL**	**Unit**	**Column**	**Column1**	**Column1**	**Column1**	**Column1**	**Column1**	**Column1**	**Column1**
mercury	7439-97-6	UM	M112	0.03	ug	< 0.03				< 0.03			
mercury	7439-97-6	UM	M112	0.5	ug/l			< 0.5	< 0.5			< 0.5	< 0.5
mercury	7439-97-6	UM	M112	0.5	ug/l		< 0.50				< 0.50		
volume of sample supplied		U	N/A	n/a	ml		164	412	177		114	387	182

Western Bio-Energy Ltd
Permit No : EPR/ZP3939GL
Variation No : V005
Report Ref : P5200 : R002

Installation Name : Biomass Plant
Visit Details : Compliance – May 2022
Survey Dates : 10th to 12th & 19th to 20th May 2022
Report Issue Date : 13th July 2022

MSS
Marchwood Scientific Services

371 Millbrook Rd West
Southampton
SO15 0HW

Tel: 02380 786979

UKAS accredited testing laboratory No. 1668

Name of Client : Environmental Compliance Ltd **Test Certificate No:** 207704
Address : Unit 1G, Main Avenue, Treforest Industrial Estate, Pontypridd, CF37 5BF

ANALYSIS OF PCDDs and PCDFs

Job Reference: P5200
Sample Identifier : ECL/22/2681-ECL/22/2683
Sample No: 207704
Order No: C4661
Sample Type: Stack
Sample Condition : conforming
Instrument : Thermo DFS
GC Column : DB5
Calibration File : 220607

Date of Receipt : 24/05/22
Date of Analysis : 06/06/22
Date of Report : 09/06/22

Test Method : 2002b
Blank : 220606
Sample size: 1

expressed as ng /sample

Congener	Conc	TEFs	TEQ[1]	TEQ[2]	DL	REC%
2378-TCDD	*	1.0000	0.0007	0.0000	0.0007	110
12378-PCDD	0.0052	0.5000	0.0026	0.0026	0.0014	97
123478-HxCDD	0.0108	0.1000	0.0011	0.0011	0.0010	83
123678-HxCDD	0.0227	0.1000	0.0023	0.0023	0.0010	87
123789-HxCDD	0.0154	0.1000	0.0015	0.0015	0.0009	
1234678-HpCDD	0.115	0.0100	0.0012	0.0012	0.0007	83
OCDD	0.109	0.0010	0.0001	0.0001	0.0012	83
2378-TCDF	0.0099	0.1000	0.0010	0.0010	0.0016	106
12378-PCDF	0.0059	0.0500	0.0003	0.0003	0.0008	121
23478-PCDF	0.0077	0.5000	0.0039	0.0039	0.0009	91
123478-HxCDF	*	0.1000	0.0000	0.0000	0.0004	94
123678-HxCDF	*	0.1000	0.0000	0.0000	0.0004	90
234678-HxCDF	*	0.1000	0.0000	0.0000	0.0004	88
123789-HxCDF	*	0.1000	0.0000	0.0000	0.0005	107
1234678-HpCDF	0.0096	0.0100	0.0001	0.0001	0.0004	84
1234789-HpCDF	0.0013	0.0100	0.0000	0.0000	0.0004	107
OCDF	0.0041	0.0010	0.0000	0.0000	0.0004	77
TEQ (NATO)			0.0149	0.0140		

*	Isomer Not detected
TEQ	Toxic Equivalent Value
TEF	Toxic Equivalent Factor
Conc	Concentration
DL	Detection Value
REC	Recovery

TEQ[1]	Concentration of Non Detected Congeners at Detection Limit
TEQ[2]	Concentration of Non Detected Congeners at Zero

UKAS TESTING
1668

Approved by : Mafalda Catarro
Position : Team Leader

Signature : Mafalda Catarro

The analysis was performed in accordance with EN1948-2:2006 and this European Standard, i.e. EN1948-3:2006

Additional Information

Measurement Information **Test Certificate No:** 207704

	Institution	Environmental Compliance Ltd
	Person	n/a
	Site sampling location	P5200
	Date : Time	11/05/2022
		Dioxins
Precision		7%
Uncertainty		14%
Sample storage	Location	Millbrook
	Temperature	21
	Date into storage	24/05/22
Extraction	Date	06/06/22
	Standard Concentration	1 ng
	Date Added	06/06/22
	Compartments Filter/XAD, Impingers	0.75/0.25
Concentration		
	Final Volume	30ul
Recovery Standards		
	Date Added	07/06/22
	Extract volume at injection	30ul
	Date of Analysis	08/06/22

The analysis was performed in accordance with EN1948-2:2006 and this European Standard, i.e. EN1948-3:2006

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

MSS
Marchwood Scientific Services

371 Millbrook Rd West
Southampton
SO15 0HW

Tel: 02380 786979

UKAS accredited testing laboratory No. 1668

Name of Client : Environmental Compliance Ltd **Test Certificate No:** 207705
Address : Unit 1G, Main Avenue, Treforest Industrial Estate, Pontypridd, CF37 5BF

ANALYSIS OF PCDDs and PCDFs

Job Reference: P5200
Sample Identifier : ECL/22/2684-ECL/22/2686
Sample No: 207705
Order No: C4661
Sample Type: Stack
Sample Condition : conforming
Instrument : Thermo DFS
GC Column : DB5
Calibration File : 220607

Date of Receipt : 24/05/22
Date of Analysis : 06/06/22
Date of Report : 09/06/22

Test Method : 2002b
Blank : 220606
Sample size: 1

expressed as ng /sample

Congener	Conc	TEFs	TEQ[1]	TEQ[2]	DL	REC%
2378-TCDD	*	1.0000	0.0001	0.0000	0.0001	101
12378-PCDD	*	0.5000	0.0001	0.0000	0.0002	104
123478-HxCDD	*	0.1000	0.0000	0.0000	0.0001	76
123678-HxCDD	*	0.1000	0.0000	0.0000	0.0001	80
123789-HxCDD	*	0.1000	0.0000	0.0000	0.0001	
1234678-HpCDD	*	0.0100	0.0000	0.0000	0.0001	75
OCDD	0.0017	0.0010	0.0000	0.0000	0.0003	72
2378-TCDF	*	0.1000	0.0000	0.0000	0.0002	83
12378-PCDF	*	0.0500	0.0000	0.0000	0.0001	112
23478-PCDF	*	0.5000	0.0001	0.0000	0.0001	94
123478-HxCDF	*	0.1000	0.0000	0.0000	0.0001	80
123678-HxCDF	*	0.1000	0.0000	0.0000	0.0001	80
234678-HxCDF	*	0.1000	0.0000	0.0000	0.0001	77
123789-HxCDF	*	0.1000	0.0000	0.0000	0.0001	101
1234678-HpCDF	0.0008	0.0100	0.0000	0.0000	0.0001	72
1234789-HpCDF	0.0002	0.0100	0.0000	0.0000	0.0001	100
OCDF	*	0.0010	0.0000	0.0000	0.0002	64
TEQ (NATO)			0.0003	0.0000		

*	Isomer Not detected	TEQ[1]	Concentration of Non Detected Congeners at Detection Limit
TEQ	Toxic Equivalent Value		
TEF	Toxic Equivalent Factor	TEQ[2]	Concentration of Non Detected Congeners at Zero
Conc	Concentration		
DL	Detection Value		
REC	Recovery		

UKAS TESTING
1668

Approved by : Mafalda Catarro
Position : Team Leader

Signature : Mafalda Catarro

The analysis was performed in accordance with EN1948-2:2006 and this European Standard, i.e. EN1948-3:2006

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Additional Information

Measurement Information **Test Certificate No:** 207705

	Institution	Environmental Compliance Ltd
	Person	n/a
	Site sampling location	P5200
	Date : Time	11/05/2022

		Dioxins
Precision		7%
Uncertainty		14%
Sample storage	Location	Millbrook
	Temperature	21
	Date into storage	24/05/22
Extraction	Date	06/06/22
	Standard Concentration	1 ng
	Date Added	06/06/22
	Compartments Filter/XAD, Impingers	0.75/0.25
Concentration		
	Final Volume	30ul
Recovery Standards		
	Date Added	07/06/22
	Extract volume at injection	30ul
	Date of Analysis	08/06/22

The analysis was performed in accordance with EN1948-2:2006 and this European Standard, i.e. EN1948-3:2006

UNCERTAINTY CALCULATIONS

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

TVOC Measurement Uncertainty

Main Stack - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges TVOC 0 - 15 mgC/m^3
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.73
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.35
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	5.33
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	5.91
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.30
Interferents[1]	u_i	Rectangular (Divisor = √3)	4.39
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	2.60
Effect of Voltage Fluctuation[7]	u_v	Rectangular (Divisor = √3)	1.80
Effect of Oxygen Synergism[7]	u_{syn}	Rectangular (Divisor = √3)	4.60

Note:

$$when\ \left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the certified range
2 Expressed as maximum drift per 24hr period as percentage of the certified range
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m^3 / %Vol taking account of an additional uncertainty of 2% for gas blending
7 Expressed as a percentage of the certified range

Main Stack - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.80
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.51
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.00
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	1.50
Effect of Voltage Fluctuation	u_v	$u(x_i) = \frac{u_v \times R_i}{\sqrt{3}} =$	0.16
Effect of Oxygen Synergism	u_{syn}	$u(x_i) = \frac{u_{syn} \times R_i}{\sqrt{3}} =$	0.40
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	1.86
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	3.73
Applied Span Concentration			149.84
Measured Span Concentration, STP Dry Gas			149.43
Expanded measurement uncertainty as % of Applied Span			2 %

* Signal 3030 FID

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

TVOC Uncertainty of Measurement Results

Main Stack - TVOC - Uncertainty of Measurement Results - Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range O_2 0 - 25 %Vol	Min Certified Range TVOC 0 - 15 mgC/m^3
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.13	0.73
Span drift[2]	$u_{d,s}$			0.029	0.35
Losses / leakage in the sample system[4]	u_{loss}			1.00	0.95
Temperature dependant span drift[5]	u_t			0.070	0.30
Interferents[1]	u_i			0.56	4.39
Effect of Voltage Fluctuation[7]	u_v			...	1.80
Effect of Oxygen Synergism[7]	u_{syn}			...	

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})(x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	O_2 0 - 25 %Vol	TVOC 0 - 15 mgC/m^3
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.019	0.064
Span drift	$u_{d,s}$			0.0041	0.031
Temperature dependant span drift	u_t			0.00	0.00
Interferents	u_i			0.081	0.38
Effect of Voltage Fluctuation (See Note)	u_v			...	0.16

Main Stack - TVOC - Uncertainty of Measurement Results - Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	O_2 0 - 25 %Vol	TVOC 0 - 15 mgC/m^3
Losses / leakage in the sample system	u_{loss}	10/05/22 13:40 - 14:40	0.10	0.018
Standard Error of Measured Value	u_{SE}	10/05/22 13:40 - 14:40	0.015	0.073
Uncertainty due to Moisture Correction[6]	u_{H2O}	10/05/22 13:40 - 14:40	0.22	0.033

Effect on Uncertainty Caused by Oxygen

$$uCorr^{B}_{O_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured}) x (20.9\% - O_{2,measured})} \text{ x Uncertainty of } O_2 \text{ Meas} = 0.05$$

$$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.4013$$

$$uf_{O_2} = \frac{uCorr^{n}_{O_2}}{f_{O_2}} x100 = 3.39 \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Main Stack - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	O_2 0 - 25 %Vol	*TVOC 0 - 15 mgC/m^3
Measured Concentration	10/05/22 13:40 - 14:40	10.27	1.85
Expanded Uncertainty as Percentage of Measured Concentration		5 %	43 %

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{syn}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the applied span concentration
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of moisture is taken from the manual extract test calculations.
7 Expressed as a percentage of the certified range
8 Where no uncertainty is presented above, the uncertainty is >100%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Combustion Gases (NO_x, CO, & O_2) Measurement Uncertainty

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Measurement Uncertainty Calculations Part 1

Horiba PG 350 Performance Characteristics	Standard Uncertainty (% of Range)	Distributiuon	Minimum Certified Range (R_i) NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.75	0.61	0.10
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.094	0.056	0.0057
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	0.12	0.46	0.12
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	2.34	0.48	0.19
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	1.80	2.00	0.15
Interferents[1]	u_i	Rectangular (Divisor = √3)	0.52	0.87	
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	5.48	1.30	0.15
Effect of Voltage Fluctuation[7]	u_v	Rectangular (Divisor = √3)	0.40	0.50	0.020
Effect of Sample Gas Flow/ Pressure[7]	u_{sg}	Rectangular (Divisor = √3)	0.10	0.10	0.10

Note:

$$when\ \left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
7 Expressed as a percentage of the certified range

Measurement Uncertainty Calculations Part 2

Horiba PG 350 Performance Characteristics	Uncertainty	Value of Standard Uncertainty	NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.58	0.26	0.014
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.073	0.024	0.00082
Repeatability Standard Deviation (span	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.12	0.46	0.12
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	1.81	0.21	0.028
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	1.39	0.87	0.022
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.40	0.38	
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	3.17	0.75	0.087
Effect of Voltage Fluctuation [7]	u_v	$u(x_i) = \frac{u_v \times R_i}{\sqrt{3}} =$	0.23	0.29	0.012
Effect of Sample Gas Flow / Pressure [7]	u_{sg}	$u(x_i) = \frac{usg \times R_i}{\sqrt{3}} =$	0.058	0.058	0.058
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2} + u2v + u2sg$	3.98	1.37	0.16
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	7.95	2.73	0.32
Applied Span Concentration			316.52	75.14	15.02
Measured Span Concentration, STP Dry Gas			313.30	75.06	15.00
Expanded measurement uncertainty as % of Applied Span			3%	4%	2%

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Combustion Gases (NO_x, CO, & O_2) Uncertainty of Measurement Results

Uncertainty of Measurement Results - Calculations Part 1

Horiba PG 350 Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Minimum Certified Range (R_i) NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.75	0.61	0.10
Span drift[2]	$u_{d,s}$			0.094	0.056	0.0057
Losses / leakage in the sample system[4]	u_{loss}			2.34	0.48	0.19
Temperature dependant span drift[5]	u_t			1.80	2.00	0.15

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,\max} - x_{i,adj})^2 + (x_{i,\min} - x_{i,adj})(x_{i,\max} - x_{i,adj}) + (x_{i,\min} - x_{i,adj})^2}{3}}$, when $\left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Horiba PG 350 Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.58	0.26	0.014
Span drift	$u_{d,s}$			0.073	0.024	0.00082
Temperature dependant span drift	u_t			1.39	0.87	0.022
Interferents	u_i			0.40	0.38	

Uncertainty of Measurement Results - Calculations Part 2

Horiba PG 350 Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	NO 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Losses / leakage in the sample system	u_{loss}	10/05/22 12:00 - 13:00	6.32	1.04	0.020
Standard Error of Measured Value	u_{SE}	10/05/22 12:00 - 13:00	3.74	42.84	0.038

Effect on Uncertainty Caused by Oxygen $uCorr^{n}_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} x\, Uncertainty\ of\ O_2\ Measurement =$ 0.048

$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} =$ 1.4450 $uf_{o_2} = \frac{uCorr^{n}_{o_2}}{f_{o_2}} x100 =$ 3.31 %

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Uncertainty of Measurement Results - Calculations Part 3

Horiba PG 350 Uncertainty	Date & Time	NOx (as NO2) 0 - 134 mg/m³	CO 0 - 75 mg/m³	O_2 0 - 25 %Vol
Measured Concentration	10/05/22 12:00 - 13:00	270.12	216.05	10.31
Expanded Uncertainty as Percentage of Measured Concentration		6%	40%	3%

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{sg}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of Moisture is taken as the standard error of the time averaged value used to correct to Dry Conditions
7 If no value for uncertainty is presented above, the uncertainty is considered to be >100%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Combustion Gases (N_2O & O_2) Measurement Uncertainty

Measurement Uncertainty Calculations Part 1

Protir 204M FTIR Performance Characteristics	Standard Uncertainty	Distributiuon	imum Certified Range N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Lack of fit[1]	u_{lof}	Rectangular (Divisor = √3)	0.67	0.19
Span drift[2]	$u_{d,s}$	Rectangular (Divisor = √3)	0.57	0.029
Repeatability Standard Deviation (span)[3]	u_r	Normal (Divisor = 1)	0.84	0.47
Losses / leakage in the sample system[4]	u_{loss}	Rectangular (Divisor = √3)	2.20	0.30
Temperature dependant span drift[5]	u_t	Rectangular (Divisor = √3)	0.30	0.13
Interferents[1]	u_i	Rectangular (Divisor = √3)	5.16	0.10
Uncertainty of Reference Gas[6]	u_{ref}	Rectangular (Divisor = √3)	1.04	0.15

Note:

$$when\ \left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|, then\ u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

1 Expressed as a percentage of the certified range
2 Expressed as a percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
7 Not Available

Measurement Uncertainty Calculations Part 2

Protir 204M FTIR Performance Characteristics	Uncertainty	Value of Standard Uncertainty	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.15	0.023
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.13	0.0034
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} =$	0.84	0.47
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.40	0.023
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.068	0.016
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	1.16	0.012
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	0.60	0.087
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	1.62	0.48
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	3.24	0.97
Applied Span Concentration			36.65	15.02
Measured Span Concentration, STP Dry Gas			35.93	14.88
Expanded measurement uncertainty as % of Applied Span			9%	6%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Combustion Gases (N_2O & O_2) Uncertainty of Measurement Results

Uncertainty of Measurement Results - Calculations Part 1

Protir 204M FTIR Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Minimum Certified Range (R_i) N_2O 0 - 39 mg/m³	Minimum Certified Range (R_i) O_2 0 - 21 %Vol
Lack of fit[1]	u_{lof}	Rectangular	$\sqrt{3}$	0.67	0.19
Span drift[2]	$u_{d,s}$			0.57	0.029
Losses / leakage in the sample system[4]	u_{loss}			2.20	0.30
Temperature dependant span drift[5]	u_t			0.30	0.13

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,\max} - x_{i,adj})^2 + (x_{i,\min} - x_{i,adj})(x_{i,\max} - x_{i,adj}) + (x_{i,\min} - x_{i,adj})^2}{3}}$, when $\left|(x_{i,\max} - x_{i,adj})\right| = \left|(x_{i,\min} - x_{i,adj})\right|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

Protir 204M FTIR Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.15	0.023
Span drift	$u_{d,s}$			0.13	0.0034
Temperature dependant span drift	u_t			0.068	0.016
Interferents	u_i			1.16	0.012

Uncertainty of Measurement Results - Calculations Part 2

Protir 204M FTIR Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Losses / leakage in the sample system	u_{loss}	20/05/22 11:35 - 12:35	0.0059	0.023
Standard Error of Measured Value	u_{SE}	20/05/22 11:35 - 12:35	2.51E-17	0.058
Uncertainty due to Moisture Correction[6]	u_{H2O}	20/05/22 11:35 - 12:35	0.0054	0.15

Effect on Uncertainty Caused by Oxygen $uCorr^n_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})x(20.9\% - O_{2,measured})} x\, Uncertainty\ of\ O_2\ Measurement =$ 0.025

$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} =$ 2.3627 $uf_{o_2} = \frac{uCorr^n_{o_2}}{f_{o_2}} x100 =$ 1.07 %

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$\therefore u(x_i) = C_i u_i$ where $C_i = \frac{\partial f}{\partial x_i}$

Uncertainty of Measurement Results - Calculations Part 3

Protir 204M FTIR Uncertainty	Date & Time	N_2O 0 - 39 mg/m³	O_2 0 - 21 %Vol
Measured Concentration	20/05/22 11:35 - 12:35	0.27	7.58
Expanded Uncertainty as Percentage of Measured Concentration		>100%	5%

Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{syn}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

1 Expressed as a percentage of the certified range
2 Expressed as percentage of the certified range as maximum drift per 24hr period
3 Expressed as a percentage of the certified range
4 Expressed as a percentage of the certified range
5 Expressed as a percentage of the certified range per one degree centigrade
6 Where the uncertainty of moisture is taken from the manual extract test calculations.
7 Not available
8 If no value for uncertainty is presented above, the uncertainty is considered to be >100%

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
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Particulates & Hydrogen Chloride Uncertainty

Site: Margam
Location: Main Stack

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K= 2 Filter mg	Solution mg	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
			TPM & HCl 1					
Particulates	0.26	0.70	0.96	0.10	0.50	0.0500	0.25	0.25
Hydrogen Chloride	…	0.12	0.12	…	0.0156	…	0.00779	0.00779
…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…

	TPM & HCl 1					
			Standard Uncertainty @ 95%			
Sampled Volume (V_m)	1.39	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	0.96	…		…	…	
Meter Temperature (T_m)	298.58	k	uT_m	1.5	k	
Average Differential Pressure (ΔH)	50.26	mmH_2O	$u\Delta H$	0.25	mmH_2O	
Barometric Pressure (p_b)	765.06	mmHg	up_b	3.8	mmHg	
ΔH + ρs (ρ_m)	102.49	kPa		…	…	
Oxygen content ($O_{2,m}$)	7.16	% by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.0314		% by volume
Moisture Content (H_2O)	16.48	% by volume	uH_2O	0.44		% by volume

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. i = uV_m, uT_m etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

TPM & HCl 1:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1.00$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component ($u\Delta H$), measured stack pressure uncertainty component (up_b) & measured temperature of dry gas uncertainty component (uT_{mDry})

TPM & HCl 1:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.891$$

	Maximum	Minimum	Sensitivity	ufstp
$u\Delta H$	0.89	0.89	0.0000852	0.0000213
up_b	0.90	0.89	0.00116	0.00435
uT_m	0.90	0.89	0.00298	0.00448
H_2O	…	…	…	…

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (up_b)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00529$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

TPM & HCl 1:

$$V_{std} = V_{measured} \times f_s = \quad 1.242$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	1.25	1.23	1.39	0.00737
Effect of uV_m	1.24	1.24	0.89	0.000891

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0103$$

Uncertainty of Oxygen Correction Factor (%):-

TPM & HCl 1:

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = \quad 1.08$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured}) x (20.9\% - O_{2,measured})} x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.0284$$

$$uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 \quad 2.62\ \%$$

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	TPM & HCl 1:			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
Particulates	1.06	0.62	0.87	0.22
Hydrogen Chloride	0.11	0.0978	0.87	0.00680
Sulphur Dioxide	…	…	…	…
Ammonia	…	…	…	…

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	TPM & HCl 1:
	uL mg/Nm^3
Particulates	0.00967
Hydrogen Chloride	0.00121
Sulphur Dioxide	…
Ammonia	…

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	TPM & HCl 1:			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
Particulates	0.84	0.83	0.67	0.00695
Hydrogen Chloride	0.11	0.10	0.0842	0.000868
Sulphur Dioxide	…	…	…	…
Ammonia	…	…	…	…

Measurement Uncertainty of Determinand (excluding correction for oxygen)

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	TPM & HCl 1:				
	Measurement Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration	Uncertainty as Percentage of ELV
Particulates	0.22	0.45	0.84	53.19	2.97
Hydrogen Chloride	0.00696	0.0139	0.10	13.31	
Sulphur Dioxide	…	…	…	…	
Ammonia	…	…	…	…	

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	TPM & HCl 1:		
	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor ($Ucombined$)
Particulates	53.19	2.62	53.26
Hydrogen Chloride	13.31	2.62	13.56
Sulphur Dioxide	…	…	…
Ammonia	…	…	…

Dioxins, Furans Uncertainty

Site: Margam
Location: Main Stack

Dioxin	Recovered Mass ng	LOD ng	LAB Method Uncert (%) K=2 %age	as Mass (ng)	Standard Uncertainty Symbol	ng
2,3,7,8 - TCDD	0.000700	0.000100	50	0.000350	**u2,3,7,8 - TCDD**	0.000175
1,2,3,7,8 - PeCDD	0.00520	0.000200	30	0.00156	**u1,2,3,7,8 - PeCDD**	0.000780
1,2,3,4,7,8 - HxCDD	0.0108	0.000100	30	0.00324	**u1,2,3,4,7,8 - HxCDD**	0.00162
1,2,3,6,7,8 - HxCDD	0.0227	0.000100	30	0.00681	**u1,2,3,6,7,8 - HxCDD**	0.00341
1,2,3,7,8,9 - HxCDD	0.0154	0.000100	30	0.00462	**u1,2,3,7,8,9 - HxCDD**	0.00231
1,2,3,4,6,7,8 - HpCDD	0.115	0.000100	30	0.0345	**u1,2,3,4,6,7,8 - HpCDD**	0.0173
OCDD	0.109	0.000300	30	0.0327	**uOCDD**	0.0164
2,3,7,8 - TCDF	0.00990	0.000200	30	0.00297	**u2,3,7,8 - TCDF**	0.00149
1,2,3,7,8 - PeCDF	0.00590	0.000100	30	0.00177	**u1,2,3,7,8 - PeCDF**	0.000885
2,3,4,7,8 - PeCDF	0.00770	0.000100	30	0.00231	**u2,3,4,7,8 - PeCDF**	0.00116
1,2,3,4,7,8 - HxCDF	0.000400	0.000100	50	0.000200	**u1,2,3,4,7,8 - HxCDF**	0.000100
1,2,3,6,7,8 - HxCDF	0.000400	0.000100	50	0.000200	**u1,2,3,6,7,8 - HxCDF**	0.000100
2,3,4,6,7,8 - HxCDF	0.000400	0.000100	50	0.000200	**u2,3,4,6,7,8 - HxCDF**	0.000100
1,2,3,7,8,9 - HxCDF	0.000500	0.000100	50	0.000250	**u1,2,3,7,8,9 - HxCDF**	0.000125
1,2,3,4,6,7,8 - HpCDF	0.00960	0.000100	30	0.00288	**u1,2,3,4,6,7,8 - HpCDF**	0.00144
1,2,3,4,7,8,9 - HpCDF	0.00130	0.000100	30	0.000390	**u1,2,3,4,7,8,9 - HpCDF**	0.000195
OCDF	0.00410	0.000200	30	0.00123	**uOCDF**	0.000615

	Measured Values			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	7.750	**m^3**		**uV_m**	0.001	**m^3**
Meter Correction Factor (Yd)	0.964	**...**			...	**...**
Meter Temperature (T_m)	302.292	**k**		**uTm**	1.5	**k**
Average Differential Pressure (ΔH)	51.427	**mmH_2O**		**uDH**	0.25	**mmH_2O**
Barometric Pressure (ρ_b)	762.810	**mmHg**		**up$_b$**	3.8	**mmHg**
ΔH + ρs (ρ_m)	102.204	**kPa**			...	**...**
Oxygen content ($O_{2,m}$)	10.622	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$		0.01	**% by volume**
Moisture Content (H_2O)	20.622	**% by volume**		**uH_2O**	0.54	**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using:

$$C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔ H), measured stack pressure uncertainty component (up$_s$) & measured temperature of dry gas

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.878$$

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.878	0.878	0.0000842	0.0000210
up$_b$	0.882	0.873	0.00114	0.00429
uT_m	0.882	0.873	0.00290	0.00436
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00509$$

Uncertainty in volume @ reference conditions due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

$$V_{std} = V_{measured} \times f_s = \quad 6.802$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty m^3
Effect of uV_{std}	6.841	6.763	7.750	0.0394
Effect of uV_m	6.803	6.801	0.878	0.000878

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.3056$$

Uncertainty of oxygen correction factor (ufO_2)

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.445 \qquad uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured})x(20.9\% - O_{2,\,measured})} x\, Uncertainty\ of\ O_2\ Measurement =$$

$$\therefore uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 3.51\ \%$$

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Uncertainty in final dioxin measurement @ reference conditions due to mass uncertainty component (uM)

Dioxin	Maximum ng/Nm³	Minimum ng/Nm³	Sensitivity	uM ng/Nm³
2,3,7,8 - TCDD	0.000186	0.000112	0.212	0.0000372
1,2,3,7,8 - PeCDD	0.00127	0.000939	0.212	0.000166
1,2,3,4,7,8 - HxCDD	0.00264	0.00195	0.212	0.000344
1,2,3,6,7,8 - HxCDD	0.00555	0.00410	0.212	0.000724
1,2,3,7,8,9 - HxCDD	0.00376	0.00278	0.212	0.000491
1,2,3,4,6,7,8 - HpCDD	0.0281	0.0208	0.212	0.00367
OCDD	0.0266	0.0197	0.212	0.00347
2,3,7,8 - TCDF	0.00242	0.00179	0.212	0.000316
1,2,3,7,8 - PeCDF	0.00144	0.00107	0.212	0.000188
2,3,4,7,8 - PeCDF	0.00188	0.00139	0.212	0.000245
1,2,3,4,7,8 - HxCDF	0.000106	0.0000637	0.212	0.0000212
1,2,3,6,7,8 - HxCDF	0.000106	0.0000637	0.212	0.0000212
2,3,4,6,7,8 - HxCDF	0.000106	0.0000637	0.212	0.0000212
1,2,3,7,8,9 - HxCDF	0.000133	0.0000797	0.212	0.0000266
1,2,3,4,6,7,8 - HpCDF	0.00235	0.00173	0.212	0.000306
1,2,3,4,7,8,9 - HpCDF	0.000318	0.000235	0.212	0.0000414
OCDF	0.00100	0.000741	0.212	0.000131

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss in the sample system (uL)

Dioxin	uL ng/Nm³
2,3,7,8 - TCDD	1.718E-06
1,2,3,7,8 - PeCDD	0.0000128
1,2,3,4,7,8 - HxCDD	0.0000265
1,2,3,6,7,8 - HxCDD	0.0000557
1,2,3,7,8,9 - HxCDD	0.0000378
1,2,3,4,6,7,8 - HpCDD	0.000282
OCDD	0.000267
2,3,7,8 - TCDF	0.0000243
1,2,3,7,8 - PeCDF	0.0000145
2,3,4,7,8 - PeCDF	0.0000189
1,2,3,4,7,8 - HxCDF	9.815E-07
1,2,3,6,7,8 - HxCDF	9.815E-07
2,3,4,6,7,8 - HxCDF	9.815E-07
1,2,3,7,8,9 - HxCDF	1.227E-06
1,2,3,4,6,7,8 - HpCDF	0.0000236
1,2,3,4,7,8,9 - HpCDF	3.190E-06
OCDF	0.0000101

Uncertainty in final measurement @ Reference Conditions due to uVstp

Dioxin	Maximum ng/Nm³	Minimum ng/Nm³	Sensitivity	uVstp mg/Nm³
2,3,7,8 - TCDD	0.000156	0.000142	0.0000219	6.695E-06
1,2,3,7,8 - PeCDD	0.00116	0.00106	0.000163	0.0000497
1,2,3,4,7,8 - HxCDD	0.00240	0.00220	0.000338	0.000103
1,2,3,6,7,8 - HxCDD	0.00505	0.00462	0.000711	0.000217
1,2,3,7,8,9 - HxCDD	0.00343	0.00313	0.000482	0.000147
1,2,3,4,6,7,8 - HpCDD	0.0256	0.0234	0.00360	0.00110
OCDD	0.0243	0.0222	0.00341	0.00104
2,3,7,8 - TCDF	0.00220	0.00201	0.000310	0.0000947
1,2,3,7,8 - PeCDF	0.00131	0.00120	0.000185	0.0000564
2,3,4,7,8 - PeCDF	0.00171	0.00157	0.000241	0.0000736
1,2,3,4,7,8 - HxCDF	0.0000890	0.0000813	0.0000125	3.826E-06
1,2,3,6,7,8 - HxCDF	0.0000890	0.0000813	0.0000125	3.826E-06
2,3,4,6,7,8 - HxCDF	0.0000890	0.0000813	0.0000125	3.826E-06
1,2,3,7,8,9 - HxCDF	0.000111	0.000102	0.0000157	4.782E-06
1,2,3,4,6,7,8 - HpCDF	0.00214	0.00195	0.000301	0.0000918
1,2,3,4,7,8,9 - HpCDF	0.000289	0.000264	0.0000407	0.0000124
OCDF	0.000912	0.000834	0.000128	0.0000392

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Dioxin	Combined Uncertainty ng/Nm³	Expanded Uncertainty ng/Nm³	Measured Concentration ng/Nm³	% of Measured Concentration
2,3,7,8 - TCDD	0.0000378	0.0000756	0.000149	50.856
1,2,3,7,8 - PeCDD	0.000174	0.000347	0.00110	31.407
1,2,3,4,7,8 - HxCDD	0.000360	0.000721	0.00229	31.407
1,2,3,6,7,8 - HxCDD	0.000757	0.00151	0.00482	31.407
1,2,3,7,8,9 - HxCDD	0.000514	0.00103	0.00327	31.407
1,2,3,4,6,7,8 - HpCDD	0.00384	0.00767	0.0244	31.407
OCDD	0.00364	0.00727	0.0232	31.407
2,3,7,8 - TCDF	0.000330	0.000661	0.00210	31.407
1,2,3,7,8 - PeCDF	0.000197	0.000394	0.00125	31.407
2,3,4,7,8 - PeCDF	0.000257	0.000514	0.00164	31.407
1,2,3,4,7,8 - HxCDF	0.0000216	0.0000432	0.0000850	50.856
1,2,3,6,7,8 - HxCDF	0.0000216	0.0000432	0.0000850	50.856
2,3,4,6,7,8 - HxCDF	0.0000216	0.0000432	0.0000850	50.856
1,2,3,7,8,9 - HxCDF	0.0000270	0.0000540	0.000106	50.856
1,2,3,4,6,7,8 - HpCDF	0.000320	0.000641	0.00204	31.407
1,2,3,4,7,8,9 - HpCDF	0.0000434	0.0000868	0.000276	31.407
OCDF	0.000137	0.000274	0.000871	31.407
		Total (ng/Nm³)	0.068	16.0

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Dioxin	% of Measured Concentration	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor ($U_{combined}$)	New Combined Uncertainty ng/Nm³
2,3,7,8 - TCDD	50.856	3.510	50.977	0.0000379
1,2,3,7,8 - PeCDD	31.407	3.510	31.602	0.000174
1,2,3,4,7,8 - HxCDD	31.407	3.510	31.602	0.000361
1,2,3,6,7,8 - HxCDD	31.407	3.510	31.602	0.000759
1,2,3,7,8,9 - HxCDD	31.407	3.510	31.602	0.000515
1,2,3,4,6,7,8 - HpCDD	31.407	3.510	31.602	0.00384
OCDD	31.407	3.510	31.602	0.00364
2,3,7,8 - TCDF	31.407	3.510	31.602	0.000331
1,2,3,7,8 - PeCDF	31.407	3.510	31.602	0.000197
2,3,4,7,8 - PeCDF	31.407	3.510	31.602	0.000257
1,2,3,4,7,8 - HxCDF	50.856	3.510	50.977	0.0000216
1,2,3,6,7,8 - HxCDF	50.856	3.510	50.977	0.0000216
2,3,4,6,7,8 - HxCDF	50.856	3.510	50.977	0.0000216
1,2,3,7,8,9 - HxCDF	50.856	3.510	50.977	0.0000270
1,2,3,4,6,7,8 - HpCDF	31.407	3.510	31.602	0.000321
1,2,3,4,7,8,9 - HpCDF	31.407	3.510	31.602	0.0000435
OCDF	31.407	3.510	31.602	0.000137

Western Bio-Energy Ltd | **Installation Name** : Biomass Plant
Permit No : EPR/ZP3939GL | **Visit Details** : Compliance – May 2022
Variation No : V005 | **Survey Dates** : 10th to 12th & 19th to 20th May 2022
Report Ref : P5200 : R002 | **Report Issue Date** : 13th July 2022

Uncertainty - Adjusted for TEQ / TEF

Dioxin	TEQ ng/m³	Uncertainty ng/Nm³	Conc ng/Nm³	WHO Humans & Mammals (TEF)	Uncertainty ng/Nm³	Conc ng/Nm³	WHO Fish (TEF)	Uncertainty ng/Nm³	Conc ng/Nm³	WHO Birds (TEF)	Uncertainty ng/Nm³	Conc ng/Nm³
2,3,7,8 - TCDD	1	0.0000757	0.000149	1	0.0000757	0.000149	1	0.0000757	0.000149	1	0.0000757	0.000149
1,2,3,7,8 - PeCDD	0.5	0.000174	0.000552	1	0.000348	0.00110	1	0.000348	0.00110	1	0.000348	0.00110
1,2,3,4,7,8 - HxCDD	0.1	0.0000722	0.000229	0.1	0.0000722	0.000229	0.5	0.000361	0.00115	0.05	0.0000361	0.000115
1,2,3,6,7,8 - HxCDD	0.1	0.000152	0.000482	0.1	0.000152	0.000482	0.01	0.0000152	0.0000482	0.01	0.0000152	0.0000482
1,2,3,7,8,9 - HxCDD	0.1	0.000103	0.000327	0.1	0.000103	0.000327	0.01	0.0000103	0.0000327	0.1	0.000103	0.000327
1,2,3,4,6,7,8 - HpCDD	0.01	0.0000769	0.000244	0.01	0.0000769	0.000244	0.001	7.690E-06	0.0000244	0.001	7.690E-06	0.0000244
OCDD	0.001	7.289E-06	0.0000232	0.0001	7.289E-07	2.316E-06	…	…	…	…	…	…
2,3,7,8 - TCDF	0.1	0.0000662	0.000210	0.1	0.0000662	0.000210	0.05	0.0000331	0.000105	1	0.000662	0.00210
1,2,3,7,8 - PeCDF	0.05	0.0000197	0.0000627	0.05	0.0000197	0.0000627	0.05	0.0000197	0.0000627	0.1	0.0000395	0.000125
2,3,4,7,8 - PeCDF	0.5	0.000257	0.000818	0.5	0.000257	0.000818	0.5	0.000257	0.000818	1	0.000515	0.00164
1,2,3,4,7,8 - HxCDF	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06
1,2,3,6,7,8 - HxCDF	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06
2,3,4,6,7,8 - HxCDF	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06	0.1	4.328E-06	8.500E-06
1,2,3,7,8,9 - HxCDF	0.1	5.410E-06	0.0000106	0.1	5.410E-06	0.0000106	0.1	5.410E-06	0.0000106	0.1	5.410E-06	0.0000106
1,2,3,4,6,7,8 - HpCDF	0.01	6.419E-06	0.0000204	0.01	6.419E-06	0.0000204	0.01	6.419E-06	0.0000204	0.01	6.419E-06	0.0000204
1,2,3,4,7,8,9 - HpCDF	0.01	8.693E-07	2.762E-06	0.01	8.693E-07	2.762E-06	0.01	8.693E-07	2.762E-06	0.01	8.693E-07	2.762E-06
OCDF	0.001	2.742E-07	8.712E-07	0.0001	2.742E-08	8.712E-08	0.0001	2.742E-08	8.712E-08	0.0001	2.742E-08	8.712E-08
TOTAL	…	0.000	0.003	…	0.000	0.004	…	0.001	0.004	…	0.001	0.006
% Uncertainty	…	…	12.339	…	…	13.348	…	…	16.058	…	…	16.1

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Heavy Metals Uncertainty

Site: Margam
Location: Main Stack

$$u_{phase\,(mg/m^3)} = \frac{u_{method} \times Mass_{\mu g}}{200000} \qquad u_{mass} = \sqrt{\sum (u_{particulate})^2 + (u_{vapour})^2}$$

Metal	Particulate	Vapour	LAB Method Uncert (%) K=2		Standard Uncertainty		Combined Standard Uncertainty of Measured	
			Particulate Phase	Vapour Phase	Particulate Phase	Vapour Phase		
	mg	mg			mg/m³	mg/m³	Symbol	mg/m³
Antimony	0.600	0.145	15	16	0.0000450	0.0000116	uMSb	0.0000465
Arsenic	1.200	0.218	11	12	0.0000660	0.0000131	uMAs	0.0000673
Cadmium	0.500	0.145	12	10	0.0000300	7.260E-06	uMCd	0.0000309
Chromium	7.700	0.829	12	10	0.000462	0.0000415	uMCr	0.000464
Cobalt	0.500	0.145	12	10	0.0000300	7.260E-06	uMCo	0.0000309
Copper	4.200	0.290	12	10	0.000252	0.0000145	uMCu	0.000252
Lead	11.700	0.145	13	16	0.000761	0.0000116	uMPb	0.000761
Manganese	4.600	0.557	16	10	0.000368	0.0000279	uMMn	0.000369
Nickel	27.900	0.218	12	9	0.00167	9.801E-06	uMNi	0.00167
Thallium	0.400	0.145	14	14	0.0000280	0.0000102	uMTl	0.0000298
Vanadium	0.600	0.0726	12	9	0.0000360	3.267E-06	uMV	0.0000361

				Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.409	**m³**	**uV$_m$**	0.001	**m³**
Meter Correction Factor (Yd)	0.964	**...**		...	**...**
Meter Temperature (T_m)	303.00	**k**	**uTm**	1.5	**k**
Average Differential Pressure (ΔH)	50.38	**mmH$_2$O**	**uDH**	0.25	**mmH$_2$O**
Barometric Pressure (ρ_b)	765.06	**mmHg**	**up$_s$**	3.8	**mmHg**
ΔH + ρs (ρ_m)	102.49	**kPa**		...	**...**
Oxygen content ($O_{2,m}$)	6.86	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$	0.02	**% by volume**
Moisture Content (H$_2$O)	16.71	**% by volume**	**uH$_2$O**	0.45	**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using:

$$C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up$_s$) & measured

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.878$$

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.878	0.878	0.0000840	0.0000210
up$_s$	0.882	0.874	0.00114	0.00428
uT$_m$	0.882	0.874	0.00290	0.00435
H$_2$O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00507$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV$_{std}$) & volume uncertainty component (uV$_m$)

$$V_{std} = V_{measured} \times f_s = \quad 1.237$$

	Maximum m³	Minimum m³	Sensitivity	Standard Uncertainty m³
Effect of uV$_{std}$	1.244	1.230	1.409	0.00714
Effect of uV$_m$	1.238	1.236	0.878	0.000878

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0101$$

Uncertainty of oxygen correction factor (*uf*$_{O2}$)

$$f_{O_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 0.71$$

$$uCorr^n{}_{O_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} \; x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.03$$

$$\therefore uf_{O_2} = \frac{uCorr^n{}_{O_2}}{f_{O_2}} x100 = \quad 3.86\ \%$$

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Metal	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uM mg/Nm³
Antimony	0.000451	0.000398	0.570	0.0000265
Arsenic	0.000847	0.000770	0.570	0.0000384
Cadmium	0.000385	0.000350	0.570	0.0000176
Chromium	0.00513	0.00460	0.570	0.000264
Cobalt	0.000385	0.000350	0.570	0.0000176
Copper	0.00270	0.00242	0.570	0.000144
Lead	0.00719	0.00632	0.570	0.000434
Manganese	0.00315	0.00273	0.570	0.000210
Nickel	0.0170	0.0151	0.570	0.000954
Thallium	0.000328	0.000294	0.570	0.0000170
Vanadium	0.000404	0.000363	0.570	0.0000206

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system

Metal	uL mg/Nm³
Antimony	4.905E-06
Arsenic	9.332E-06
Cadmium	4.247E-06
Chromium	0.0000561
Cobalt	4.247E-06
Copper	0.0000296
Lead	0.0000780
Manganese	0.0000339
Nickel	0.000185
Thallium	3.589E-06
Vanadium	4.427E-06

Uncertainty in final measurement @ Reference Conditions due to uVstp

Metal	Maximum mg/Nm³	Minimum mg/Nm³	Sensitivity	uVstp mg/Nm³
Antimony	0.000428	0.000421	0.000343	3.463E-06
Arsenic	0.000815	0.000802	0.000653	6.589E-06
Cadmium	0.000371	0.000365	0.000297	2.998E-06
Chromium	0.00490	0.00482	0.00393	0.0000396
Cobalt	0.000371	0.000365	0.000297	2.998E-06
Copper	0.00258	0.00254	0.00207	0.0000209
Lead	0.00681	0.00670	0.00546	0.0000550
Manganese	0.00296	0.00292	0.00238	0.0000240
Nickel	0.0162	0.0159	0.0130	0.000131
Thallium	0.000313	0.000308	0.000251	2.534E-06
Vanadium	0.000387	0.000380	0.000310	3.126E-06

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Metal	Combined Uncertainty mg/Nm³	Expanded Uncertainty mg/Nm³	Measured Concentration mg/Nm³	Percent of Measured Concentration
Antimony	0.0000272	0.0000543	0.000425	12.790
Arsenic	0.0000400	0.0000800	0.000808	9.903
Cadmium	0.0000183	0.0000367	0.000368	9.977
Chromium	0.000273	0.000546	0.00486	11.239
Cobalt	0.0000183	0.0000367	0.000368	9.977
Copper	0.000148	0.000297	0.00256	11.593
Lead	0.000444	0.000888	0.00675	13.150
Manganese	0.000214	0.000429	0.00294	14.589
Nickel	0.000981	0.00196	0.0160	12.238
Thallium	0.0000175	0.0000351	0.000311	11.287
Vanadium	0.0000213	0.0000426	0.000383	11.114

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Metal	% of Measured Concentration	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor ($Ucombined$)	New Combined Uncertainty mg/Nm³
Antimony	12.790	3.860	13.359	0.000028
Arsenic	9.903	3.860	10.629	0.000043
Cadmium	9.977	3.860	10.697	0.000020
Chromium	11.239	3.860	11.883	0.000289
Cobalt	9.977	3.860	10.697	0.000020
Copper	11.593	3.860	12.218	0.000156
Lead	13.150	3.860	13.704	0.000463
Manganese	14.589	3.860	15.091	0.000222
Nickel	12.238	3.860	12.833	0.001028
Thallium	11.287	3.860	11.929	0.000019
Vanadium	11.114	3.860	11.765	0.000023

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Note: Uncertainty for each metals group is based on the summation in quadrature of the individual standard uncertainties (in mg/m3) of each contributing metal. Combined standard uncertainty of each group is converted to 95% confidence (multiplication by k = 2) before being expressed as a percentage of the combined group concentration.

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Mercury Uncertainty

Site: Margam
Location: Main Stack

$$u_{phase(mg/m^3)} = \frac{u_{method} \times Mass_{\mu g}}{200000} \qquad u_{mass} = \sqrt{\sum (u_{particulate})^2 + (u_{vapour})^2}$$

Metal	Particulate mg	Vapour mg	LAB Method Uncert (%) K=2 Particulate Phase	LAB Method Uncert (%) K=2 Vapour Phase	Standard Uncertainty Particulate Phase mg/m³	Standard Uncertainty Vapour Phase mg/m³	Combined Standard Uncertainty of Measured Symbol	Combined Standard Uncertainty of Measured mg/m³
Mercury	0.112	0.295	10	12	5.600E-06	0.0000177	uMHg	0.0000185

				Standard Uncertainty @ 95%		
Sampled Volume (V_m)	1.366	**m³**	**uV_m**	0.001	**m³**
Meter Correction Factor (Yd)	0.964	**...**		...	**...**
Meter Temperature (T_m)	296.00	**k**	**uTm**	1.5	**k**
Average Differential Pressure (ΔH)	50.10	**mmH_2O**	**uDH**	0.25	**mmH_2O**
Barometric Pressure (ρ_b)	765.06	**mmHg**	**up$_s$**	3.8	**mmHg**
ΔH + ρs (ρ_m)	102.49	**kPa**		...	**...**
Oxygen content ($O_{2,m}$)	6.97	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$	0.02	**% by volume**
Moisture Content (H_2O)	16.52	**% by volume**	**uH_2O**	0.44	**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using:

$$C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up$_s$) & measured

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.899$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.899	0.899	0.0000860	0.0000215
up$_s$	0.903	0.894	0.00117	0.00438
uT_m	0.903	0.894	0.00304	0.00456
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = 0.00543$$

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = 1$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

$$V_{std} = V_{measured} \times f_s = 1.228$$

	Maximum m³	Minimum m³	Sensitivity	Standard Uncertainty m³
Effect of uV_{std}	1.235	1.220	1.366	0.00741
Effect of uV_m	1.229	1.227	0.899	0.000899

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.0102$$

Uncertainty of oxygen correction factor (*uf*$_{O2}$)

$$f_{o_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 0.71$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured}) x (20.9\% - O_{2,measured})} \; x \; Uncertainty \; of \; O_2 \; Measurement = 0.03$$

$$\therefore uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = 3.89\ \%$$

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Metal	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
Mercury	0.000246	0.000225	0.579	0.0000107

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system

Metal	uL mg/Nm^3
Mercury	2.718E-06

Uncertainty in final measurement @ Reference Conditions due to uVstp

Metal	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
Mercury	0.000237	0.000233	0.000192	1.947E-06

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Metal	Combined Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration
Mercury	0.0000112	0.0000225	0.000235	9.552

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Metal	% of Measured Concentration	Measurement Uncertainty of Oxygen Corr^n Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (*Ucombined*)	New Combined Uncertainty mg/Nm^3
Mercury	9.552	3.890	10.314	0.000012

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Note: Uncertainty for each metals group is based on the summation in quadrature of the individual standard uncertainties (in mg/m3) of each contributing metal. Combined standard uncertainty of each group is converted to 95% confidence (multiplication by k = 2) before being expressed as a percentage of the combined group concentration.

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Ammonia Uncertainty

Site: Margam
Location: Main Stack

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	Solution mg	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
				Ammonia				
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
Ammonia	...	0.0750	0.0750	...	0.00975	...	0.00488	0.00488
				...				
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	Ammonia			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	0.96	m^3	uV_m	0.001	m^3	
Meter Correction Factor (Yd)	0.96	...		...	...	
Meter Temperature (T_m)	292.50	k	uT_m	1.5	k	
Average Differential Pressure (ΔH)	25.00	mmH_2O	uΔH	0.25	mmH_2O	
Barometric Pressure (ρ_b)	763.56	mmHg	up_b	3.8	mmHg	
ΔH + ρs (ρ_m)	102.04	kPa		...	...	
Oxygen content ($O_{2,m}$)	7.58	% by volume	$uO_{2,m} = \sigma/\sqrt{n}$	0.0699		% by volume
Moisture Content (H_2O)	16.81	% by volume	uH_2O	0.46		% by volume

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. i =uV_m, uT_m etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

Ammonia :

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1.00$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_s) & measured temperature of dry gas uncertainty component ($uT_{m\ Dry}$)

Ammonia :

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.906$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.91	0.91	0.0000870	0.0000218
up_b	0.91	0.90	0.00118	0.00444
uT_m	0.91	0.90	0.00310	0.00464
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00560$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

Ammonia :

$$V_{std} = V_{measured} \times f_s = \quad 0.867$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV_{std}	0.87	0.86	0.96	0.00536
Effect of uV_m	0.87	0.87	0.91	0.000906

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.00519$$

Uncertainty of Oxygen Correction Factor (%):-

Ammonia :

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.12$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.0302$$

$$uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 2.70\ \%$$

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	Ammonia :			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Ammonia	0.10	0.0905	1.29	0.00629

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	Ammonia :
	uL mg/Nm^3
…	…
…	…
…	…
Ammonia	0.00112

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	Ammonia :			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Ammonia	0.0974	0.0962	0.11	0.000580

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	Ammonia :			
	Combined Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration
…	…	…	…	…
…	…	…	…	…
…	…	…	…	…
Ammonia	0.00642	0.0128	0.0968	13.26

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corrn Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (Ucombined)
…	…	…	…
…	…	…	…
…	…	…	…
Ammonia	13.26	2.70	13.53

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Sulphur Dioxide Uncertainty

Site: Margam
Location: Main Stack

$$u_{mass} = \sqrt{\sum (u_{filter})^2 + (u_{solution})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Uncert (%) K=2 Filter mg	LAB Method Uncert (%) K=2 Solution mg	Standard Uncertainty Filter mg	Standard Uncertainty Solution mg	Combined Uncertainty mg
			SO2					
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
Sulphur Dioxide	...	29.06	29.06	...	3.78	...	1.89	1.89
...	...	...	...	...	...	...	...	...
			...					
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	SO2			Standard Uncertainty @ 95%		
Sampled Volume (V_m)	2.37	**m^3**	**uV_m**	0.001	**m^3**	
Meter Correction Factor (Yd)	0.96	**...**		...	**...**	
Meter Temperature (T_m)	298.92	**k**	**uT_m**	1.5	**k**	
Average Differential Pressure (ΔH)	10.00	**mmH_2O**	**uΔH**	0.25	**mmH_2O**	
Barometric Pressure (ρ_b)	763.56	**mmHg**	**up$_b$**	3.8	**mmHg**	
ΔH + ρs (ρ_m)	101.90	**kPa**		...	**...**	
Oxygen content ($O_{2,m}$)	10.28	**% by volume**	$uO_{2,m} = \sigma/\sqrt{n}$	0.0124		**% by volume**
Moisture Content (H_2O)	15.24	**% by volume**	**uH_2O**	0.40		**% by volume**

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. i=uV$_m$, uT$_m$ etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

SO2:

$$f_{s,wet} = \frac{100}{(100 - H_2O)} = \quad 1.00$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up$_s$) & measured temperature of dry gas uncertainty component (uT$_{m\ Dry}$)

SO2:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = \quad 0.885$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.88	0.88	0.0000851	0.0000213
up$_b$	0.89	0.88	0.00116	0.00434
uT$_m$	0.89	0.88	0.00296	0.00444
H_2O	...	...	...	...

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_s)^2}}{(P_m/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{100/(100 - H_2O)}\right)^2} = \quad 0.00524$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV$_{std}$) & volume uncertainty component (uV$_m$)

SO2:

$$V_{std} = V_{measured} \times f_s = \quad 2.095$$

	Maximum m^3	Minimum m^3	Sensitivity	Standard Uncertainty (m^3)
Effect of uV$_{std}$	2.11	2.08	2.37	0.0124
Effect of uV$_m$	2.10	2.09	0.88	0.000885

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = \quad 0.0294$$

Uncertainty of Oxygen Correction Factor (%):-

SO2:

$$f_{o_2} = \frac{20.9\% - O_{2,\,ref}}{20.9\% - O_{2,\,measured}} = \quad 1.40$$

$$uCorr^n{}_{o_2} = \frac{20.9\% - O_{2,\,ref}}{(20.9\% - O_{2,\,measured}) x (20.9\% - O_{2,\,measured})} x\, Uncertainty\ of\ O_2\ Measurement = \quad 0.0476$$

$$uf_{o_2} = \frac{uCorr^n{}_{o_2}}{f_{o_2}} x100 = \quad 3.39\ \%$$

Western Bio-Energy Ltd		**Installation Name**	**: Biomass Plant**
Permit No	**: EPR/ZP3939GL**	**Visit Details**	**: Compliance – May 2022**
Variation No	**: V005**	**Survey Dates**	**: 10th to 12th & 19th to 20th May 2022**
Report Ref	**: P5200 : R002**	**Report Issue Date**	**: 13th July 2022**

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	SO2:			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uM mg/Nm^3
…	…	…	…	…
…	…	…	…	…
Sulphur Dioxide	20.73	18.20	0.67	1.27
…	…	…	…	…

Uncertainty in final measurement @ reference conditions due to uncertainty component arrising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	SO2:
	uL mg/Nm^3
…	…
…	…
Sulphur Dioxide	0.22
…	…

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	SO2:			
	Maximum mg/Nm^3	Minimum mg/Nm^3	Sensitivity	uVstp mg/Nm^3
…	…	…	…	…
…	…	…	…	…
Sulphur Dioxide	19.74	19.19	9.29	0.27
…	…	…	…	…

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	SO2:			
	Combined Uncertainty mg/Nm^3	Expanded Uncertainty mg/Nm^3	Measured Concentration mg/Nm^3	Percent of Measured Concentration
…	…	…	…	…
…	…	…	…	…
Sulphur Dioxide	1.31	2.63	19.46	13.50
…	…	…	…	…

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corrn Factor	Overall Measurement Uncertainty inc O_2 Corr^n factor (Ucombined)
…	…	…	…
…	…	…	…
Sulphur Dioxide	13.50	3.39	13.92
…	…	…	…

Western Bio-Energy Ltd		Installation Name	: Biomass Plant
Permit No	: EPR/ZP3939GL	Visit Details	: Compliance – May 2022
Variation No	: V005	Survey Dates	: 10th to 12th & 19th to 20th May 2022
Report Ref	: P5200 : R002	Report Issue Date	: 13th July 2022

Stack Reference Main Stack

Measurement Uncertainty Calculations - Velocity at Stack Conditions

Contribution From	Standard u/c (mm H_2O)	
Pitot Calibration Uncertainty Contribution	0.137	A
Manometer Calibration Uncertainty Contribution	0.137	B
Variation in Actual Pitot reading at sample points	0.08	C
Combined u/c (mm H_2O) =	**Combined u/c (mm H_2O)**	
SQRT $(A/\sqrt{3})^2 + (B/\sqrt{3})^2 + (C/\sqrt{3})^2$)	0.12	
Expanded Uncertainty of Flow Measurements (mm H_2O)	**0.24**	
	Standard u/c (K)	
Temperature Calibration (K)	2.02	D
Variation in Actual Temp reading at sample points	0.50	E
Combined u/c of Temp (K)	**Combined u/c (K)**	
SQRT $((D/\sqrt{3^2}) + (E/\sqrt{3})^2$)	1.20	
Expanded Uncertainty of Temp Measurements (K)	**2.41**	
Measured Average Velocity (m/s) at Stack Conds	21.09	
Maximum Average Velocity (m/s) at Stack Conds	21.25	
Standard Uncertainty Velocity at Stack Conditions (%)	0.74	
Expanded Uncertainty Velocity (at Stack Conditions)	**1.48 (%)**	

Measurement Uncertainty Calculations - Flowrate at Stack Conditions

Contribution From	Standard u/c (m^2)
Area (m2)	0.02011
Measured Average Flowrate (m^3/s) at Stack Conds	42.40
Maximum Average Flowrate (m^3/s) at Stack Conds	43.15
Standard Uncertainty Flowrate (m^3/s) at Stack Conditions (%)	1.75
Expanded Uncertainty Flowrate (m^3/s) at Stack Conditions	**3.50 (%)**

Measurement Uncertainty Calculations - Flowrate at STP & Wet Gas

Contribution From	Standard u/c (%)
Temperature Calibration (K)	0.5
Barometer Calibration	0.5
Measured Average Flowrate (m^3/s) at STP Wet	28.74
Maximum Average Flowrate (m^3/s) at STP Wet	29.34
Standard Uncertainty Flowrate (m^3/s) at STP Wet	2.09
Expanded Uncertainty Flowrate (m^3/s) at STP Wet	**4.18 (%)**

Measurement Uncertainty Calculations - Flowrate at STP & Dry Gas

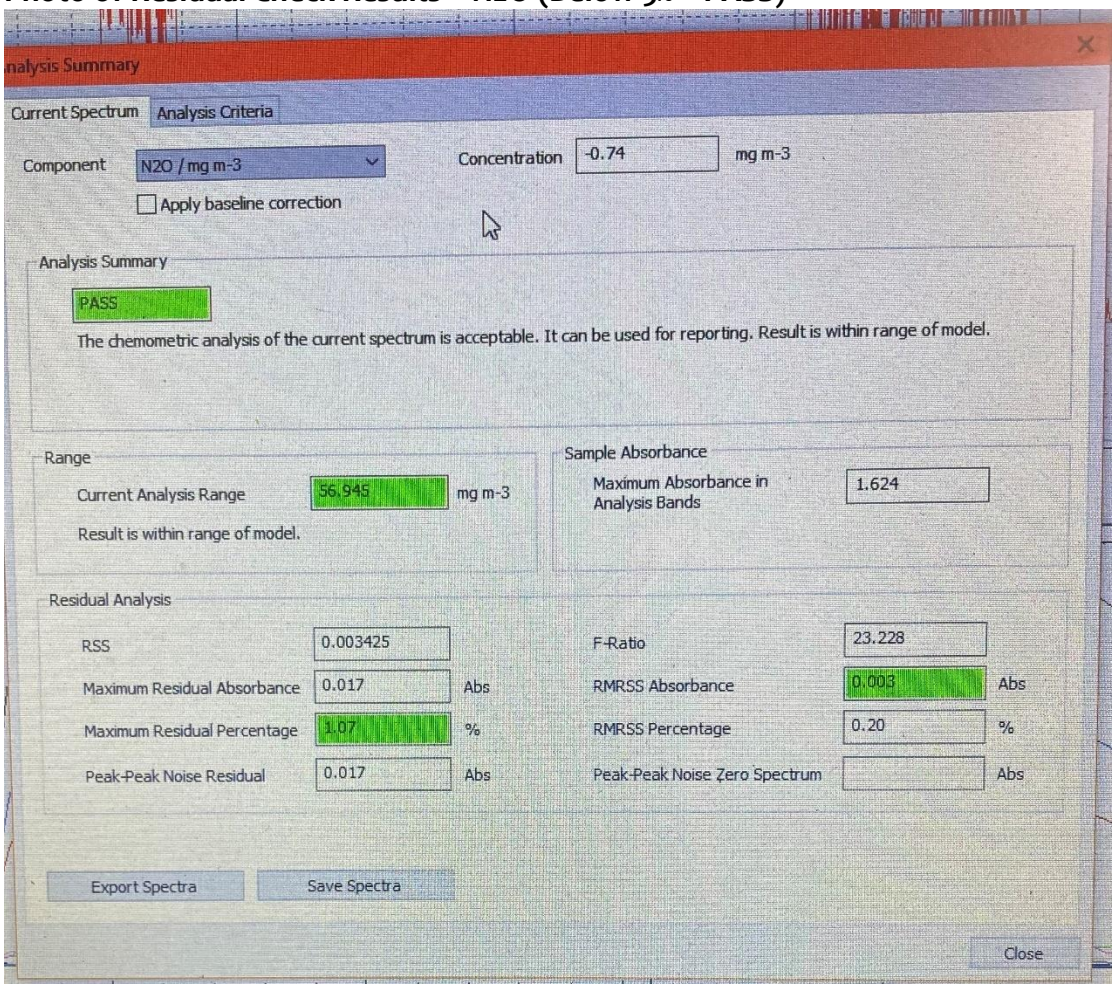
Contribution From	Standard u/c (%)
Moisture Uncertainty (% v/v)	0.27
Measured Average Flowrate (m^3/s) at STP Dry	22.81
Maximum Average Flowrate (m^3/s) at STP Dry	23.37
Standard Uncertainty Flowrate (m^3/s) at STP Dry	2.44
Expanded Uncertainty Flowrate (m^3/s) at STP Dry	**4.88 (%)**

Measurement Uncertainty Calculations - Flowrate at STP, Dry Gas & Ref Oxygen

Contribution From	Standard u/c (%)
Oxygen Uncertainty (% v/v)	0.103
Measured Average Flowrate (m^3/s) at STP Dry & Ref Oxygen	16.26
Maximum Average Flowrate (m^3/s) at STP Dry & Ref Oxygen	16.82
Standard Uncertainty Flowrate (m^3/s) at STP Dry & Ref Oxygen	3.43
Expanded Uncertainty Flowrate (m^3/s) at STP Dry & Ref O_2	**6.85 (%)**

RESULTS OF FTIR DAILY SPECTRAL RESIDUALS CHECKS

Photo of Residual Check Results – N2O (Below 5% = PASS)



FTIR SUMMARY OF ANALYTICAL BANDS

SUMMARY OF ANALYTICAL BANDS – PROTEA FTIR 204M

Gas Species	Primary Method Band / cm^{-1}	Secondary Method Band / cm^{-1}	Tertiary Method Band / cm^{-1}
H_2O	3319.374 – 3404.709		
CO_2	2043.693 – 2091.905 902.523 – 997.018		
CO	2132.885 – 2201.345	2021.034 – 2201.345	2021.034 – 2201.345
NO	1872.060 – 1905.326	2012.838 – 1851.329 (sub-set of smaller bands in this region)	3388.317 – 3404.709 1905.326 - 1872.060
NO_2	1548.077 – 1677.284	1605.931 - 1583.754; 2810.741 – 3160.276	2810.259 – 2936.091
N_2O	2113.600 – 2223.041	2528.703 – 2651.160 2113.600 – 2223.041	
SO_2	1295.448 – 1414.531	3388.317 – 3404.709 1342.695 – 1360.052 1019.195 – 1233.737	2810.259 – 2936.091
NH_3	899.148 – 969.055		
HCl	2587.521 – 2884.023	2587.521 – 2884.023	