enviroDAT
AIR QUALITY & ENVIRONMENTAL CONSULTANTS

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Report for the Periodic Re-monitoring of Emissions to Air from the Biogas Engine Stack Located at Waen Anaerobic Digestion Site

Part 1: **Executive Summary**

Permit Number: EPR/DP3735NP

Operator: Biogen UK Ltd.

Installation: Waen AD Site - Engine

MCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING
4251

Monitoring dates:	18th October 2017
Job Number:	**R17150/R**
Version:	1
Address:	Biogen UK Ltd Milton Park Milton Ernest Bedfordshire MK44 1YU
Monitoring Organisation:	**EnviroDat Ltd.**
Address:	Science & Technology Centre Earley Gate Whiteknights Road Reading, RG6 6BZ
Date of Report:	1st November 2017
Report Approved By:	David Littlewood
MCERTS Registration Number:	MM 06 772 (Level II, TE1, 2, 3 & 4)
Function:	Operations Manager (Team Leader)
Signed:	

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PART 1: EXECUTIVE SUMMARY

1.1 Monitoring Objectives

Biogen UK Ltd operates a spark ignition engine at Waen Anaerobic Digestion Site. This combustion plant has the potential to pollute the atmosphere. Consequently, these processes are subject to regulation and periodic environmental monitoring is necessary under this regulation.

Methane is produced from the decomposition of organic waste that is anaerobically digested within the plant system. This methane is extracted and pumped through inert piping to a gas holder which in-turn supplies the fuel for the engine or flare.

EnviroDat Ltd. was commissioned to re-test the pollutants within the engine emissions - as prescribed in the operational permit - in order to establish the sites environmental compliance.

The pollutants monitored, as required under EPR/DP3735NP, are summarised below:

Substances to be monitored	**Emission Point Identification**
	Engine
Sulphur Dioxide (SO_2)	✓
Oxygen (O_2 - for correction)	✓
Moisture (H_2O - for correction)	✓
Special requirements	None requested

1.2 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Estimate of Uncertainty (2σ at 95% confidence)	Units	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method (see note below)	Operating Status
Engine	Sulphur dioxide (SO2)	350	**212.9**	±20.7	$mg(N)m^{-3}$	101.3kPa, 273K, dry gas, 5% Oxygen	18-10-17	13:18-14:18	BS EN 14791	B	At 100% MCR
	Moisture	-	**11.1**	n/a	%	101.3kPa, 273K, dry gas			BS EN 14790	A	
	Oxygen	-	**7.46**	±0.45	%				BS EN 14789	A	

NOTE:

A. EnviroDat Ltd MCerts/UKAS Accredited for sampling and analysis.

B. EnviroDat Ltd MCerts/UKAS Accredited for sampling only, UKAS Accredited analysis conducted by sub-contract laboratory.

C. EnviroDat Ltd UKAS Accredited for sampling only (further clarification is given in section 1.4). Analysis of this component is not UKAS Accredited.

D. The method for sampling and analysis is not UKAS or MCerts Accredited, method follows documented in-house procedure (further clarification is given in section 1.4).

1.3 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results			
								Substance	CEMS Results	Periodic Monitoring Results	Units
Engine	18/10/17	Combustion	Continuous	Biogas	N/A	None	Producing 1064kW (100% MCR)	N/A	N/A	N/A	N/A

1.4 Monitoring Deviations

Emission Point Reference	Substance Deviations	Monitoring Deviations	Other Relevant Issues
Engine	None	None	None

PART 2: SUPPORTING INFORMATION

2.1 Appendix I: General Information

2.1.1 Monitoring organisation staff details

Monitoring at Waen AD Site was conducted by the following EnviroDat Engineers:

Team Leader, Dean Kyle – Mcerts Level II (TE3 & 4) MM12 1188

2.1.2 Monitoring method details

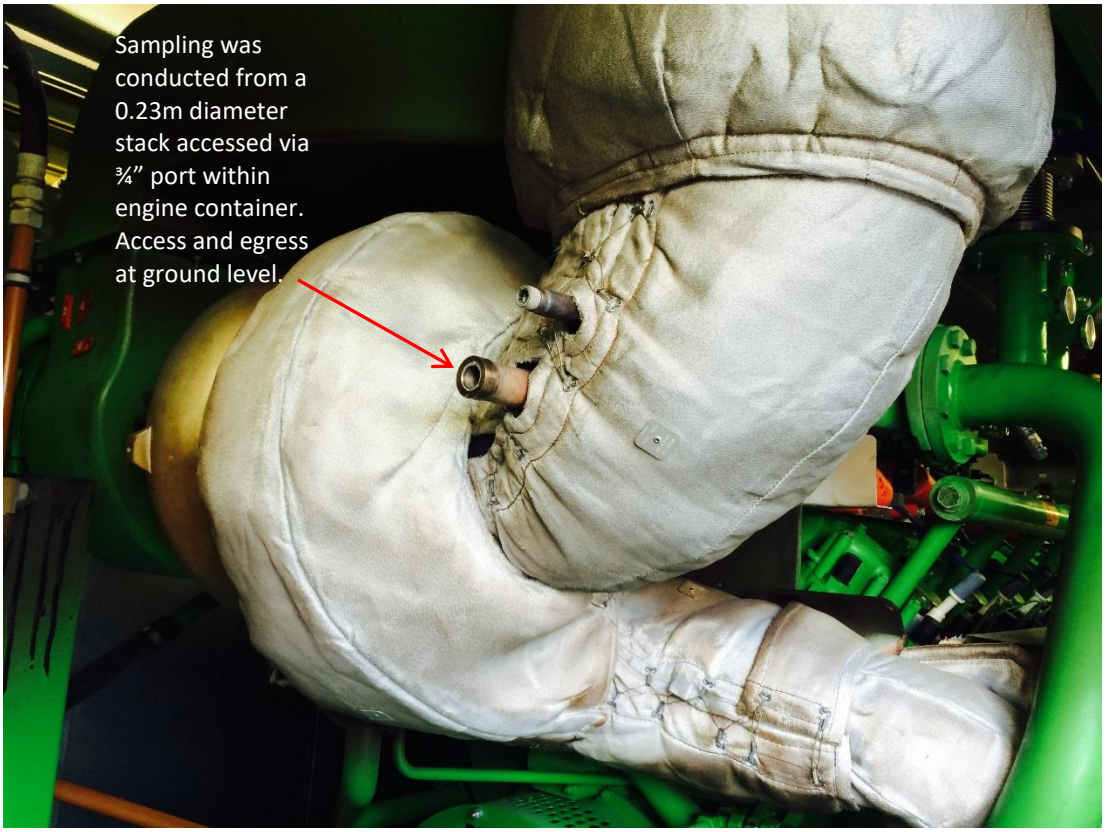
Parameter	Standard Reference Method/Alternative	EnviroDat Procedure	MCerts Accreditation
Sulphur Dioxide (SO2)	BS EN 14791	SP14791	MCerts
Moisture (H_2O)	BS EN 14790	SP14790	MCerts
Oxygen (O_2)	BS EN 14789	SP14789	MCerts

2.1.3 Monitoring organisation equipment and gas check list references

EQUIPMENT			
Item	**Reference**	**Calibration Due**	**PAT Due**
Portable Gas Analyser	PGA#06	12-Mar-18	Sep-18
Gas Conditioner	COND#03	01-Oct-18	Sep-18
Data Logger	DL#04	21-Nov-17	-
Digital Barometer	DB#22	28-Oct-18	-
Balance	BAL#02	23-Mar-18	-
Heated Filter Head	HFH#01	05-Feb-18	-
Heated Line	HL#11	22-Dec-17	-
Heated Line Controller[1]	HLC#11	22-Dec-17	Sep-18
'Apex' Kit	Apex#02	See each item	Sep-18
Dry Gas Meter ('Apex')	DGM#07	18-Apr-18	-
Thermocouple Reader[1] ('Apex')	TCR#13	18-Apr-18	-
Thermocouple Reader[2] ('Apex')	TCR#14	18-Apr-18	-
Thermocouple Reader[3] ('Apex')	TCR#11	18-Apr-18	-
Manometer ('Apex' Orange)	MAN#06	18-Apr-18	-
Manometer ('Apex' Red)	MAN#07	18-Apr-18	-
Timepiece[1] ('Apex')	TP#09	18-Apr-18	-
Timepiece[2]	TP#17	02-Jan-18	-
Thermocouple (Apex Dogleg Exit)	TC#21	27-Sep-18	-
Thermocouple (Stack Temperature Check)	TC#44	06-Feb-18	-
GAS CYLINDERS			
	Certificate No.	**Level (ppm)**	**Validity**
'Zero' Gas (%)[1]	GU92VQC	99.999%	-
Oxygen Span Gas (%)	EQ64NAF	8.15%	30-Jan-18

2.2 Appendix II: Emission Point Reference Data & Results

2.2.1 Photograph of Sampling Location on Engine



2.2.2 Homogeneity testing

BSEN15259 stipulates that the exhaust gases emitted from combustion processes are tested to ensure homogeneity and that a representative sample is obtained during the monitoring, subject to a number of caveats as elucidated in Environment Agency guidance MID15259. The details of the testing at each emission point are summarised below:

Stack	Result of Homogeneity Testing
Engine	N/A –homogeneity testing only required on stacks exceeding 1.13 m diameter, as specified in MID 15259. Homogeneity assumed and single point sampling acceptable.

2.2.3 Gas analyser site measurements and calibrations

The data in the following Chart and in Table 2 are expressed in %. Calibration data is shown in Table 1.

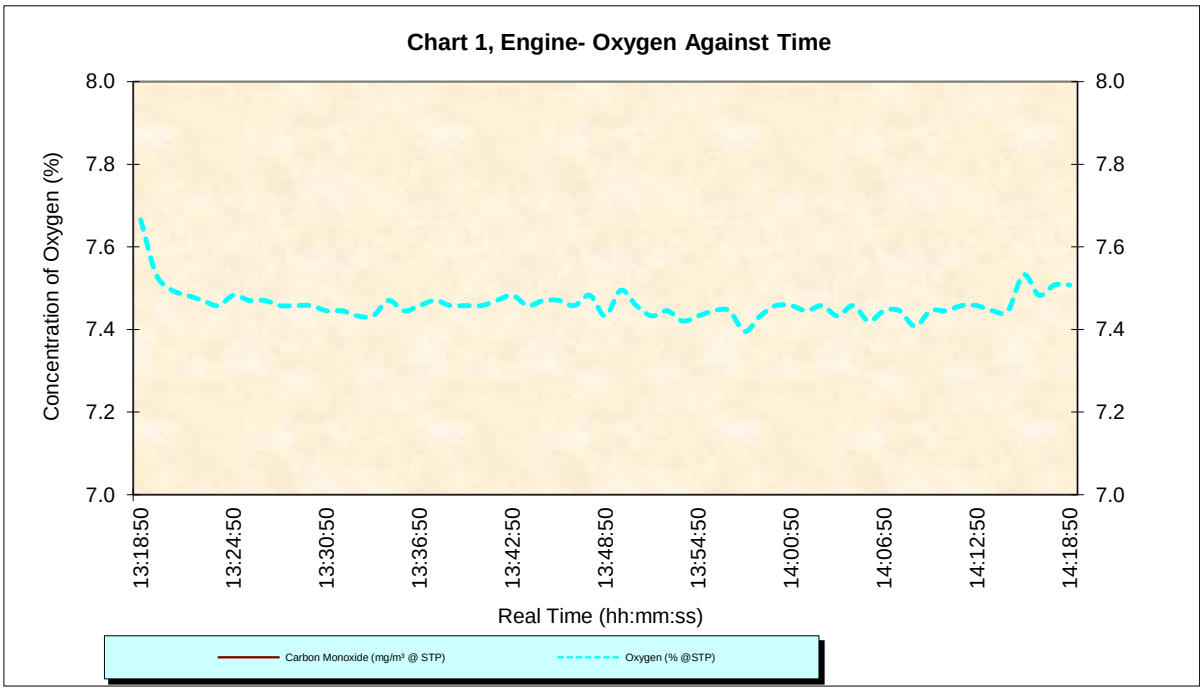


Table 1 – Calibration Data

ANALYSER CALIBRATION DATA		
Pre Sampling Check		
		O2 (%)
Range		25
Zero Gas	**Cylinder No.**	GU92VQC
Span Gas	**Cylinder No.**	EQ64NAF
	Certified Value	8.15
Zero Check	**Value**	0.04
<2 x repeatability (Yes/No)		YES
Down Line Zero & Span Check		
Zero Gas	**Value**	0.16
	<2% of span	**YES**
Span Gas	**Value**	8.09
	Within 2% of span	YES
Post Sampling Drift Check		
Zero Gas	**Value**	0.15
	Drift (%)	0.1
	Validation	**No Correction Required**
Span Gas	**Value**	8.16
	Drift (%)	0.9
	Validation	**No Correction Required**

Table 2 – Engine, Raw data

Time	Oxygen (%)
13:18:50	7.7
13:19:50	7.5
13:20:50	7.5
13:21:50	7.5
13:22:50	7.5
13:23:50	7.5
13:24:50	7.5
13:25:50	7.5
13:26:50	7.5
13:27:50	7.5
13:28:50	7.5
13:29:50	7.5
13:30:50	7.4
13:31:50	7.4
13:32:50	7.4
13:33:50	7.4
13:34:50	7.5
13:35:50	7.4
13:36:50	7.5
13:37:50	7.5
13:38:50	7.5
13:39:50	7.5
13:40:50	7.5
13:41:50	7.5
13:42:50	7.5
13:43:50	7.5
13:44:50	7.5
13:45:50	7.5
13:46:50	7.5
13:47:50	7.5
13:48:50	7.4
13:49:50	7.5
13:50:50	7.5
13:51:50	7.4
13:52:50	7.4
13:53:50	7.4
13:54:50	7.4
13:55:50	7.4
13:56:50	7.4
13:57:50	7.4
13:58:50	7.4
13:59:50	7.5
14:00:50	7.5
14:01:50	7.4

Time	Oxygen (%)
14:02:50	7.5
14:03:50	7.4
14:04:50	7.5
14:05:50	7.4
14:06:50	7.4
14:07:50	7.4
14:08:50	7.4
14:09:50	7.4
14:10:50	7.4
14:11:50	7.5
14:12:50	7.5
14:13:50	7.4
14:14:50	7.4
14:15:50	7.5
14:16:50	7.5
14:17:50	7.5
14:18:50	7.5

2.3 Appendix III: Uncertainty Calculation

2.3.1 Engine, Uncertainty Calculations

Oxygen - Measurement performance related to stationary conditions		
Performance characteristic	**Uncertainty**	**Value of uncertainty quantity**
Standard deviation of repeatability at zero	u_{r0}	0.20
Standard deviation of repeatability at span level	u_{rs}	0.03
Lack of fit	u_{fit}	0.09
Drift	u_{0dr}	0.11
volume or pressure flow dependence	u_{spres}	0.00
atmopsheric pressure dependence	u_{apres}	0.00
ambient temperature dependence	u_{temp}	0.10
CO2 (15%)	-	0.00
NO(300)	-	0.06
NO2(30)	-	0.00
dependence on voltage	u_{volt}	0.02
losses in the line (leak)	u_{leak}	0.09
Error in Logger voltage	-	0.03
Uncertainty of calibration gas	u_{calib}	0.09

O2 Measurement uncertainty	Result	7.46	%vol
Combined uncertainty		0.23	%vol
% of value		3.02	%
Expanded uncertainty	**expressed with a level of confidence of 95%**	**6.04**	**% of value**
Expanded uncertainty	**expressed with a level of confidence of 95%**	**0.45**	**% vol**

Sulphur Dioxide

Parameter		Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard conditi	V	0.43	m^3	421.39	1.10 $mg.m^{-3}$	0.61 %
Mass	m	93.76	mg	1.92	9.31 $mg.m^{-3}$	5.17 %
Factor for O2 Correction	fc	1.18		152.32	3.87 $mg.m^{-3}$	2.15 %
Leak	L	2.08	$mg.m^{-3}$	1.00	2.08 $mg.m^{-3}$	1.15 %
Combined uncertainty					**10.35** $mg.m^{-3}$	

Expanded uncertainty as percentage of measured value	**11.50**	**% measured of value**	**expressed with a level of confidence of 95% (Using a coverage factor k=2)**
Expanded uncertainty in units of measurement	**20.71**	**$mg.m^{-3}$**	
Expanded uncertainty as percentqge of limit value	**5.92**	**% ELV**	

2.4 Appendix IV: Moisture Calculations

Test No	T2		Site	Biogen		
Date	18-10-17			Waen		
pbar (mbar)	1004		Stack	Engine		
pbar (mnHg)	753		Job Number:	R17150R		
Nozzle Diameter (mm)	n/a		Site Team:	DK		
Temp of Meter (in)/(out) deg. C	20		Data Entered By:	DK		
ΔH_{ave} (mm$H_2$0)	10.0					
DGM Cal Factor (Y)	1.0180		Enter Data into coloured cells only			

Start Volume Reading	141.5440	m³		Start time	13:18	hr:min
End Volume Reading	142.0970	m³		End time	14:18	hr:min
Volume Sampled	0.5630	m³		Total time	1:00	hr:min

IMPINGER	1	2	3	4	Initials of Analyst
Absorber Solution (Type):	H2O2			SILICA	
Sample No:	T2A		T2B	n/a	
Analysis Required:	Sulphate			n/a	
Initial Weight of Impingers plus absorber (g)	924.1	771.0	644.9	876.2	DK
Final Weight of Impingers plus absorber (g)	962.6	773.4	646.1	886.1	DK
Weight Gain (g)	38.5	2.4	1.2	9.9	

Total Weight Gain (1+2+3+4) (g)	52

Gas Volume of water at 0 °C (l)	64.74
Gas Meter volume at 0 °C (l)	520.37

Moisture content of Gases (%)	11.1

2.5 Appendix V: Sulphur Dioxide Calculations & Lab Results

SUMMARY OF ACID GAS IMPINGEMENT SAMPLING		
Stack ID		Engine
Stack Dimensions (m)		0.23
Date of Test		18-Oct-17
TEST NUMBER		T2
	Applied Standard	***14791***
Start Time	(hh:mm)	13:17
Stop Time	(hh:mm)	14:17
Duration	(minutes)	60
Sampled Gas Volume	(m3)	0.5530
Mean Temperature DGM	(oC)	20.00
Mean Sample Pressure	(mm H2O)	10.00
Mean Stack Temperature	(oC)	510.00
Corrected Sampled Gas Vol.	(Sm3@20oC)	0.5588
Corrected Sampled Gas Vol.	(Nm3@STP)	0.5206
Average Flowrate	(l/m @STP)	8.68
Required Pollutant *(eg:HCl, HF or SO_2)*		SO2
Molecular Weight Pollutant		64
Determinant Species		sulphate
Molecular Weight Determinand		96
	Analysing Laboratory UKAS No.	***1549***
Measured concentration*(Front)*	(ug/ml)	370.0
Solution Sample Volume	(ml)	380.0
Measured concentration*(Back)*	(ug/ml)	0.2
Solution Sample Volume	(ml)	172.0
	Efficiency of Capture (%)	*99.97%*
Total Determinand Mass	(mg)	140.640
Moles of Determinand (mol)	(mol)	1.465
Mass of Pollutant	(mg)	93.76
Concentration (@ STP, Dry)	(mg/m3)	180.09
Stack Moisture	(%)v/v	11.05
Moisture Correction	dim'less	1.12
Stack Oxygen	(%)v/v	7.46
Oxygen Correction Factor	dim'less	1.18
Net Correction Factor	dim'less	1.18
Concentration @ Ref	**(mg/(N)m3)**	**212.94**
Sample as a percentage of ELV	*(%)*	*60.84%*
Blank Value	*(mg/(N)m3)*	*0.23*
Is Blank value < 10% of ELV		Yes

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Certificate of Analysis

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Report Number: 690986-1

Date of Report: 26-Oct-2017

Customer: EnviroDat
Science & Technology Centre
Earley Gate
Whiteknights Road
Reading
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Customer Contact: Mr Dean Kyle

Customer Job Reference: R17150/R
Date Job Received at Concept: 20-Oct-2017
Date Analysis Started: 20-Oct-2017
Date Analysis Completed: 26-Oct-2017

The results reported relate to samples received in the laboratory and may not be representative of a whole batch.
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with Concept Life Sciences SOPs
All results have been reviewed in accordance with Section 25 of the Concept Life Sciences, Analytical Services Quality Manual

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Report checked
and authorised by :
Emma Spear
Customer Service Advisor

Issued by :
Emma Spear
Customer Service Advisor

Validity unknown
Digitally signed by Emma Spear
Date: 2017.10.26 11:31:27 BST
Reason: Issue
Location: SAL

Concept Reference: 690986
Customer Reference: R17150/R

Impinger(peroxide) Sulphate & Volume Analysed as Impinger(peroxide)

				Concept Reference	690986 001	690986 002	690986 003	690986 004
				Customer Sample Reference	T1A	T1B	T2A	T2B
				Test Sample	AR	AR	AR	AR
				Date Sampled	18-OCT-2017	18-OCT-2017	18-OCT-2017	18-OCT-2017
Determinand	Method	LOD	Units	Symbol				
Sulphate	IC	0.05	mg/l	U	(13) 0.20	(13) 0.19	(195,13) 370	(13) 0.23
Volume	Vol	1	ml	U	44	32	58	35

Index to symbols used in 690986-1

Value	Description
AR	As Received
13	Results have been blank corrected.
195	Due to levels found in the sample that are outside of the normal calibration range of the instrument, analysis was conducted on a diluted sample
U	Analysis is UKAS accredited