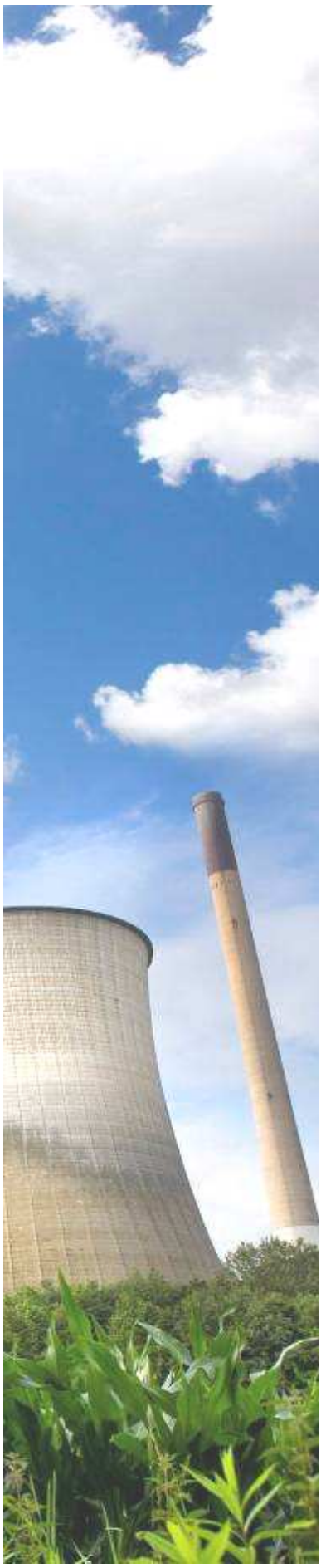
REC
Resource & Environmental Consultants Ltd

UKAS TESTING 2082



MONITORING OF EMISSIONS FROM THE DRYER, COOLER & BBF PROCESS

27 & 28 February 2013

Prepared for Sundown Products Ltd

REC Report 71506p1r0

Issued: 20 March 2013

REC Air Quality

GREEN ACHIEVER

SAFEcontractor APPROVED

UKAS TESTING 2082

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EXECUTIVE SUMMARY

Resource & Environmental Consultants (REC) Ltd was commissioned by Sundown Products Ltd to monitor emissions of pollutants released from the Animal Feed manufacturing process at their site in Huntingdon.

In accordance with the requirements of their site permit, monitoring has been undertaken for the following pollutants:-

- Total Particulate Matter
- Oxygen

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

Species	Emission Source	Accreditation Status	Emission Concentration (mg/Nm^3)	Permit Limit (mg/Nm^3)
Particulate Matter	Dryer	B	33.7	150
Particulate Matter	Cooler	B	25.2	150
Particulate Matter	BBF	B	5.8	20

NOTE 1: Data from all sources except Dryer are expressed in mg/Nm^3 at 273K, 101.3kPa, without correction for moisture and oxygen content. Data from Dryer expressed in mg/Nm^3 at 273K, 101.3kPa, wet gas and corrected to 17% oxygen content
NOTE: UKAS Status:-. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd

1. INTRODUCTION

1.1 Background

Sundown Products Ltd commissioned REC Ltd to conduct an emission monitoring survey on their various process emission stacks from the animal feed manufacturing process at their site in Huntingdon, Cambridgeshire.

Operations at Sundown Products Ltd, involve the use of drying and cooling processes to manufacturer a wide range of animal feed.

The Dryer process removes moisture from straw through heating in a rotational drum.

The Cooler process helps to complete the pellets chemical reactions with sodium hydroxide and also allows them to cool down.

The BBF stack acts as an outlet from a cyclone process on a conveyor belt.

1.2 Scope of the Survey

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

- Total Particulate Matter
- Oxygen

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

Results were to be reported at 273K, 101.3kPa, without correction for moisture and oxygen content. Results from the Dryer were to be referenced to 17% O_2 content.

1.3 Sampling Personnel

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

- Ibai Castezubi - Team Leader, MM05 674, MCERTS Level 2, TE1-4
- Aidan Wrynne - Assistant, MM08 921, MCERTS Level 1

2. METHODOLOGY

2.1 Species & Techniques

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

Species	UKAS Status	Method	Uncertainty (±%)	Limit of Detection
Moisture	A	In house method MM0010 based on BS EN 14790	20	0.1%vol
Particulate Matter	B	In house method MM0004 based on BS EN 13284	10	1 mg/m^3
Oxygen	A	In house method MM0002 based on ISO 12039	10	0.1%vol

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

2.2 Sampling & Analytical Methodology

Total Particulate Matter

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

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

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

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

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

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

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

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

Oxygen

To determine the concentration of O_2 in emissions, a Testotherm Model 350XL multigas analyser was used. The analyser incorporates a gas conditioner to enable the gas stream to be presented to the electrochemical cells on a dry gas basis. In house method MM0002 was followed.

The analyser satisfies the requirements of the following Standards:-

O_2 - ISO 12039

For each parameter the measured value (m.v.) and accuracy associated with this type of measurement using the Testo 350XL is:

O_2 ± 0.8% of full scale deflection

The analyser would be calibrated against traceable test gases prior to the survey.

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

Stack Temperature and Velocity

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

2.3 Laboratory Analysis

An approved UKAS accredited sub-contractor which in this case was Sal Ltd would undertake the sample analysis for Total Particulate Matter.

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

3. SAMPLING AND OPERATIONAL DETAILS

3.1 Process Description

The operations at Sundown Products Ltd are authorised under a Part B permit issued by the Local Authority under the Environmental Permitting Regulations, 2010.

The process is therefore under Local Authority regulation and must demonstrate compliance with the emission limits stipulated in the site permit B03/94.

The Dryer process is a continuous process using a rotational heating drum to dry products, with the excess dust passing through a cyclone before being discharged to the atmosphere.

The Cooler process is a continuous process involving the reaction of feed pellets with sodium hydroxide. Emissions pass through a cyclone before being discharged in to the atmosphere.

The BBF stack is a continuous dust extraction process. Emissions pass through a cyclone before being discharged in to the atmosphere.

3.2 Sampling Positions

On the Dryer stack, 1 x 4" BSP sampling ports was installed, in a horizontal plane. The sampling points provided were less than 5 x hydraulic diameters downstream from a flow disturbance but greater than five hydraulic diameters upstream from the stacks exit.

On the Cooler stack, 1 x 4" BSP sampling port was installed. The sampling points provided were less than 4 x hydraulic diameters from any flow disturbance both upstream and downstream from the sampling plane.

On the BBF stack 1 x 4" BSP sampling port was installed in a horizontal plane. The sampling points provided were greater than five hydraulic diameters both upstream and downstream from flow disturbances.

Both the sample locations and sample port size do not fully comply with the positional requirements of Environment Agency Technical Guidance Note M1 (EA TGN M1). M1 requires 2 x 5"BSP sockets to be fitted, at least 5 hydraulic diameters from any flow disturbances.
The initial temperature and velocity traverse conducted along the sample planes showed that the flow requirements of TGN M1 were however met.

Diagrams detailing the sampling positions and taken from Site Worksheets are provided in Appendix 2.

3.3 Uncertainty

Due to access restrictions sampling from each source could only be conducted through one sampling port.

However on both the Dryer and Cooler Stack the number of sample points, were increased along the single sampling plane and therefore the standard uncertainties would still apply.

Due to the access restrictions on the BBF Stack, only a single sampling plane could be utilised and at limited points. This in addition to the isokinetic test rate being below standard will increase the measurement uncertainty from the standard ±10%.

The sample plane does not meet the requirements stated in Environment Agency Technical Guidance Note M1.

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

3.4 Emission Monitoring Survey Details

The emission monitoring survey was carried out on the animal feed manufacturing process over the period 27 & 28 February 2013. The table below summarises the actual sampling periods.

SAMPLING PERIODS

Stack	Parameter	Sample Time (& Date)
Dryer	Particulates & Oxygen	14:05 –14:45(27/02/13)
Cooler	Particulates	10:40 -11:20 (28/02/13)
BBF	Particulates	13:20 -14:00 (28/02/13)

4. RESULTS AND DISCUSSION

4.1 Initial Velocity and Temperature Traverse

An initial pitot-static pressure and temperature traverse was carried out. From these data stack velocity, expressed in metres per second (m/s), and volumetric flowrates expressed in cubic metre per hour (m^3/hr) have been calculated.

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

4.2 Particulate Matter

The results of the particulate sampling runs are summarised in Tables 2 to 4. From the mass of particulate matter on the filter and in the acetone/water wash residue and volume sampled an emission concentration was calculated.

The results for the Dryer are expressed in mg/m^3 at 273K, 101.3kPa, without correction for water vapour and referenced to17% O_2 content.

The results for Cooler & BBF TPM are expressed in mg/m^3 at 273K, 101.3kPa without correction for water vapour and oxygen content.

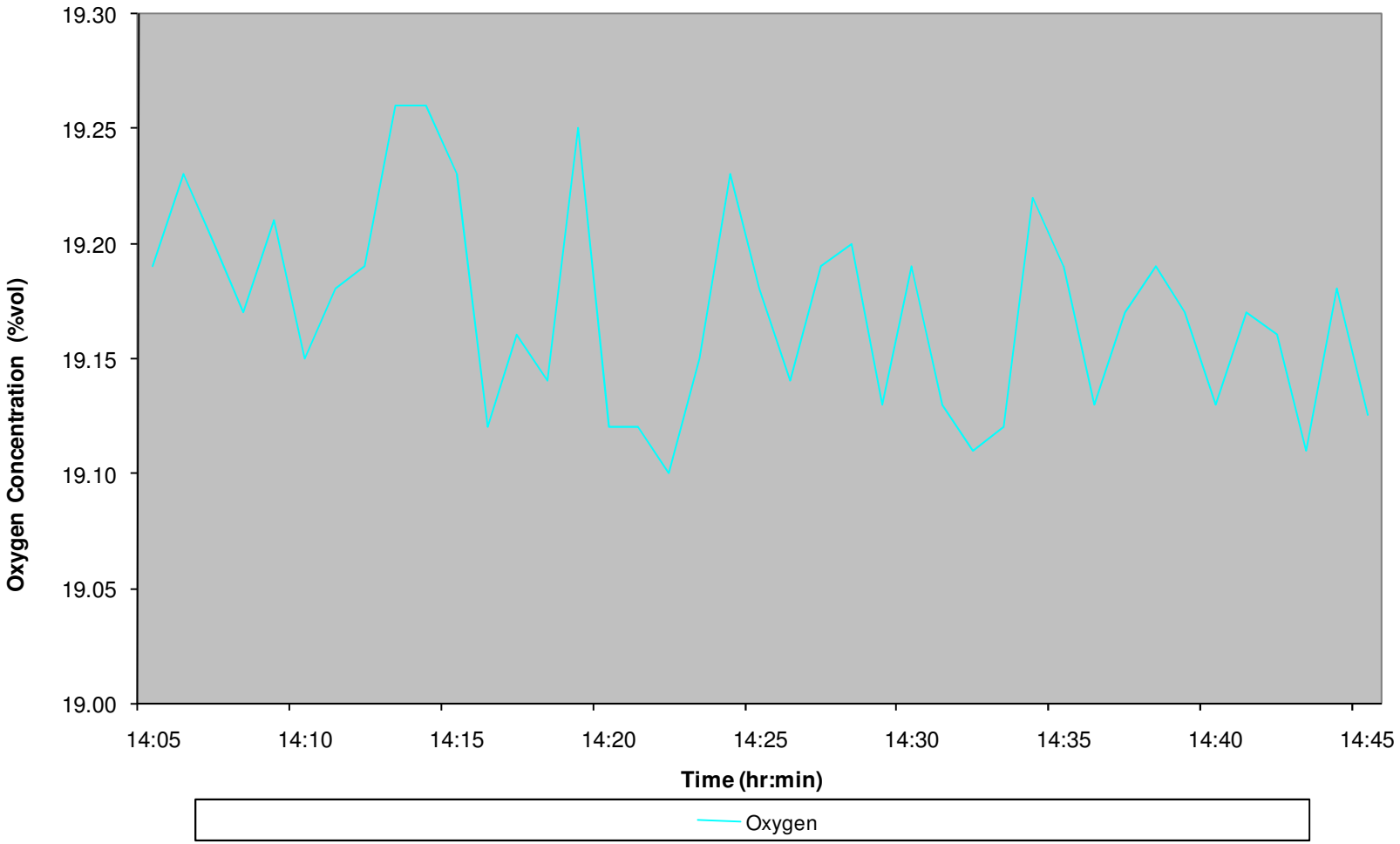
4.3 Combustion Gases

The results of the oxygen monitoring test on the Dryer are summarised in Table 6. The table presents the average of concentrations measured throughout the sample period. Concentrations are expressed as a percentage by volume (%vol).

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

FIGURES

Fig 1: Oxygen Gas Emission Data, Sundown Products, Ltd Huntingdon, Dryer Stack (27/02/13)



TABLES

TABLE 1

FLOW DATA

Stack Ref.	Stack Temp	Av Pitot ΔP	Duct Diam	X-Sect. Area	Velocity (actual)	Volume Flow (m^3/hr)	
	(^{0}C)	(Pa)	(cm)	(m^2)	(m/s)	(actual)	(@ ntp)
Dryer	79	66	100	0.785	11.4	32,164	24,970
Cooler	24	117	100	0.785	14.0	39,639	36,461
BBF	13	219	50	0.196	18.9	13,338	12,740

TABLE 2

PARTICULATE EMISSION DATA SUMMARY – DRYER

DATE: 27/02/13 **14:05 - 14:45**

Sampling Data	
Run Time (min)	**40**
Total mass H_2O collected (g)	**44.0**
Pitot tube constant, Cp	**0.84**
Dry gas meter (DGM) volume (m^3)	**0.739**
Temperature DGM (^oC)	**11**
Temperature stack (^oC)	**79**
Mean pitot tube pressure drop, delta P (mm H_2O)	**8.0**
Orifice meter pressure drop, delta H (mm H_2O)	**35.2**
Barometric Pressure (kPa)	**102.5**
X-sectional area of stack (m^2)	**0.785**
Nozzle size (mm)	**7.01**
Flow Data	
Velocity, actual (m/s)	**10.6**
Velocity, ntp (m/s)	**8.2**
Vol. Flow, actual (m^3/hr)	**29,840**
Vol. Flow, ntp (m^3/hr)	**23,280**
Volume sampled, ntp, dry gas (m^3)	**0.769**
Volume sampled, ntp, wet gas (m^3)	**0.824**
Analytical Data	
Filter Weight Gain (mg)	**12.0**
Acetone Wash Residue Weight (mg)	**0.1**
Total Particulates (mg)	**12.1**
Partics Field Blank (mg)	**0.2**
Blank % of ELV	**0.2**
Emission Data	
O_2 (%vol)	**19.2**
H_2O (% vol)	**6.7**
Percentage Isokinetic	**107.9**
Particulates (mg/m^3 at ref O_2)	**33.7**
Uncertainty (± mg/m^3)	**4.9**

TABLE 3

PARTICULATE EMISSION DATA SUMMARY – COOLER

DATE: 28/03/13 **10:40 - 11:20**

Sampling Data	
Run Time (min)	**40**
Total mass H_2O collected (g)	**2.2**
Pitot tube constant, Cp	**0.84**
Dry gas meter (DGM) volume (m^3)	**1.053**
Temperature DGM (^oC)	**12**
Temperature stack (^oC)	**24**
Mean pitot tube pressure drop, delta P (mm H_2O)	**14.5**
Orifice meter pressure drop, delta H (mm H_2O)	**62.6**
Barometric Pressure (kPa)	**101.1**
X-sectional area of stack (m^2)	**0.785**
Nozzle size (mm)	**7.01**
Flow Data	
Velocity, actual (m/s)	**13.0**
Velocity, ntp (m/s)	**12.0**
Vol. Flow, actual (m^3/hr)	**36,793**
Vol. Flow, ntp (m^3/hr)	**33,800**
Volume sampled, ntp, dry gas (m^3)	**1.077**
Volume sampled, ntp, wet gas (m^3)	**1.080**
Analytical Data	
Filter Weight Gain (mg)	**7.2**
Acetone Wash Residue Weight (mg)	**20.0**
Total Particulates (mg)	**27.2**
Partics Field Blank (mg)	**0.2**
Blank % of ELV	**0.1**
Emission Data	
H_2O (% vol)	**0.3**
Percentage Isokinetic	**97.5**
Particulates (mg/m^3)	**25.2**
Uncertainty (± mg/m^3)	**0.7**

TABLE 4

PARTICULATE EMISSION DATA SUMMARY – BBF

DATE: 28/2/13 **13:20 - 14:00**

Sampling Data	
Run Time (min)	**40**
Total mass H_2O collected (g)	**12.8**
Pitot tube constant, Cp	**0.84**
Dry gas meter (DGM) volume (m^3)	**1.430**
Temperature DGM (^oC)	**12**
Temperature stack (^oC)	**15**
Mean pitot tube pressure drop, delta P (mm H_2O)	**27.6**
Orifice meter pressure drop, delta H (mm H_2O)	**125.1**
Barometric Pressure (kPa)	**101.1**
X-sectional area of stack (m^2)	**0.196**
Nozzle size (mm)	**7.01**
Flow Data	
Velocity, actual (m/s)	**17.8**
Velocity, ntp (m/s)	**16.9**
Vol. Flow, actual (m^3/hr)	**12,591**
Vol. Flow, ntp (m^3/hr)	**11,939**
Volume sampled, ntp, dry gas (m^3)	**1.460**
Volume sampled, ntp, wet gas (m^3)	**1.476**
Analytical Data	
Filter Weight Gain (mg)	**2.2**
Acetone Wash Residue Weight (mg)	**6.4**
Total Particulates (mg)	**8.6**
Partics Field Blank (mg)	**0.2**
Blank % of ELV	**0.7**
Emission Data	
H_2O (% vol)	**1.1**
Percentage Isokinetic	**94.3**
Particulates (mg/m^3)	**5.8**
Uncertainty (± mg/m^3)	**0.4**

TABLE 5

OXYGEN GAS EMISSION DATA – DRYER – 27/02/13

Stack Ref	O_2 (% vol)
Dryer	19.2
Uncertainty (±)	3.2

APPENDIX 1

Certificate of Analysis

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

Scientific Analysis Laboratories Ltd

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
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M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2404

Report Number: 319293-1

Date of Report: 08-Mar-2013

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

Customer Contact: Mr Ibai Castezubi

Customer Job Reference: 71506
Customer Site Reference: Date collected: 27+28/02/13
Date Job Received at SAL: 05-Mar-2013
Date Analysis Started: 05-Mar-2013
Date Analysis Completed: 08-Mar-2013

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

UKAS TESTING
1549

Report checked and authorised by :
Jennifer Wraith
Sales Support Manager

Issued by :
Jennifer Wraith
Sales Support Manager

SAL Reference: 319293
Project Site: Date collected: 27+28/02/13
Customer Reference: 71506

Wash(Acetone) Analysed as Wash(Acetone)
Miscellaneous

				SAL Reference	319293 002	319293 004	319293 006	319293 008	319293 010
				Customer Sample Reference	2	4	6	8	10
				Test Sample	AR	AR	AR	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**					
Particulates (Total)	Grav	0.1	mg	U	<0.1	<0.1	**20**	<0.1	**6.4**

SAL Reference: 319293
Project Site: Date collected: 27+28/02/13
Customer Reference: 71506

Wash(Acetone) Analysed as Wash(Acetone)
Miscellaneous

				SAL Reference	319293 012
				Customer Sample Reference	12
				Test Sample	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**	
Particulates (Total)	Grav	0.1	mg	U	<0.1

SAL Reference: 319293
Project Site: Date collected: 27+28/02/13
Customer Reference: 71506

Filter Quartz 90mm Analysed as Filter Quartz 90mm
Miscellaneous

				SAL Reference	319293 003	319293 007
				Customer Sample Reference	3	7
				Test Sample	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**		
Particulates (Total)	Grav (5 Dec)	0.10	mg	U	<0.10	<0.10

SAL Reference: 319293
Project Site: Date collected: 27+28/02/13
Customer Reference: 71506

Filter Quartz 110mm Analysed as Filter Quartz 110mm
Miscellaneous

				SAL Reference	319293 001	319293 005	319293 009	319293 011
				Customer Sample Reference	1	5	9	11
				Test Sample	AR	AR	AR	AR
Determinand	**Method**	**LOD**	**Units**	**Symbol**				
Particulates (Total)	Grav (5 Dec)	0.10	mg	U	**12**	**7.2**	**2.2**	<0.10

Index to symbols used in 319293-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited

APPENDIX 2

Diagrams & Photographs of Sampling Points

BBF Stack

Dryer Stack

Cooler Stack

APPENDIX 3

Calculations

Conversion Factors

ppm ® mg/Nm³ (at 273K, 101.3kPa: STP)

CO	x	1.25	
SO_2	x	2.86	
VOC's	x	1.61	(ppm as C_3H_8 to mg/Nm^3 as C)
NO_X	x	2.05	(ppm NO + NO_2 to mg/m^3 as NO_2)

Oxygen Correction to Reference Value

Concentration at (STP) -> Concentration at 273K, 101.3kPa, reference O_2 and Dry Gas, i.e.

Concentration X ((20.9-O_2 ref)/(20.9-O_2 measured)) = Concentration at ref Oxygen state.

Example Calculation

SO_2 concentration at STP	=	170.7 mg/Nm³
Oxygen percentage in gas stream	=	13.8%
Reference Oxygen	=	11%
SO_2 concentration at reference O_2 conditions	=	170.7 ((20.9-11)/(20.9-13.8))
	=	238 mg/Nm³ at 273K, 101.3kPa, 11% O_2 and Dry Gas

Moisture Correction (Wet to Dry)

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

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

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

Example

VOC concentration	=	25 mg/Nm³ (Wet)
Moisture Content	=	27.1%
Concentration of VOC	=	25 (100/(100-27.1))

Carbon (C) to Trichloethylene (TCE)

ppm TCE = ppm C x 0.6715

TCE in mg/m^3 = TCE ppm x 5.864 (Mol Wt/22.4)