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Stack Emissions Testing Report

Total Particulate Matter
Lead
Chlorides (as HCl)

Clark - Drain Ltd

Yaxley

Fume Extraction System

Sampling Date **6th July 2004**

Report by Mark Sproson

Job Number LAB 05258

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Introduction

Clark - Drain Ltd operates a Galvanising Process at Yaxley which is subject to Local Air Pollution Control under the Environmental Protection Act 1990, Part 1.

Scientifics Limited were commissioned by Clark - Drain Ltd to carry out stack emissions testing to determine the releases of prescribed pollutants from the following Plant under normal operating conditions.

Company	Clark - Drain Ltd
Site	Yaxley
Stack	Fume Extraction System
Sampling Date	6th July 2004
Time Test Started	14:15
Time Test Ended	15:15
Abatement Plant	Rowe Scrubber
Operating Conditions	Normal
Materials Processed	Metal Items
Fuel Type	Natural Gas
Plume Appearance	None Visible
Process	Hot Dip Galvanising Processes
Process Guidance Note	PG 2/2 (96)

Throughout sampling, the operating conditions were maintained as above. Any deviations from BS 3405 : 1983 are noted in the conclusion.

Written Summary

Total Particulate Matter	Passed

Two particulate tests were performed during continuous operating conditions. The mean sampling time was 16 minutes. The mean particulate concentration was 13 mg/m³ at reference conditions. This value is below the specified emission limit of 15 mg/m³.

The tests were performed following the main procedural requirements of BS 3405 : 1983 using a Ströhlein STE 4 isokinetic particulate sampling train.

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Lead	Passed

One lead sample was collected over the 32 minute period of total particulate matter sampling. The lead concentration was 0.007 mg/m³ at reference conditions. This value is below the specified emission limit of 2 mg/m³.

The lead concentration in the total particulate matter was determined at our Harwell laboratory by ICP-MS.

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Chlorides (as HCl)	Passed

Two HCl tests were performed during normal operating conditions. The mean HCl concentration was 2 mg/m³. This value is below the specified emission limit of 30 mg/m³.

The chloride concentration was determined at our Harwell laboratory by Ion-chromatography.

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Emissions Summary

Company	Clark - Drain Ltd
Site	Yaxley
Stack	Fume Extraction System
Sampling Date	6th July 2004

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m^3	13	15	Passed
Particulate Emission Rate	g/hr	168	-	-
Chloride as HCl	mg/m^3	1.7	30	Passed
Chloride Emission Rate	g/hr	21	-	-
Lead	mg/m^3	0.007	2	Passed
Lead Emission Rate	g/hr	0.089	-	-
Stack Gas Temperature	°C	36	-	-
Stack Gas Volumetric Flow Rate	m^3/hr	14365	-	-
Stack Gas Velocity	m/s	9.0	-	-

All results are mean values, with pollutant concentrations expressed at the appropriate reference conditions.

Total Particulate Matter Summary

Sample	Sampling Times	Concentration	Limit
Run 1	14:32 - 14:48	19 mg/m^3	-
Run 2	14:51 - 15:07	7.2 mg/m^3	-
Mean Particulate Concentration		13 mg/m^3	15 mg/m^3

Sample	Sampling Times	Particulate Emission Rates	Ratio of Particulate Emission Rates
Run 1	14:32 - 14:48	0.068 g/s	-
Run 2	14:51 - 15:07	0.025 g/s	-
Mean Particulate Emission Rate		0.047 g/s	2.69 : 1

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Chloride (as HCl) Summary

Run	Lab Result ug	Volume Sampled m^3	Concentration mg/m^3	Limit mg/m^3
1	1490	0.692	2.2	-
2	802	0.692	1.2	-
Mean Chlorides Concentration			1.7	30

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Lead Summary

Lab Result ug	Emission Rate g/hr	Concentration mg/m^3	Limit mg/m^3
7	0.089	0.007	2

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Calculations - Run 1

1. Stack Gas Velocity (V)

$V = 0.075 \times Cp \times \sqrt{\Delta P} \times \sqrt{T}$

V = Velocity (m/s)
Cp = Pitot Tube Calibration Coefficient
ΔP = Mean Differential Pressure (Pa)
T = Mean Temperature (K)

2. Stack Gas Volumetric Flow Rate (Q)

Stack Gas Velocity (V)	9.02 m/s
Stack Diameter (D)	0.75 m
Stack Area (A)	0.44 m^2
Stack Temperature (T)	309.00 K
Atmospheric Pressure (P_A)	100.70 kPa
Static Pressure (P_{St})	0.14 kPa
Standard Barometric Pressure (P_B)	101.30 kPa

$$Q_{(STP)} = \frac{273}{T} \times \frac{(P_A + P_{St})}{P_B} \times V \times A \qquad Q_{(actual)} = V \times A$$

$Q_{(STP)}$ = 3.50 m^3/s **$Q_{(actual)}$ = 3.98 m^3/s**

3. Particulate Mass Emission Rate (M)

No. of Sampling Points (n)	4
Duration at each point (s)	240 s
Nozzle area (a)	63.63 mm^2
Particulate mass (m)	0.0094 g
Stack Area (A)	0.44 m^2

$$M = \frac{(A \times m)}{(n \times a \times s)} \times 10^6 = 6.8E\text{-}02 \text{ g/s}$$

M = 0.068 g/s

4. Particulate Concentration (C) at 273K, 101.3kPa

$C = (M / Q_{(STP)}) \times 1000$

C = 19.41 mg/m^3

Calculations - Run 2

1. Stack Gas Velocity (V)

$V = 0.075 \times Cp \times \sqrt{\Delta P} \times \sqrt{T}$

V = Velocity (m/s)
Cp = Pitot Tube Calibration Coefficient
ΔP = Mean Differential Pressure (Pa)
T = Mean Temperature (K)

2. Stack Gas Volumetric Flow Rate (Q)

Stack Gas Velocity (V)	9.05 m/s
Stack Diameter (D)	0.75 m
Stack Area (A)	0.44 m^2
Stack Temperature (T)	308.50 K
Atmospheric Pressure (P_A)	100.70 kPa
Static Pressure (P_{St})	0.14 kPa
Standard Barometric Pressure (P_B)	101.30 kPa

$$Q_{(STP)} = \frac{273}{T} \times \frac{(P_A + P_{St}) \times V \times A}{P_B} \qquad Q_{(actual)} = V \times A$$

$Q_{(STP)}$ = 3.52 m^3/s **$Q_{(actual)}$ = 4.00 m^3/s**

3. Particulate Mass Emission Rate (M)

No. of Sampling Points (n)	4
Duration at each point (s)	240 s
Nozzle area (a)	63.63 mm^2
Particulate mass (m)	0.0035 g
Stack Area (A)	0.44 m^2

$$M = \frac{(A \times m)}{(n \times a \times s)} \times 10^6 = 2.5E\text{-}02 \text{ g/s}$$

M = 0.025 g/s

4. Particulate Concentration (C) at 273K, 101.3 kPa

$C = (M / Q_{(STP)}) \times 1000$

C = 7.19 mg/m^3

Total Particulate Matter Sampling Methodology

Job Preparation

A pre-site survey must first be undertaken to obtain the following information. Client details (full address & contact *names), description of stack (name & location), sampling platform / access (Permanent - platform of adequate size &* load capability, kick boards, hand & middle rails, free from debris, good drainage, fixed ladders with hoops and chain. Temporary - adequate size & load capability, stabilising legs, valid inspection tag, kick boards, hand & middle rails. Both types of platform must have a secure anchorage point to fix pulley system) hazards (dust, noise, temperature, gases/vapours, vibration, light, moving machinery, electricity etc) power supply and location, additional PPE required (high temperature gloves/overalls, PPE).

The Strohlein STE 4, isokinetic particulate measurement equipment, is fully inspected prior to use and its calibration status observed. This includes:

Pitot Tube - All pitot tubes are physically checked for damage, paying particular attention to the inlet holes. All dirt and blockages are removed.

Micromanometer - Digital differential pressure meters are used capable of measuring pressure in the range 0 Pa to 2250 Pa with a sensitivity of ±1 Pa. These instruments are checked for obvious physical damage, battery life tested and calibrated status observed.

Thermocouple - Temperature is measured using k type thermocouples. Each thermocouple is inspected for obvious damage and its calibration status observed. Digital temperature meters are used in conjunction with K type thermocouples. These are also checked for obvious physical damage and their battery life tested.

Nozzles - All nozzles used have been constructed in accordance BS 3405 : 1983, section 5.3.2. Each nozzle is physically checked for damage and removed if necessary. The nozzle calibration status is observed.

Flowmeter - The flowmeter is checked for blockages and obvious physical damage. Its calibration status is also observed.

Balance - A Mettler Toledo balance is used to weigh filters. The balance is positioned on a solid base located in a specially built weighing room. The balance is serviced and calibrated routinely each year by the manufacturer and also checked daily with in-house check weights.

Rope Kit - All lifting tackle i.e. rope, pulleys, karabiners, brakes and slings are physically checked for cuts and *contamination.*

Should the calibration certainty of any of the above equipment be in question, that item of equipment must be recalibrated and replaced if necessary.

Filter Selection and Preparation

Stack conditions can vary greatly for temperature, moisture, acidity, low and heavy particulate loading. Following the pre-site survey, the stack gas condition should be known and the appropriate filter can be selected and prepared as described below.

Filter mediums - glass wool, quartz wool, Gelman Sciences A/C Glass Fibre filter papers, Gelman Sciences Low Ash *PVC membrane filter papers, Schleicher & Schuell Glass Fibre Thimbles or Schleicher & Schuell Quartz Thimbles.*

Filters are prepared by drying in an oven at 160°C for a period of one hour and then placed to cool in a dessicator. The filters are weighed accurately on a 4-figure balance and then placed in clean individual petri dishes and transported to site in a filter storage box. Spare filters are also prepared to allow for accidents and to obtain blank values.

Sampling Procedure

Suitability of Sampling Location

Before sampling can commence, a preliminary velocity and temperature survey must be undertaken along the two sampling lines at ten equally spaced points excluding the region within 5% of the effective flue diameter from the wall. The stack diameter is measured using a steel rod. If the ratio of the highest to lowest dynamic pressures exceeds 9:1 or if the ratio of the highest to lowest gas velocities exceeds 3:1, another sampling plane should be used. Sampling is undertaken from either four or eight sampling points.

Four sampling points are used when the ratio of the highest to lowest dynamic pressures is less than 4:1 and eight sampling points when the ratio of highest to lowest dynamic pressures exceeds 4:1 but less than 9:1 or the stack area exceeds 2.5 m^2. Temperature is also measured at ten equally spaced points along the sampling lines and an average temperature calculated. Should the temperature at any of the sampling points differ by more than + 10% from that of the average temperature, then that point must not be used.

The required number of sampling points can now be calculated using the following:

4 point sampling, circular stacks: 0.15 x D and 0.85 x D.

4 point sampling, square stacks: 0.25 x D and 0.75 x D.

8 point sampling, circular stacks: 0.065 x D, 0.25 x D, 0.75 x D and 0.935 x D.

8 point sampling, square stacks: 0.125 x D, 0.375 x D, 0.625 x D and 0.875 x D.

Leak Checks

A leak check should be undertaken before and after the iso-kinetic sampling is carried out. This is to make sure that all suction is taken at the sampling nozzle.

Sampling

nce the iso-kinetic sampling flow rates have been calculated, the probe is inserted into the stack at 90° to the stack gas flow, as not to impinge any particulate matter on to the filter media prior to sampling. Allow the filter head and probe to attain the stack gas temperature. Start the suction device, and set the flowmeter to the correct suction rate for isokinetic sampling. At the same time turn the nozzle into flow and start the timing device.

Duration of Sampling Time

Duration of sampling time depends on :

(a) ensuring adequate quantities of particulate matter on the filter for weighing (> 0.3 % of the filter weight).

(b) whether cumulative or incremental sampling is undertaken.

(c) the number of sampling points i.e. either 4 or 8 point sampling.

(d) the continuity of plant operation.

Cumulative Sampling

After the first sample is taken from the first sampling position the control valve is closed simultaneously turning the sampling probe 90° to the stack gas flow, moving the probe to the next sample position. This process should be repeated until all the sample points have been used once.

epeat Velocity and Temperature Readings

At each of the sampling points repeat the readings for the stack gas flow rate and stack gas temperatures. Calculate the new iso-kinetic sampling flow rates. If the stack gas velocity is more than ± 5% from the initial readings the test result shall not be regarded as having the required accuracy. The new temperature reading should not exceed the permitted range calculated in the preliminary survey. i.e. it should be within ± 10% of the original mean temperature.

N.B. The filter head should be cleaned and the particulate matter added to the particulate matter on the filter.

The Sampling procedure should be repeated to obtain a duplicate sample, the ratio of the two particulate emission rates should not exceed 1.5 : 1.

Weighing of Sample

The used filter should be placed in an oven at 180°C and dried thoroughly, cooled and equilibrated in a desiccator and weighed as quickly as possible so as to avoid any errors due to moisture absorption onto the filter. The gross weight of the filter should be measured to within ± 0.1 mg. The filter weight and any residual particulate matter from the filter head can then be used in the final report to calculate the particulate concentration.

On Site Isokinetic Data Sheet

Preliminary Stack Survey		Sampling Line A		Sampling Line B	
Traverse Point	Distance in Stack (m)	Dynamic Pressure (Pa)	Temperature (°C)	Dynamic Pressure (Pa)	Temperature (°C)
1	0.04	-	-	61	36
2	0.11	-	-	63	36
3	0.19	-	-	67	36
4	0.26	-	-	65	36
5	0.34	-	-	73	36
6	0.41	-	-	79	36
7	0.49	-	-	81	36
8	0.56	-	-	85	36
9	0.64	-	-	76	36
10	0.71	-	-	88	36
Mean	-	-	-	74	36

Lowest Dynamic Pressure (any line) 61 Ratio of Above 1.44 : 1

Highest Dynamic Pressure (any line) 88 (Highest permitted ratio 9:1)

Temperature Range permitted for any point is between 5 and 67 °C

Run 1	Sampling Time (mins)		16		Nozzle size used (mm)		9.00
Sampling Point	Dynamic Pressure (Pa)		Temperature (°C)		Velocity (m/s)		Flowmeter set at (m^3/hr)
	Initial	Final	Initial	Final	Initial	Final	
1	61	64	36	36	8.16	8.35	1.80
2	67	71	36	36	8.55	8.80	1.89
3	85	80	36	36	9.63	9.34	2.13.
4	88	83	36	36	9.80	9.51	2.16
Mean	75	75	36	36	9.03	9.00	2.00

Difference between Initial Velocity and Final Velocity = -0.33 % (Limit permitted is ± 5%)

Start Filter Weight = 0.1185 g Sample Weight = 0.0094 g

End Filter Weight = 0.1279 g Sample as % of Filter Weight = 7.93 %

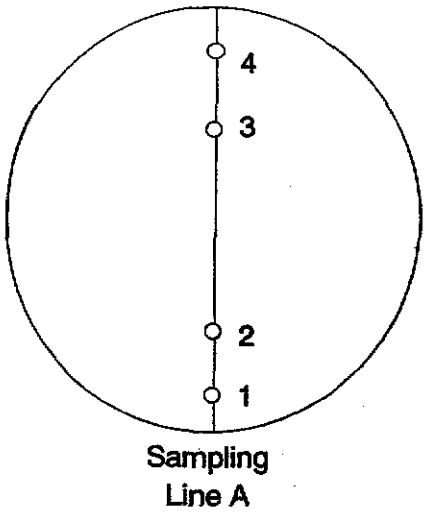
Run 2	Sampling Time (mins)		16		Nozzle size used (mm)		9.00
Sampling Point	Dynamic Pressure (Pa)		Temperature (°C)		Velocity (m/s)		Flowmeter set at (m^3/hr)
	Initial	Final	Initial	Final	Initial	Final	
1	64	66	36	35	8.35	8.47	1.85
2	71	73	36	35	8.80	8.91	1.94
3	80	79	36	35	9.34	9.27	2.06
4	83	87	36	35	9.51	9.72	2.10
Mean	75	76	36	35	9.00	9.09	1.99

Difference between Initial Velocity and Final Velocity = 0.99 % (Limit permitted is ± 5%)

Start Filter Weight = 0.1193 g Sample Weight = 0.0035 g

End Filter Weight = 0.1228 g Sample as % of Filter Weight = 2.93 %

Stack Diagram

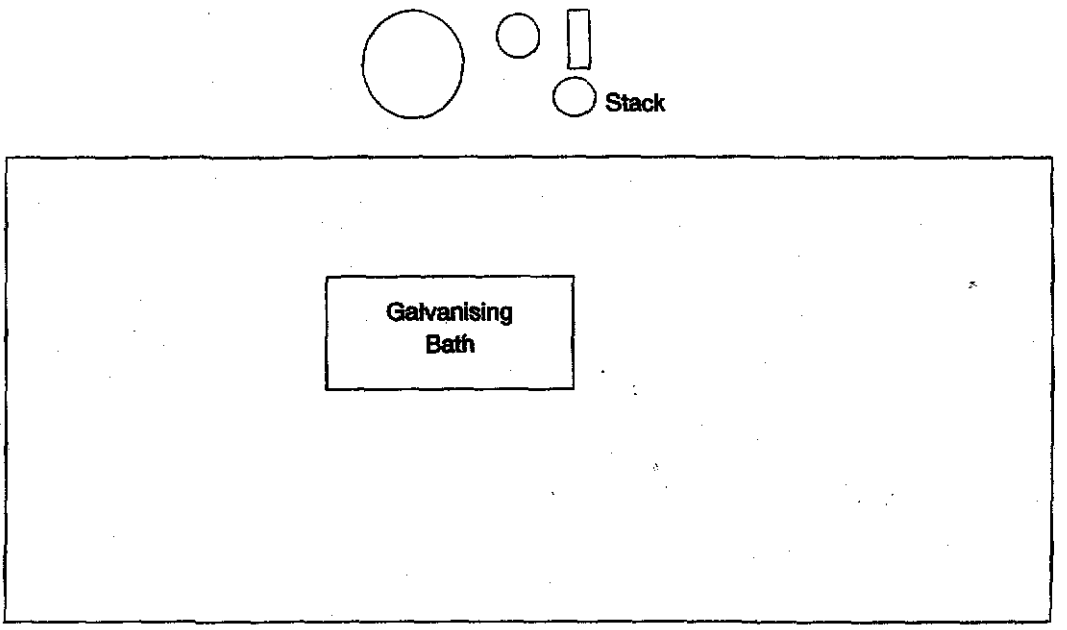


Stack Diameter (D) = 0.75 m

Stack Area (A) = 0.44 m^2

Sampling Point	Distance as a % of (D)	Distance in m
1	6.5	0.05
2	25.0	0.19
3	75.0	0.56
4	93.5	0.70

Plant Layout



Environmental Monitoring Team

Environmental Team Leader	Mark Sproson BA (Hons) Historical Studies Post Graduate Certificate. Historical Studies
Environmental Technician	Tim Heaton BSc (Hons) Environmental and Resource Science MA Sustainable Energy Technology
Report by	Mark Sproson Technician

Checked and authorised by _____ Signed

Mark Allison Print Name

29th June 2004 Dated

Team Leader Business Title

Deviations from BS 3405 : 1983

In this instance there were no deviations from BS 3405 : 1983, apart from the fact that only 1 sampling line could be used as only 1 line could be accessed. However, 4 points were used on the 1 available line instead of just 2.

The ratio of particulate emission rates was greater than 1.5:1. However it should be noted the most likely reason for this is that the Process is of a batch nature.

Conclusion

The results of these tests demonstrate that under normal operating conditions, this Plant is being operated in compliance with all emission limits specified in PG 2/2 (96).

Good housekeeping and maintenance of the ducting and associated Plant should be continued in order to maintain this level of Plant performance.

A regular programme of stack emissions testing in accordance with the Plant's Local Air Pollution Control Authorisation will be required to demonstrate continued compliance.