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ADVANCE
ENVIRONMENTAL

PARTICULATE EMISSION MONITORING
AGGREGATE INDUSTRIES UK LIMITED
EXPRESS ASPHALT
COVENTRY
WARWICKSHIRE

Report on Particulate Emission Monitoring
to
Determine the Levels of Particulate Emission
from the
Parker Asphalt Plant
at
Aggregate Industries UK Limited
Express Asphalt
Coventry
Warwickshire

Report Submitted to:

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Report Prepared By:

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Date:

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SUMMARY INFORMATION

DETERMINED	UNITS	RESULTS	LIMIT
Particulate Concentration (STP)	mg/m^3	35.0	50
Mass Emission (STP)	Kg/hr	0.83	-
Stack Temperature	°C	91	-
Gas Velocity	ms^{-1}	14.03	-
Stack Volume Flow Rate (Actual)	m^3/hr	32136	-
Stack Volume Flow Rate (STP)	m^3/hr	23889	-

All results are reported at reference conditions of 273K, 101.3kPa, wet gas.

1. INTRODUCTION

On 05 August 2008, particulate emission testing was undertaken by Advance Environmental, on the Parker asphalt plant at Aggregate Industries UK Limited, Express Asphalt, Coventry.

The purpose of the emission testing was to ensure compliance with the requirements of the permit issued by Coventry City Council under The Pollution Prevention and Control (PPC) regime introduced by the PPC Act 1999.

2. BACKGROUND INFORMATION

The Pollution Prevention and Control Act came into force in December 1999, superseding Part 1 of the Environmental Protection Act, 1990. The Act introduced a new regime of integrated pollution prevention and control (IPPC) for those industrial activities regulated by the Environment Agency and Local Authority Pollution Prevention and Control (LAPPC) for those regulated by Local Authorities. Roadstone coating, mineral drying and cooling and other quarry processes were scheduled for LAPPC under Section 3.5 of Part B of the Pollution Prevention and Control (England and Wales Regulations) 2000, and were brought under the revised regime in March 2003.

To continue operations, all sites operating scheduled processes must obtain a permit from their Local Authority and comply with the conditions contain therein. The conditions will include a requirement to monitor emissions to air both periodically and continuously in accordance with relevant clauses of following process guidance note:-

- PG3/15a(04) Secretary of State's Guidance – Roadstone Coating Processes

3. MONITORING CONTRACTOR

The emissions test was co-ordinated by Mr K Gough, Company Principal, Advance Environmental. Mr Gough has 19 years experience of undertaking particulate emission testing on plant used in the quarrying and allied industries.

4. MONITORING PROTOCOL

4.1 Test method and references

Isokinetic sampling of the contained emission sources was undertaken using the APEX Instruments Inc Method Five isokinetic sampling apparatus in accordance with the main procedural requirements of given within the following British Standards and Technical Guidance Notes:-

- **BS ISO 9096:2003** - Stationary source emissions. Manual determination of mass concentration of particulate matter.

- **Environment Agency - Technical Guidance Document (Monitoring) M1** Sampling requirements for monitoring stack emissions to air from industrial installations; and

- **Environment Agency - Technical Guidance Document (Monitoring) M2** Monitoring of Stack Emissions to Air.

4.2 Sampling Procedure

The work carried out was, as far as was reasonably practical, in accordance with BS ISO 9096.

Isokinetic flow means that sample gases laden with particulates are drawn off at the same velocity as the free stream velocity in the flue. Isokinetic sampling thus avoids possible inertial effects of particulates approaching the vicinity of the inlet nozzle which may result in significant error.

The Apex Instruments test equipment used, is designed to meet the sampling requirements of US EPA Method 5 and with a modified nozzle design, meets the sampling requirements of BS ISO 9096.

The principle of BS ISO 9096 is to draw a known volume of dust laden gas isokinetically through a filter. The weight gain on the filter, after sampling, divided by the gas sample volume equates to the particulate concentration, which in turn can be used to calculate a mass emission.

4.3 Sampling equipment

The test equipment is inspected prior to use and the calibration status observed. This includes:-

- *Pitot Tube* - All pitot tubes are checked for damage, alignment and that there are no blockages;
- *Manometer* - Oil levels, connectors and orientation level are checked;
- *Thermocouple* - Temperature is measured using k type thermocouples. Each thermocouple is inspected for calibration and damage. Digital temperature meters are used in conjunction with k type thermocouples which are also checked for calibration dates;
- *Gas meter* - The calibration of the gas meter is checked before and after sampling using a critical orifice.
- *Nozzles* - All nozzles used have been constructed in accordance with BS ISO 9096. Each nozzle is checked for damaged and measured using a vernier caliper on at least 3 planes. Non conforming nozzles will be rejected.
- *Balance* - A Mettler Toledo balance is used to weigh filters. It is calibrated yearly by the manufacturer and checked daily by in-house weights.
- *Filters* - Pall quartz membrane filters with a collection efficieny of >99.5% at 0.3microns.

4.4 Preparation for sampling

4.4.1 Filter Preparation

Filters are pre-conditioned before arrival on site. The filters are dried in an oven at 180 ^{o}C for a period of at least one hour and then placed to cool in a dessicator for at least four hours. The filters are then weighed on a five figure balance and placed in individual transport containers. Spare filters are prepared to obtain blank values.

4.4.2 Sampling Location

No site visit was undertaken prior to undertaking the sampling procedure, as monitoring had previously been undertaken at the site, during which time the sampling position, working platform, sampling ports, access and safety precautions were found to be satisfactory.

The internal dimension of the flue was known from the previous monitoring undertaken. However, further measurements were taken to check that the internal diameter had not changed.

Prior to sampling a pressure and temperature survey, using a pitot static tube, a micromanometer, a digital thermometer and a nickel-chromium/nickel-aluminium thermocouple, is carried out to check whether the flow conditions meet with the requirements of BS ISO 9096. From this initial survey sample locations, isokinetic flow rates, nozzle size, and sample period can be calculated.
Sampling

4.5 Sample collection

A leak check is carried out before and after sampling to confirm all the suction is drawn through the nozzle.

With the required isokinetic flow rates known the sample probe was inserted into the stack at 90^{o} to the gas flow, this is to stop any particulate matter impinging on the filter before sampling.

The filter head and probe were allowed to obtain the stack gas temperature.

The initial gas meter volume was noted and the suction device and timer started. The correct flow rate for isokinetic sampling was set and the nozzle positioned to face parallel to the gas flow.

Sampling was then carried out for the planned duration and number of sample points, recording all the necessary data for final calculations. On completion, the suction device, timer were stopped and the final gas meter volume recorded.

The probe was removed from the process stack and a further leak test carried out prior to removal of the filter, which was subsequently removed and placed in a storage container.

Any residual particulates upstream of the filter was washed with water and acetone into an appropriate beaker.

The above procedures were then repeated to obtain duplicate samples.

At all times during the sampling procedure the sampling technicians were in contact with the process operator to ensure that the plant was in full production and there were no changes in the process that might affect the representative nature of the samples collected.

4.6 Analysis of samples

On returning to the laboratory, the used filters were dried in an oven at 160 ^{o}C for a minimum of one hour and then desiccated and weighed as before. The water/acetone washings are first evaporated, without boiling, then dried and weighed as above. The total particulate mass is the sum of the differential filter weight added to the differential water/acetone component.

4.7 Calculation of results

The calculations were made using the formula specified in BS ISO 9096.

The recorded filter weights, velocity, temperature, sampling duration and internal flue dimensions were than used to calculate:-

- the mass rate of solids emission in kg/hr; and
- the solids concentration in mg/m^3.

4.8 Sampling Results

Two particulate tests were carried out, under continuous operating conditions, to assess the emission concentration in the exhaust gases. The sample time of each test was 24 minutes, primarily due to the limited production time to enable completion of the test.

At the time of sampling, a mean particulate matter concentration of 35.0 mg/m^3 at reference conditions. It can be concluded, therefore, that the emission from this plant was found to comply with the emission limit currently imposed.

4.9 Comments

On the completion of sampling, the data from the PCME DT 990 continuous emission monitor was interrogated and the average results, which were recorded during each measurement period, noted. Levels of 40.0015 mg/m^{-3} (Test 1) and 42.7049 mg/m^{-3} (Test 2) were obtained together with an existing calibration factor of 6.9221. It can be concluded that the monitor could be adjusted if required, to improve the level of accuracy with a new calibration factor of 5.854.

Full test data demonstrating procedural compliance with BS ISO 9096 for total particulate monitoring is provided the following sections.

5. SAMPLING RECORDS

5.1 - Process Conditions

Table A

Arrestment Plant:	Bag Filter
Particulate Type:	Aggregate
Plant Loading:	Continuous - various grades @ 40tph.
Appearance of plume:	No visible discharge

5.2 - Sampling Results

Table B

	Test Run No. 1.	Test Run No. 2.	Average
Time of Test:	08.05 - 08.29	08.34 - 08.58	
Sampling Duration: (mins)	24	24	
Gas Temperature (°C)	92	91	91
Mean Velocity at Sampling Points: (m/s)	14.54	14.34	14.44
Gas Flow Rate at STP (1): (m^3/min)	396.2	391.6	393.9
Particulate Loading at STP (1): (mg/m^3)	33.42	36.52	34.97
Particulate at Normalised Conditions (2): (mg/m^3)	-----	-----	-----

(1) Particulate stated at 273K, 101.3kPa without correction for water vapour.

(2) State normalised conditions (eg 11% O_2, etc).

5.3 - Calculations Sample Run No. 1

On-site measurements

O2 = 17.9 % CO2 = 1.7 % N2 = 80.4 %
Bws = 0.03 Ps = 100.5 kPa Ts = 364.5 K

Md = Molecular weight of gas at DGM (g/g mole)
Md = $(0.44 \times \%CO_2) + (0.32 \times \%O_2) + (0.28 \times \%N_2)$
= 28.99 g/g mole

Ms = Molecular weight of gas wet (g/g mole)
= 28.66 g/g mole

Stack gas velocity at sample points

V = Kp x Cp x Ö(Ts.DP/Ps.Ms)
= 14.54 m/s

Kp = 4.07
DP = 101.5 average Dp at sample plane
Cp = 1.00 pitot tube coefficient

Stack gas volume at sample points

Q = V x A x 60
= 555.1 m^3/min

A = 0.64 area of stack m^2

Volume of water vapour collected, standard conditions (m^3)

Vwstd = 0.00124 x Vlc
= 0.019 m^3

Vlc = 15 ml

Volume of gas metered, standard conditions (m^3)

$$Vmstd = \frac{2.695 \times Vm \times (Pa + (DH/102)) \times Yd}{(T + Tm)}$$

= 0.4604 m^3

Tm = 15 °C
Vm = 0.4776 m^3
Pa = 100.5 kPa
DH = 51.4 mm H_2O
Yd = 1.020

Moisture content

Bwo = Vwstd/(Vwstd +Vmstd)
= 0.0396

Dry total flow of stack gas, standard conditions (m^3/min)

$$Qstd = \frac{Q \times Ps(2.695)(1 - Bwo)}{Ts + 273}$$

= 396 m^3/min

Ts = 91.5 °C
Ps = 100.5 kPa

Percent isokinetic

$$\%I = \frac{(6.184\times10^5)(Ts + 273) \times Vmstd}{Ps \times V \times Aa \times t \times (1-Bwo)}$$

= 97.3 %

Aa = 31.7 area of nozzle m^2

5.3 - Calculations Sample Run No. 1 Cont.

Filter & rinsing weights sample no. 1

weight gain on filters = 15.39 mg
weight of acetone wash = mg
total weight gain (M) = 15.39 mg

Particulate concentration (mg/m^3)

C = M/Vmstd   M = 15.39 mg
= 33.42 mg/m^3

Particulate emission rate (kg/hr)

E = (C x Qstd x 60)/1000
= 0.79 kg/hr

5.4 - Calculations Sample Run No. 2

On-site measurements

O2 = 18.0 % CO2 = 1.6 % N2 = 80.4 %
Bws = 0.04 Ps = 100.5 kPa Ts = 363.8 K

Md = Molecular weight of gas at DGM (g/g mole)
Md = (0.44 x %CO_2) + (0.32 x %O_2) + (0.28 x %N_2)
= 28.98 g/g mole

Ms = Molecular weight of gas wet (g/g mole)
= 28.54 g/g mole

Stack gas velocity at sample points

V = Kp x Cp x Ö(Ts.DP/Ps.Ms)
= 14.34 m/s

Kp = 4.07
DP = 98.5 average Dp at sample plane
Cp = 1.00 pitot tube coefficient

Stack gas volume at sample points

Q = V x A x 60
= 547.4 m^3/min

A = 0.64 area of stack m^2

Volume of water vapour collected, standard conditions (m^3)

Vwstd = 0.00124 x Vlc
= 0.0195 m^3

Vlc = 16 ml

Volume of gas metered, standard conditions (m^3)

$$Vmstd = \frac{2.695 \times Vm \times (Pa + (DH/102)) \times Yd}{(T + Tm)}$$

= 0.4756 m^3

Tm = 15 °C
Vm = 0.4934 m^3
Pa = 100.5 kPa
DH = 49 mm H_2O
Yd = 1.020

Moisture content

Bwo = Vwstd/(Vwstd +Vmstd)
= 0.0393

Dry total flow of stack gas, standard conditions (m^3/min)

$$Qstd = \frac{Q \times Ps(2.695)(1 - Bwo)}{Ts + 273}$$

= 391.6 m^3/min

Ts = 90.8 °C
Ps = 100.5 kPa

Percent isokinetic

$$\%I = \frac{(6.184\times10^5)(Ts + 273) \times Vmstd}{Ps \times V \times Aa \times t \times (1-Bwo)}$$

= 101.6 %

Aa = 31.7 area of nozzle m^2

5.4 - Calculations Sample Run No. 2 Cont.

Filter & rinsing weights sample no. 2

weight gain on filters = 17.37 mg
weight of acetone wash = mg
total weight gain (M) = 17.37 mg

Particulate concentration (mg/m^3)

C = M/Vmstd
= 36.52 mg/m^3

M = 17.37 mg

Particulate emission rate (kg/hr)

E = (C x Qstd x 60)/1000
= 0.86 kg/hr

5.5 - Sample Blank

An overall sample blank was taken after the measurement series, following the sampling procedure in the methodology without starting the suction device and keeping the blank in the duct for 15 minutes with the sampling nozzle 180º from the direction of flow. This leads to an estimation of the dispersion of results related to the whole procedure.

weight gain on filters = 0.00009 mg
weight of acetone wash = mg
total weight gain (M) = 0.00009 mg

Particulate concentration (mg/m^3)

C = M/Vmstd
= 0.19 mg/m^3

M = 0.09 mg

5.6 - On Site Velocity and Flow Data

Company	EXPRESS ASPHALT	Stack Diameter	0.90	m
Site	DOYLE DRIVE	Area	0.64	m^2
Location	ROADSTONE COATING PLANT	Barometric Pressure	100.5	kPa
Job No	577	Stack Pressure	0.02	kPa
Operators	AJY/MJR	Pitot Tube Coefficient	0.997	

Preliminary readings taken before sampling				
			Pitot Traverse B	
Pitot Settings	D P pa	Temp °C	D P pa	Temp °C
1	93	90	91	91
2	102	91	108	92
3	110	91	109	92
4	108	91	102	92
5	91	91	79	92
6	82	92	81	91
7	97	92	93	91
8	102	92	95	92
9	105	91	91	92
10	92	91	80	91

av temp (K)=((average temp traverse A+average temp traverse B)/2)+273	364
av press (Pa)=((average press traverse A+average press traverse B)/2)	96

Suitability of sampling positions & Required No. of sample points	Actual Stack Conditions
Permitted highest to lowest pressure range = 9:1	1.4 : 1
Negative pressure	Not permitted
Differential pressure minimum > 5 Pa	79
No. of sampling points	4

5.7 - Sampling Conditions

	Sample Run No. 1			Sample Run No. 2		
Sample Position	Stack Temp °C	Velocity Pressure DP (Pa)	Nozzle Area mm^2	Stack Temp °C	Velocity Pressure DP (Pa)	Nozzle Area mm^2
0.15D	91	102	31.7	90	99	31.7
0.85D	91	105	31.7	90	102	31.7
0.15D	92	108	31.7	91	106	31.7
0.85D	92	91	31.7	92	87	31.7

5.8 - Weighing Results

The below filters and acetone rinsings were weighed on a balance in a temperature controlled room with corrections made for differences in atmospheric pressure. Control parts and blank filters are used to confirm accuracy of weighings.

Sample Run No.1.	Ref No.	Weight gms			Sample time at each point (mins)	% weight gain
		Before	After	Collected		
Filter	CV1	0.02718	0.04257	0.01539	6.0	56.6%
Acetone						
Total weight =				0.01539		
Sample Run No.2.	Ref No.	Weight gms			Sample time at each point (mins)	
		Before	After	Collected		
Filter	CV2	0.02657	0.04394	0.01737	6.0	65.4%
Acetone						
Total weight =				0.01737		
Sample Blank	Ref No.	Weight gms			Sample time at each point (mins)	
		Before	After	Collected		
Filter	CV3	0.02683	0.02692	0.00009	n/a	0.3%
Acetone						
Total weight =				0.00009		

5.9 - Main conditions for compliance with BS ISO 9096:2003

The following requirements must be met:

Preliminary Velocity Survey

		Pass	**Fail**
	No negative flow at sampling points	*	
	Direction of gas flow within 15° of flue axis	*	
	Pitot-static pressure differential greater than 5 Pa (3m/s)	*	
	Ratio of highest to lowest pitot-static readings less than 9:1	*	

Sampling procedure

	Sampling plane was corectly positioned	*	
	Sampling centroids of equal area	*	
	Nozzle was facing upstream to within ± 10°	*	
	Leak check performed	*	
	Constant 'at' during cumulative sampling	*	

Post Sampling Operations

	Leak test performed	*	
	Isokinetic rate 95 % to 115 %	*	
	Samples achieved stable weights	*	

Note : A single tick in the "fail" column indicates that this test does not comply with the full provisions of BS ISO 9096:2003. Due to site/sampling locations it is not always practically possible for all the conditions to be met. Best practical means are employed to try and achieve a representative result.