Measuring and Managing Particulates and Dust – Technical and Practical Issues

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RSC Law Group Seminar on Managing the Risk of Environmental Nuisance Claims

Andy Talbot, Associate
Air Quality & Greenhouse Gas Management
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Plan Design Enable

Introduction

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This talk covers:

- Definitions of particulates and dust
- Sources
- Perception
- Measurement
- Management

Definitions

- ‘Particulates’
  - Collection of discrete particles
    - In practical terms anything from a ‘few’ nm to a ‘few’ mm in diameter that can become suspended in the atmosphere
    - Compositionally homogenous or varied
    - Characteristic morphology(ies)
  - Primary particles are emitted directly
  - Secondary particles are formed by chemical processes in atmosphere
  - Health effects associated with fine particles smaller than 10 µm (PM_{10} and $PM_{2.5}$)
  - Synonymous with dust?

Definitions

- ‘Dust’
  - BS 6069 Part 2: Solid particulate matter 1 to 75 µm in diameter (larger = ‘grit’)
  - Particulate matter that can become suspended in the atmosphere and deposited (a process that may repeat many times over)
  - ‘Nuisance dust’ generally associated with coarse fraction particulates >20 µm in diameter, and not health effects

Sources

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- Natural
  - Pollen and spores
  - Sea salt
  - Soil
  - Volcanic ash
  - Fires etc ….
- Anthropogenic
  - Agriculture
  - Construction/demolition
  - Minerals extraction
  - Industry
  - Transport
  - ‘Leisure’ activities (e.g. off-roading)

Perception

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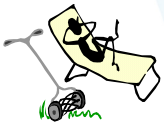
- Senses



- Tolerance



Very bothered

Not bothered

  - Very variable, many influencing factors

Measurement

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Questions:

- Where is the dust coming from?
- At what level is it going to be a 'nuisance'?

To answer these questions we need:

- Indicators
- Sampling methods
- Analytical methods

Measurement – Visual Inspection

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- Deposited dust and surface soiling
- Dust plume(s) from site

SITE INSPECTION PROFORMA – DUST/EMISSIONS CONTROL MEASURES

Sheet of

Contractor Name: ..... Contract: .....

Date: ..... Time (24 hour): ..... Completed By (print name):..... (signature): .....

1. Site activities and control measures

Site location identifier	**Activity observed**	**Type of control applied**	**Effectiveness of applied control** (tick appropriate box)			**Details of remedial action/change required**
			No visible emissions	Emissions visible within site boundary only (consider tightening control)	Emissions crossing site boundary (remedial action required)	

2. Weather and ground conditions (circle as appropriate):

Wind speed (use Beaufort scale)	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Wind from	*N*	*NE*	*E*	*SE*	*S*	*SW*	*W*	*NW*		
Rain	*None*		*Intermittent (showers)*			*Prolonged (>1hour)*			Light	*Heavy*
Ground surface	*Dry*		*Drying*			*Damp*			*Wet (puddles)*	

3. Give any other relevant information (such as investigation of complaint)

Measurement – Dust Deposition

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Dry ‘Frisbee’ deposit gauge
(substantial improvement on
BS 1747 Part 1 Deposit Gauge)

BS1747 Part 5 flux gauge
(N.B. not deposition)

Measurement – Dust Deposition

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- Deposition rate as monthly mean as mg/m^2/day of insoluble material

	Dry Frisbee (Foam) Gauge	
	Complaints possible	Complaints likely
Open country	100	140
Residential areas and outskirts of towns	150	200
Commercial centres of towns	200	260

From: Vallack, H. W. & Shillito, D. E. (1998), “Suggested guidelines for deposited ambient dust”, Atmospheric Environment, Vol.32, pp.2737-2744

Measurement – Dust Soiling

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- Unidirectional and directional 'sticky pad' gauges measuring percentage Effective Area Coverage per day (%EAC/day) – original concept by Beaman & Kingsbury
- Further development of the directional 'sticky pad' gauge by University of Leeds and then by DustScan, with the introduction of additional measure of Absolute Area Coverage (AAC) and 'new' analytical techniques

Measurement – Dust Soiling

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- Soiling rate measured with original 'sticky pad' method

%EAC/day	Situation
0.01	Rural
0.02	Suburban/ small towns
0.3 – 0.4	Urban
0.5	Rural summer time
0.8 - 1	Industrial

%EAC/day	Public response
0.2	Noticeable
0.5	Possible complaints
0.7	Objectionable
2	Probable complaints
5	Serious complaints

From: Beaman, A.L. & Kingsbury, R.W.S.M. (1981), "Assessment of nuisance from deposited dust particulates using a simple and inexpensive measuring system", Clean Air, Vol.11, No.2, pp.77-81

Measurement – Dust Soiling

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- Soiling rate and dust coverage measured with DustScan method

Source Significance		%EAC/week	%AAC/week
Very low	0	<2.5	<80
Low	1	2.5-5	80-95
Medium	2	5-15	95-99
High	3	15-25	99-100
Very High	4	>25	100 for 45°

Ref: Datson, H., Birch, W.J. (2006), "The development of a novel method for directional dust monitoring", Environmental Monitoring and Assessment, Vol.124(1-3), pp.301-308

Measurement – Dust Soiling

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- Dust slides (unidirectional) measuring soiling units per week (>25 SU/week is likely to cause complaint)
- References:
  - Moorcroft, J.S. & Laxen, D.P.H. (1990) "Assessment of nuisance dust", Environmental Health, August 1990, pp.215-217
  - Schwar, M.J.R. (1994), "A dust meter for measuring dust deposition and soiling of glossy surfaces", Clean Air, Vol.24, pp.164-169

Measurement – Airborne Dust

- Continuous ‘real-time’ measurement of ambient particulates concentration can be useful in day-to-day site management
- More expensive and complex than deposition and soiling methods
- Gravimetric and non-gravimetric methods
- Permits rapid response when action trigger level exceeded (agreed with planning authority/regulator)
  - though cannot in itself prove a ‘nuisance’
- Mayor of London guidance recommends an action trigger level for PM_{10} (not ‘nuisance’ dust) of 250 µg/m^3 as a 15 minute average (200 µg/m^3 if TEOM measurement)

Measurement – Sample Analysis

- Dry weight measurement
- Reflectance
- Optical microscopy
- Scanning electron microscopy with energy dispersive x-ray spectrometry (SEM/EDXS)
- Other

Measurement – Sample Analysis

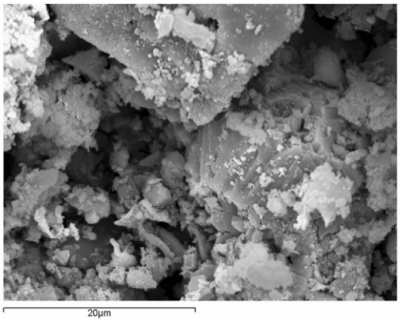
SEM/EDXA

Particle Category	Morphology / Elemental Composition
Unburnt Coal	Mainly organic, sulphur and chlorine may also be detected by EDXA Angular appearance with conchoidal fractures
Partially combusted Carbonaceous material	Negligible presence of elements detected by EDXA Irregular cellular structure, particles tend to appear round
Sand	Silicon rich particles with either amorphous or crystalline appearance
Amorphous dirt	Irregularly shaped particles, containing aluminium, silicon, calcium, potassium and Iron in varying proportions
Fly Ash	Spherical in shape, usually containing combinations of silicon, aluminium, potassium, calcium, iron and titanium
Plant/Animal	Organic fragments, often of uniform or regular structure, recognisable as having originated from insects or plants
Limestone	Calcium detected as the major element
Iron Oxide	Iron detected as the major element

Source: TES Bretby

Measurement – Sample Analysis

- Photomicrograph showing large crystalline angular iron, large slag plus assorted small iron and slag particles

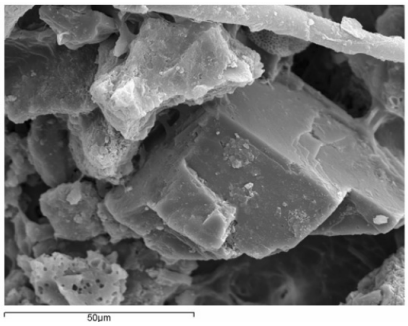


- Composition

Particle type	% freq	Range (µm)	Mean (µm)	Mode (µm)
Angular iron	14	1-30	8.5	*
Calcium (iron) alumina-silicate (slag)	72	0.5-100	11.8	2
Quartz (silica)	5	5-7	6.0	6
Alumina-silicate (clay etc)	2	5-6	5.5	*
Limestone	0	-	-	-
Carbon based	7	3-20	9.7	5
Spherical fly ash	0	-	-	-
Others	0	-	-	-

Measurement – Sample Analysis

- Large angular dolomitic limestone, assorted slag and clay articles plus a fragment of carbon flyash with vesicular texture (bottom left)



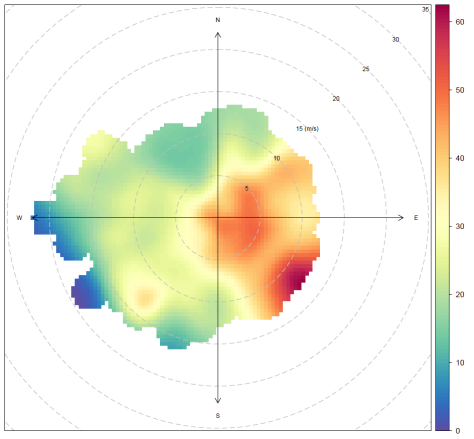
- Composition

Particle type	% freq	Range (µm)	Mean (µm)	Mode (µm)
Angular iron	5	3-50	19.6	*
Calcium (iron) alumina-silicate (slag)	19	1-30	6.9	3
Quartz (silica)	17	2-100	28.5	20
Alumina-silicate (clay etc)	27	1-40	9.6	*
Limestone	9	2-70	19.9	3
Carbon based	16	1-100	31.1	*
Spherical fly ash	7	2-60	29.3	30
Others	0	-	-	-

Measurement - Analysis

- Bivariate polar plot showing PM concentration by wind direction and speed
- Indicates low level source (unpaved car park) to E with high level sources to SE and SW (crematorium and boiler stacks)

Plot generated using 'R' and the 'openair' package (ref. Carslaw, D.C. and K. Ropkins (2010), "Open-source tools for analysing air pollution data", Environmental Research Group, King's College London, 24th May 2010)



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Management

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Good Management:

- Undertakes risk assessments at appropriate intervals
- Obtains and complies with permits for prescribed processes/installations
- Maintains industry 'best practice' …
  - 'measures' to address the risks (prevent, control, contain)
  - in 'monitoring' to inform site management when there is potentially a problem
- Has formally documented (controlled) and readily accessible dust/particulate management and incident response procedures
- Undertakes staff training, has open communications with stakeholders, carries out regular process and management reviews + periodic formal audits

=

no/few complaints, no action by the local authority/regulator/court, money not wasted, reputation maintained/enhanced

Management

Management

Examples of good practice references:

- Mayor of London, “The Control of Dust and Emissions from Construction and Demolition: Best Practice Guidance”, November 2006
- CIRIA C650 “Environmental good practice on site”
- www.goodquarry.com (University of Leeds and Mineral Industry Research Organisation)
- Environment Agency, “Monitoring of particulate matter in ambient air around waste facilities”, Technical Guidance Document (Monitoring) M17

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Any questions?

Andy.talbot@atkinsglobal.com

0207 121 2229