

Evaluation of Active & Passive Dust Deposition Techniques

Evaluation of active and passive dust deposition techniques

Natacha Claeys (natacha.claeys@ine.vlaanderen.be)*
Edward Roekens**
Martine Van Poppel, Nico Bleux and Patrick Berghmans***

* Flemish Government, Koning Albert II-laan 20 bus 8, 1000 Brussel
**Flemish Environment Agency (VMM), Kronenburgstraat 45, Antwerp, Belgium
***Flemish Institute for Technological Research (VITO), Boeretang 200, 2400 Mol, Belgium

Introduction

- Fugitive dust emissions (from e. g. coal piles) can cause nuisance in nearby residential areas due to dust deposition.
- Traditionally (also in Flanders (Belgium)) deposited dust has been monitored gravimetrically using passive deposit gauges. Also reflection techniques are used for diffuse dust measurements.
- Main problems related to measuring dust:
 - no international standards currently exist.
 - no clear correlation is shown between dust nuisance and measured deposited dust. Next to mass, also e.g. colour can be important. Background levels are also important.

Evaluation of active and passive dust deposition techniques | Natacha Claeys

Current available techniques

```

    graph TD
      A[DEPOSITED DUST SAMPLING TECHNIQUES] --> B[Semi-quantitative]
      A --> C[Quantitative techniques]
      B --> D[Sticky plates]
      C --> E[Dust soiling techniques]
      C --> F[Deposit gauges]
      E --> G[Sticky pads]
      E --> H[Dust slides]
      F --> I[Omni-directional gauges]
      F --> J[Directional gauges]
    
```

Evaluation of active and passive dust deposition techniques | Natacha Claeys

Flemish guidelines based on dust deposition – type deposition gauge

- Flemish legislation
 - VLAREM Titel II (1995) – based on TA Luft values (1976)
 - Guide value of 350 mg/(m².day) as average month value
 - Limit value of 650 mg/(m².day) as average month value
 - National Standard – NBN T94-101 with NILU jar and a sampling time of 30 days (+/-2 days).

Evaluation of active and passive dust deposition techniques | Natacha Claeys

Other guidelines based on deposit gauges

Country		Unit (mg.m ⁻² day ⁻¹)	Sampling standard
England en Wales*		200	Deposition gauge
USA	Only residential areas	187	
Germany (TA Luft)	Possible nuisance (yearly average)	350	Deposition gauge according VDI2119 (Bergerhoff jar)
W Australia	Less quality	133	Deposition gauge according ISO/DIS4222.2
	Unaccepted air quality	333	
Sweden (SEI) *	Rural area	140	
	Urban area	260	
New. Zealand *		4 g m ⁻² /30days (above background)**	Recommended 'trigger level' ISO jar

* no limit values

Evaluation of active and passive dust deposition techniques | Natacha Claeys

Other guidelines based on dust soiling

Dust Slides (Reflection expressed as Soiling Unit (SU))
Sticky pads (Reflection expressed in Effective Area Coverage (EAC))

Suggested 'Threshold' values for complaints


- 0.2% EAC per day :observable
- 0.5% EAC per day : possible complaints
- 0.7% EAC per day: unpleasant
- 2.0% EAC per day: plausible complaints
- 5.0% EAC per day :serious complaints

- DUSTSCAN - EAC and AAC**
- Absolute Area Coverage (AAC%):** dust coverage irrespective of colour; and **Effective Area Coverage (EAC%):** dust soiling or loss of reflectance.
- AAC% is a criteria for source significance and EAC% is a criteria for nuisance potential**

In UK no legislation but next limits are used for evaluation :
 200 mg/m².day and 20- 25 SU /EAC % per week averaged over a time period of 4 weeks

Evaluation of active and passive dust deposition techniques | Natacha Claeys

Evaluation of Active & Passive Dust Deposition Techniques




Aim of the study

Field evaluation of different state-of-the-art techniques to monitor dust deposition / nuisance

- Literature study of the available techniques in Europe
 - Based on experience in other European countries
 - Active and Passive Methods
- Field campaign nearby diffusive source: comparison between all around techniques

Evaluation of active and passive dust deposition techniques Natacha Claeys



Correlation between observed nuisance and deposition measurements

Study near a local source:

- Selection of 70 habitants
- Deposition measurements were performed
- Observation evaluation based on three questions/ asked 2 times per day:
 - question 1: Did you clean recently an object?
 - question 2: Do you see dust on the object?
 - question 3: Does this annoy you? How much? (not, a little bit, mostly, very much, every time)

Outcome of study of Vrins (NL, 1992) :

- >Best correlation was found with a sampling period of one week.
- >Nuisance is mainly caused by coarse 'dust'

Evaluation of active and passive dust deposition techniques Natacha Claeys



Literature study :Commonly used methods


Classification

1. Passive sampling techniques
 - Deposition Gauges (non directional)
 - Deposition Gauges (directional active)
 - Deposition Gauges (directional, passive) and flux measurements
 - Sticky plates – pads and dust slides
2. Active sampling techniques
 - Dust sampler
 - Dust monitor

Important evaluation criteria

- Measurement set up/ approach/ plan
- Cost price
- Technical Performance (easy to operate, size, service, power supply, materials)
- Time resolution (flexibility)
- Dust Properties (differences in colour, size, ..)


Evaluation of active and passive dust deposition techniques Natacha Claeys



Overview of techniques in Europe

Type	Description	Measuring Period	Type of dust /unit	International	+/ - points
PASSIVE SAMPLING TECHNIQUES					
Deposition gauges (non directional)					
Deposition gauges (type BS, ISO, Bergerhoff)	Gauge (different sizes, with or without collection bottle)	Longer periods (Sampling time in general: 1 month)	Dust deposition $mg\ m^{-2}\ day^{-1}$	New- Zealand Australia England Belgium Germany Sweden Denmark	- Pollution through algal growth, insects, bird droppings, ... - no good efficiency - low cost
Deposition gauges Frisbee	Upside down Frisbee with collection bottle Different types with or without coating or foam filter	Shorter sampling periods possible (starting from 1 week)	Dust deposition $mg\ m^{-2}\ day^{-1}$	England	-better efficiency Less sensitive to pollution -relative low cost


Evaluation of active and passive dust deposition techniques Natacha Claeys



Overview of techniques in Europe

Type	Description	Measuring Period	Type of dust /unit	International	+/ - points
Deposition gauges (directional, active)					
Directional METDUST	Measure in two 2 gauges (in relation to wind direction)	Sampling period in general: 1 month (a few months are necessary for representative data and evaluation)	Dust deposition $mg\ m^{-2}\ day^{-1}$ (source and background)	Denmark	- correct tuning between two gauges -more expensive
Directional Frisbee	see Frisbee , only sampling in a specific wind direction	idem Frisbee	idem Frisbee but only in one specific wind direction		-with multiple sites (see remark above) - limited experience

Evaluation of active and passive dust deposition techniques Natacha Claeys



Overview of techniques in Europe

Type	Description	Measuring Period	Type of dust /unit	International	+/ - points
Techniques for 'dust soiling'		A few months			
Dust Slides	Plate where the amount of dust is measured	Sampling period: typical 1 week or less	Expressed in SU	England	-Measure directly the 'dust nuisance' - loss of dust - average cost
Sticky strips	Can be used horizontally for deposition (fall out) or round a vertically cylinder (blown dust)	Sampling period: 1 week or less	EAC (%)	England New Zealand	-relative low cost
Sticky Pads (Dust Scan)	Measures the amount of blow dust coming from all directions	Sampling period: 1 week	EAC (%) AAC (%)	England Limited experience	-Measures dust coming from all directions -relative low cost
Sticky Plates type: Vaseline plates	Measures dust deposition , further analysis is possible towards the composition	Sampling period 1 week	$mg\ m^{-2}\ day^{-1}$	New Zealand Belgium	-measures deposited and blown dust semi technique: characterization possibility - low cost Natacha Claeys

Evaluation of active and passive dust deposition techniques Natacha Claeys

Evaluation of Active & Passive Dust Deposition Techniques

Overview of techniques in Europe

Type	Description	Measuring Period	Type of dust / unit	International	+ / - points
ACTIVE SAMPLING TECHNIQUES					
Measurement of					
Dust Sampler	Measures the dust concentration	Daily values	$\mu\text{g m}^{-3}$ (per day)	The Netherlands England New-Zealand	- possibility to select a certain wind direction - expensive
Dust Monitor	Measures online the dust concentrations	Daily values hourly averages, Measurement period: some months	$\mu\text{g m}^{-3}$ (per hour or 1/2 hour, day)	The Netherlands Belgium	- optical monitors (different fractions) - e.g. TEOM (1 fraction) - expensive

Evaluation of active and passive dust deposition techniques
Natacha Claeys

Field campaign nearby diffusive source : comparison between current available techniques

Selection of area and field campaign:

- Around a large surface source of coal piles in the harbour of GHENT
- Measurement campaign during a dry season period: June- September 2007 (Short period because – limited study budget)
- Spatial Strategy (selection of multiple points on E, SW and W transect)
- Log book of activities and register of complaints
- Comparison of dust deposition techniques: sticky pads (Dust Scan), sticky plates and the MWAC–catcher as blown dust methods and NILU deposit gauges, Bergerhoff deposit gauges, Frisbee and METDUST (directional) as total dust deposit methods. In addition, PM concentrations (TSP–PM10-PM2.5) with LVS and optical dust monitor.

Evaluation of active and passive dust deposition techniques
Natacha Claeys

Field campaign nearby diffusive source : selected techniques

Evaluation of active and passive dust deposition techniques
Natacha Claeys

Measurement strategy Harbour of Ghent

Evaluation of active and passive dust deposition techniques
Natacha Claeys

Overview of different techniques and specifications

Technique	sampling time	parameter
Deposit gauge (NILU, Bergerhoff, Frisbee)	28 days	$\text{mg m}^{-2} \text{d}^{-1}$
Sticky pads (DustScan)	7 days	AAC & EAC in % (abs. & eff. area coverage)
Sticky plates	7 days	$\text{mg m}^{-2} \text{d}^{-1}$ deposited dust & dust flux
METDUST™ (directional deposit gauges)	28 days	$\text{mg m}^{-2} \text{d}^{-1}$ (source & backgr.)
Partisol (sequential low volume sampler)	day	$\mu\text{g m}^{-3}$ (TSP)
Grimm 1.108 (Optical dust monitor):	1 hour average	$\mu\text{g m}^{-3}$ (TSP, PM ₁₀ ,...)

Evaluation of active and passive dust deposition techniques
Natacha Claeys

Meteorological results

2007

Wind roses based on meteorological dataset from Harbour

Evaluation of active and passive dust deposition techniques
Natacha Claeys

