Odour Monitoring for Anaerobic Digestion Facilities
Le suivi des odeurs dans un projet de biométhanisation
Thierry Pagé
Odotech

Faites un cadeau à la terre ... compostez !
Give Back to the Earth ... Compost!
22e Conférence nationale annuelle sur le compost
Du 19 au 21 septembre, 2012
22nd Annual National Compost Conference
September 19-21, 2012

www.compost.org

While simultaneous translation of the audio presentation was provided at the conference, the presentation document is available only as provided.

Tant que la traduction audio simultanée de la présentation a été fourni lors de la conférence, le document de présentation est disponible uniquement tel que fourni.
Odour Monitoring for Anaerobic Digestion Facilities

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The Odour Management blog:  
http://blog.odotech.com/
Who is Odotech?

ODOTECH has been in the business of odor management for 12 years

Over 700 projects in all types of industries;

40 employees (North America, Europe and Latin America) active in:
- Odor studies;
- Odor mitigation plans and prevention programs;
- Odor Monitoring System (e-nose) and real-time modeling tools (More than 40 systems installed, nearly half on composting sites);

2009-2010, worked with 50+ organic plants in Canada, US, France, Belgium, Switzerland (Composting, Digestion, Landfills and integrated sites).
An environmental problem...

Odours:
- lower quality of life
- are the main perception of pollution (with dust and noise)
- 70% of air quality complaints
- are a growing concern as cities encroach on plants
ANAEROBIC DIGESTION CONTEXT

A significant number of projects are underway or under study for the management of:
- the organic fraction of household waste
- on farm co-digestion
- and as an addition to WWTP plants

The technology is appealing to many due to interesting characteristics:
- Enclosed operation;
- Production of biogas, an alternative fuel readily useable once purified;
- Reduction of the overall organic mass after processing;
- Funding available;

Some success stories in Europe (integration of waste management and traditional fuel displacement).
REALITY CHECK

- Significant price tag, of the order of $500 per installed annual ton (often more).
- Ensuring full operating capacity otherwise the "installed tons" must be replaced by "actual tons".
- Odor issues are one of the most critical triggers for "loss of processing capacity"

Many examples of forced scale back by regulatory agencies due to odor issues are documented:
- Ametyst France: designed for 200 kT & running at 50% capacity in 2010
- Ecoparc 1 Barcelona: Anaerobic digestion closed in 2009
- 2 Ontario plants, one of them running at 11% of its 150 kTm capacity, and hoping for an increase to 50% by 2013
- Cedar Grove anaerobic project dropped in 2012
Why and what's to be done?

- Core of the digestion process itself is less odorous than composting
- But everything around it is pretty much similar and DOES lead to odour emissions
- The odor risks must be considered in the project as early as possible (site selection, process selection, design, odor modeling, operational plans, odor abatement selection, odour monitoring).
- The concepts and goals of an odour management plan (OMP) are essential
Multiple Odour Emission Sources

- Transport to site (route to site, waiting queue to reception)
- Reception of material
- Pre-treatment of material (bag opening, mechanical separation, mixing/homogenization)
- Transportation on-site
- Treatment process releases (composting, digestion, drying, etc.)
- Building envelope releases (fugitives)
- Biogas fugitive emissions
- Waste material and by-products management
  - Waste water ponds
  - Leachate accumulations
  - Screening and blending
- Finished products management
How to evaluate your odor risk (R factor)

The concept of FIDOL (Frequency, Intensity, Duration, Offensiveness and Location) is standard in the odor management industry, however the reality is a bit more complex (L becomes $N \times M$ and C is of importance since it is often the only measured and controlled value). The concept (simplified) can therefore be expanded to:

$$R = F \times C \times I \times D \times O \times N \times M$$

$F =$ probability (or frequency)
$C =$ Odor Concentration
$I =$ Odor intensity
$D =$ Duration of events
$O =$ Offensiveness or Hedonic tone
$N =$ Number of affected people
$M =$ Mysterious factor: increases with media coverage, poor communication, history of the site, history of the industry, stakeholders interests,…

**Factor M is where preventative management has the largest return**
Typical chemicals responsible for the odors

Sulphides (H₂S, DMS, DMDS, CS₂, Methanethiol)
Volatile Fatty Acids (Acetic Acid, Butyric Acid, Propionic Acid)
Nitrogen Compounds (Ammonia, Trimethylamine)
+ Many Others depending on Organic waste managed and the process used!

Unfortunately: No single tracer gas can be used to estimate off site odor impacts (a blend of multiple components… many at the detection limits of existing methods): must rely on olfactometry (D/T or O.U./m³) and modeling.
Olfactometry: Definitions

- **Odour unit:** by definition, 1 o.u./m³ when the odour is perceived by 50% of a panel (1 o.u./m³ corresponds to the detection threshold)

- **Odour concentration** (c) (number of odour units): Number of dilutions (with odorless air) of the gas mixture required to obtain 1 o.u./m³.

- Ex.: $c = 10,000$ o.u./m³ means that it takes 10 thousand dilutions to reach the detection threshold for this gas sample.
Odour Concentration

Threshold examples

1 o.u./m³: Perception threshold
2-3 o.u./m³: Recognition threshold
5 o.u./m³: Discrimination threshold
10 o.u./m³: Risk of Complaint

Perfumed person: 20-50 o.u./m³
Freshly cut grass: 250 o.u./m³
Hold garbage: 500 o.u./m³
## Typical odour levels

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reception hall</td>
<td>Varies, can be &gt;10’000 O.U./m³</td>
</tr>
<tr>
<td>Active composting</td>
<td>Varies, 1000 to &gt;10’000 O.U./m³</td>
</tr>
<tr>
<td>(or biological drying)</td>
<td></td>
</tr>
<tr>
<td>Biofilter exhaust</td>
<td>Varies, but typically 100 to 1’000 O.U./m³</td>
</tr>
<tr>
<td>Biogas</td>
<td>&gt;1M (O.U.)/m³</td>
</tr>
<tr>
<td>Pond (leachate)</td>
<td>Varies, can be &gt;100’000 O.U./m³</td>
</tr>
</tbody>
</table>

Data extracted from Odotech’s database (odour concentrations vary with processed material, process parameters and a multitude of other factors)
Point Source Sampling
Area Source Sampling
Example: Odour Plume
Odour assessment / monitoring for anaerobic digestion plants

- Odour impact assessment
- Odour baseline assessment
- Odour monitoring
- Odour observer committee
Pre project Odour Impact Assessment:

- Evaluate technological options in relation to the levels of impact generated.
- Improve the project by including specific commitments (and demonstrated) in terms of levels of odour pollution.

Assess the level of nuisance generated by the new activity and compare it to applicable guidelines or objectives;

Several configurations and operational modes can be evaluated;
Pre project Odour Impact Assessment

- Historical weather data
- Inventory of all potential emission contributors
- Local land use and topography
- Assess regulatory compliance
- Consider building configuration
Odour baseline monitoring with eNoses

- Odour monitoring for 2 years before the installation
- Prove odours existence before commissioning
- Reuse system in monitoring mode once the plant is in operation
- Reassures the population against the risks of odours and increased social acceptability of projects
- Create a reference base for stakeholder understanding of the odour impact results
Odour Baseline Assessment

Upon identification of the implantation site:
• Establishment of an eNose
• Coupled with a weather station
• Reactions to Local odours

• Recording of existing odour footprints
• Association with meteorological measurements on site
• Correlation of odour episodes and wind directions
Assessing the pre-existing baseline

- Recording the frequency of odor
- Relation with the wind direction
- Seasonal reports on key statistics
- Send alerts when thresholds are exceeded
- Estimate the contribution of neighboring sites
Topography and weather have an important influence
Automated Odour monitoring using Electronic Noses

- Matrix of non specific sensors
- Specialised for classes of chemicals
- Reacts to wide diversity of chemicals
- Gas conditioning units
- Continuous gas sampling and measurement
eNose Calibration

STANDARDS
EN 13725
ASTM E679-04

Odour Monitoring for Anaerobic Digestion Facilities
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Real-time odor monitoring at the facility

Electronic noses → Met tower → Computer with modelling software and database → Real time impact assessment and archiving

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Citizen committee

Citizen committee members are trained people from the community who enter odour observations on a special form every time they smell an odour.

- Excellent community involvement tool
- Direct channel with community
- Converts complaints into observations (information)
- Training is important to get comparable observations
- A great deal of organisation required
- Specific time and location evaluation. What is happening elsewhere in the plume?
- Qualitative information: no odour concentration
- Data useless for odour abatement design
- After a certain time participants will get bored
Pre construction Odour impact assessment
Composting and Anaerobic digestion plant
Chagny, France
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<table>
<thead>
<tr>
<th>Source</th>
<th>Surface ou Diamètre</th>
<th>Hauteur par rapport au sol</th>
<th>Température</th>
<th>Débit odeur surfacique</th>
<th>Débit odeur</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[m² / m]</td>
<td>[m]</td>
<td>[°C]</td>
<td>[u.o.E/m²-s]</td>
<td>[Mu.o.E/h]</td>
</tr>
<tr>
<td><strong>Variante 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cogénération</td>
<td>0,5</td>
<td>13,0</td>
<td>170</td>
<td>N.A.</td>
<td>8,1</td>
</tr>
<tr>
<td>Biofiltres ouverts</td>
<td>1 080 m²</td>
<td>2,5</td>
<td>Ambiante</td>
<td>30,9</td>
<td>120,0</td>
</tr>
<tr>
<td>Stock de compost</td>
<td>1 500 m²</td>
<td>4,0</td>
<td>Ambiante</td>
<td>0,1</td>
<td>0,5</td>
</tr>
<tr>
<td><strong>Variante 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cogénération</td>
<td>0,5 m</td>
<td>13,0</td>
<td>170</td>
<td>N.A.</td>
<td>8,1</td>
</tr>
<tr>
<td>Sortie canalisée des biofiltres (couverts)</td>
<td>1,6 m</td>
<td>20,0</td>
<td>Ambiante</td>
<td>N.A.</td>
<td>120,0</td>
</tr>
<tr>
<td>Stock de compost</td>
<td>1 500 m²</td>
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Green waste Anaerobic Digestion plant, SIG, Switzerland
Green waste Anaerobic Digestion plant, SIG, Switzerland
Green waste Anaerobic Digestion plant, SIG, Switzerland
Anaerobic Digestion food waste, Bil Ta Garbi, Basque Country

Before construction
Anaerobic Digestion food waste, Bil Ta Garbi, Basque Country

Construction phase
Anaerobic Digestion food waste, Bil Ta Garbi, Basque Country
Anaerobic Digestion, Biosolids, Nantes, France
Anaerobic Digestion, Biosolids, Nantes, France
Anaerobic Digestion, Biosolids, Nantes, France
Odour monitoring Value Proposition

- Establish a trust based relationship with stakeholders (elected officials, neighbours, regulatory agencies)
- Rational evaluation of the project and site based on existing and anticipated constraints
- Management of odor events in real time and based on a proactive approach (prevention of off-site impacts)
- Continuous improvement and associated off-site impact reduction
- Minimization of odor management costs (capital and operational)
- Optimization of odor abatement equipment and processes
- Revenue maximization
- Risk reduction
- Odor traceability

Estimated around 2% of the project operating budget, odor planning and odor monitoring will provide a reduced risk of shutdown, reduced processing capacity and no chaotic upgrades at great costs.