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Static Vs Dynamic Odour Control
A Better & More
Cost Effective Solution

Stuart Lee and Raymond Porter
Odotech
3333 Queen Mary
Montréal, Qc, Canada
+1 514 340 5250
slee@odotech.com
Chesapeake-Elizabeth WwTP

- 24 MGD US (91 MLD)
- Virginia Beach
- USA

- Physical-Chemical-Biological Secondary treatment plant
- Without Primary Clarification
- Partially covered ASP + OCU
- Peroxide Regenerated Iron Sulfide Odour Control at Headworks
- OdoWatch real-time odour monitoring & modelling
**Typical Chemicals Responsible for Odours**

- **Sulphides** ($\text{H}_2\text{S}$, DMS, DMDS, $\text{CS}_2$, Methanethiol)
- **Volatile Fatty Acids** (Acetic Acid, Butyric Acid, Propionic Acid)
- **Nitrogen Compounds** (Ammonia, Trimethylamine)
- **Plus** Many Others depends on waste stream and the process used!

**Unfortunately** No single tracer gas for estimating off site odour impacts (Odour is a blend of multiple components... many at the detection limits of existing methods)

Must rely on olfactometry (D/T or O.U./m$^3$) and modelling
Olfactometry Definitions

- **Odour Unit**: by definition, 1 o.u./m³ when odour is perceived by 50% of a human panel (1 o.u./m³ corresponds to the detection threshold)
  
  Also Dilution to Threshold (D/T)

- **Odour Concentration** (c) (number of odour units): Number of dilutions (with odourless air) of the sample required to obtain 1 o.u./m³

- Example: if c = 10,000 o.u./m³ means it takes 10 thousand dilutions to reach the detection threshold for this sample
The Costs of Odour Problems

- Forced Shutdowns
- Revoked or Refused Permits
- Fines and Penalties
- Lawsuits and Lawyers
- Massive Investment in Technology Upgrades
- Daily Operation & Consumables Costs
- Difficult Public Relations with Neighbours
Odour Dispersion Modelling

• **Defines relationship** between the emission source and receptors

• **Compliance** with nuisance standards depend on whether the odour levels at the receptor have been reduced with respect to their Frequency, Intensity, Duration, Offensiveness and Location (FIDOL, also FIDOR)
Purpose of Dispersion Modelling

Understand fate of odour emissions as a function of weather conditions

Impact assessment

Retrofit & control
  • new technology
  • largest contributor
  • stack design

Complaints
  • validity
  • distribution
  • anticipation

Permitting and compliance

Operation management
# AERMOD v CALPUFF Modelling

<table>
<thead>
<tr>
<th>AERMOD</th>
<th>CALPUFF</th>
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**AERMOD**
- Uses value of source once to perform all calculations in the grid.
- A plume calculated at time \( T \) will follow this path to infinity and not change direction with the following weather data.

**CALPUFF**
- Runs in successive stages.
- Takes calculated values in the first mesh to estimate the second values and so on. The model has a memory of the previous position of the plume.

![AERMOD Diagram](image1.png)

![CALPUFF Diagram](image2.png)
Static Modelling

- Sources sampled at a single campaign
- Olfactometric results define the source
- Modelling with historical metrological data (1 to 5 years)
- The result pairs "worst case" emissions with "worst case" dispersion
- Compliance = some "acceptable" level of exceedance as a percentile of hours
- Static modelling only option on new or proposed sources, as the does not exist

Static modelling is ‘Odour Dispersion Modelling Assessment’ or ‘Odour Impact Study’
Dynamic Modelling

- Pairs real time monitored odour emissions and measured real-time meteorology
- Emissions and dispersion no longer independent parameters
- Odour control measures can be applied dynamically, not worst case condition
- Dynamic modelling preferred option on large open emission source
- Also applicable to control/optimisation of OCU’s

Real-Time measurements  Live Weather Data  Modelling iteration every 4 minutes
Odour Concentration & Emission Rates

- **Static Modelling:**
  - Emission rate limited to the odour concentration obtained during the sampling campaign and olfactometry analysis

- **Dynamic Modelling:**
  - Emission rate measured/calculated continuously
  - Updated for at each model iteration
  - Considers fluctuation from unsteady state processes and/or weather variations
Source Parameters

• **Static Modelling:**
  • Values represent worst case release scenario at time of sampling

• **Dynamic Modelling:**
  • Exhaust gas temperature and exit velocity considered for each model iteration
  • Adjusts for operational variable (e.g. influent wastewater quality)
  • Include open/closed door conditions (e.g. Sludge Dewatering Building)
Meteorological Data

- **Static Modelling:**
  - Historical data from the nearest airport.
  - Meteorological data is an independent variable from the odour emissions.
  - The static modelling often predicts maximum odour impact on
    - calm winter morning
    - and maximum odour emissions on warm summer days.
  - Data is often not local (distance from data source to site)
  - Weather data doesn’t reflect micro scale changes at site or surroundings

- **Dynamic Modelling:**
  - On-site weather tower data
  - Linked to real-time odour monitoring
  - Calculates real-time emission rates
Chesapeake-Elizabeth WwTP
<table>
<thead>
<tr>
<th>Meteorological Data</th>
<th>Static Modelling</th>
<th>Dynamic Modelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>Historical 1 to 5 years</td>
<td>Real-time and historical data</td>
</tr>
<tr>
<td>Frequency</td>
<td>1 hour average</td>
<td>As low as 4 minute intervals</td>
</tr>
<tr>
<td>Representation</td>
<td>Regional scale</td>
<td>Local scale next to the source</td>
</tr>
<tr>
<td>Location</td>
<td>Nearest airport</td>
<td>On-site</td>
</tr>
<tr>
<td>Upper air</td>
<td>Two (2) per day usually remote location far from the site (50+km)</td>
<td>Assumes unlimited surface mixing layer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Topography &amp; Receptor Array</th>
<th>Static Modelling</th>
<th>Dynamic Modelling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Taken in consideration</td>
<td>Taken in consideration</td>
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</table>

<table>
<thead>
<tr>
<th>Complex Changing Local Patterns</th>
<th>Static Modelling</th>
<th>Dynamic Modelling</th>
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<tbody>
<tr>
<td></td>
<td>Not considered</td>
<td>Taken in consideration</td>
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Wind Rose Variations (2013)

Norfolk International Airport

On-site Station at CETP

‘wind blowing from’
## Utilisation Source Characteristics

<table>
<thead>
<tr>
<th>Utilizations</th>
<th>Static Modelling</th>
<th>Dynamic Modelling</th>
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</thead>
<tbody>
<tr>
<td>Alert upon threshold exceedance</td>
<td>Not possible</td>
<td>Visual, sound or email</td>
</tr>
<tr>
<td>Proactive</td>
<td>Not possible</td>
<td>Can trigger measures to mitigate odour emissions</td>
</tr>
<tr>
<td>Compliance determination</td>
<td>For new sources and existing sources</td>
<td>For existing sources</td>
</tr>
<tr>
<td>Review of specific odour event</td>
<td>No</td>
<td>History of all archived plumes. Animation (movies) of odour events in the last 24 hours</td>
</tr>
<tr>
<td>Current compliance assessment</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Complaint validation</td>
<td>Yes but limited to average exposure</td>
<td>Yes on a case by case event</td>
</tr>
<tr>
<td>Automated report</td>
<td>No</td>
<td>Yes on demand</td>
</tr>
<tr>
<td>Process optimization</td>
<td>Limited to average results</td>
<td>Process optimization with control loop adjusted every model iteration</td>
</tr>
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Static Modelling; Maximum Impact
Dynamic Modelling; Maximum Impact
Static Modelling; 98%ile Impact
Dynamic Modelling; 98%ile Impact
Budget will vary according to number of sources.

- Electronic Nose Source monitoring, live weather data and dynamic modelling:
  See actual odour fluctuations & impact.

- Dynamic plume modelling from measured odours & live weather data.

- Manual Odour Study or Static Modelling:
  - $25k
  - $100k
  - $300k

Whatever the approach, budget will be a fraction of a site capital budget or litigation.
Dynamic Odour Monitoring Value

- Minimize odour management costs (CAPEX & OPEX)
- Manage odour events in real time based on a proactive approach (reduce of off-site impacts)
- Continuous improvement possible with associated off-site impact reduction & tractability
- Rational evaluation of the project and site based on existing and anticipated constraints
- Establish a trust based relationship with stakeholders (elected officials, neighbours, regulatory agencies)

Real-time odour monitoring & modelling - OdoWatch
Economic Consequences

(Chesapeake-Elizabeth WwTP)

• **Phase 1** – Partially Cover Aeration Basins
  • Implemented + using Odour Control Unit

• **Phase 2** – (Proposed)
  • Completely Cover Aeration Basins
  • Not implemented due to high capital cost

• **Phase 2** – (Implemented)
  • Hydrogen Peroxide to control odour emissions
  • OdoWatch real-time continuous monitoring & modelling
  • +10% reduction in chemicals with OdoWatch
Thank you

- **OdoWatch** a real-time odour monitoring & modelling system for:
  - Continuous odour emission measurement
  - Real time, 24/7 atmospheric dispersion modelling
  - Advanced data analysis
  - Threshold alerts (alarm)
  - An operational tool for managing odour impact

Questions please contact
Stuart Lee
slee@odotech.com
www.odotech.com