ODOUR ASSESSMENTS AND AMBIENT MONITORING AT THE WASTEWATER TREATMENT PLANTS AND THEIR CHALLANGES

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Overview

- Principles and Challenges when Assessing Odours at the WWTP
- Introduction to Odour Sampling:

  How do you measure odour?
- Standards and Guidelines for Odour Sampling
- Methodologies Commonly used to Estimate Odour Emissions from the Area Sources
- Case Study
- Conclusions

Challenges when Assessing Odours at WWTP

- Difficulty in Accurately Measuring Emissions from Potential Odour Sources
- Sources at WWTP
  - Point Sources (vents, stacks)
  - Area Sources:
  - 1. Active Surface Sources with Noticeable Flow (Aeration Tanks)
  - 2. Passive Surface Sources- without Flow
  - 3. Partially Passive, Partially Active
  - Fugitive - (Open Doors, Truck Waiting to Load/Unload)

Odour Sampling at the Sources

How Do You Measure Odour?

- Collection of Samples at Each Potential Odour Source
- Olfactometry Evaluation for Odour Detection Threshold Values (ODTV)
- Estimation of Odour Emission Rates
- Dispersion Modeling Analysis to Predict Off-Site Odour Concentrations

Standards/Guidelines for Sampling

- **European Standard:** *EN:13725:2003*
  Air Quality-Determination of Odour Concentration by Dynamic Olfactometry
- **Australian/New Zealand**: *2001* Stationary Source Emissions. Part 3: Determination of Odour Concentration by Dynamic Olfactometry
- **German VDI** (Verein Deutscher Ingenieure): *VDI 3880;2011*
  Olfactometry - Static Sampling;
- **United States of America**:
  ASTM -679
- **Canada, Ontario:** *Ontario Source Testing Code, Method ON-6* "Determination of Odour Emissions from Stationary Sources"

Methodologies Used for Estimation of Emissions From Point Sources

- Dilution Sampling Method- samples are diluted with nitrogen (on site) using dynamic dilution sampler
- Sampler- calibration, check for leakage, odour sampler blank
- Lung Sampling Method- samples are not diluted

Methodologies Used for Estimation of Emissions From Area Sources

- Flux Chamber Method
- Wind Tunnel Method
- A Back Calculation with Air Dispersion Model Method
- A new Method- Based on the Principle of Mass Transfer from Liquid to Gas Phase- 2015 A&WMA Conference

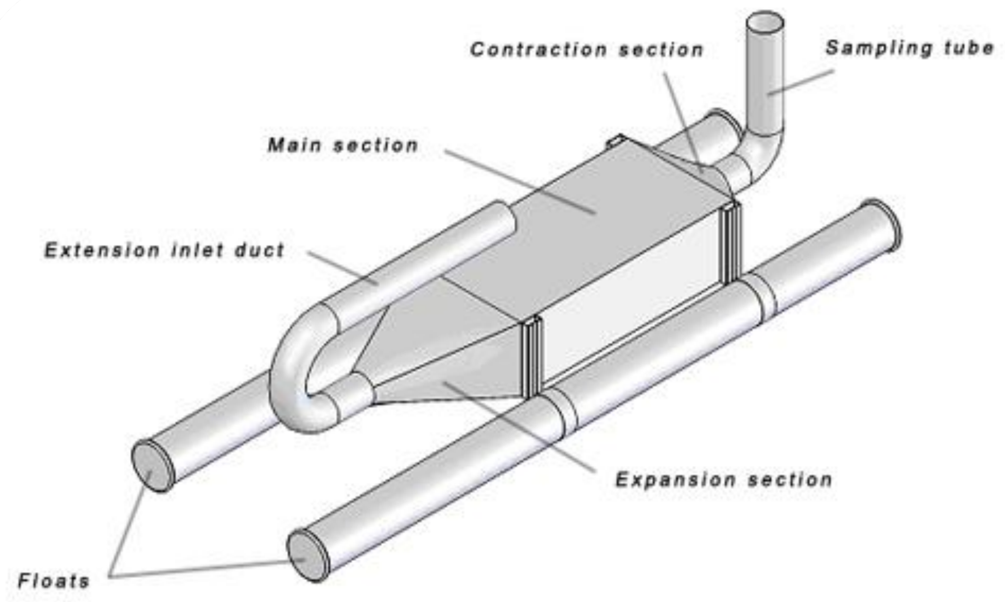
Flux Chamber Method

Flux Chamber Method

Flux Chamber Method

- Nitrogen Used as a Sweep Gas
- Sample Collected at the Outlet of the Chamber
- Three Samples Collected Which May be Diluted on Site
- Purging of the System before Collection of the Samples
- Nitrogen Flow used Together with ODTV for Calculations of Emission Rates

Portable Wind Tunnel Method



DynaTunnel portable wind tunnel

Portable Wind Tunnel Method

A Back Up Calculation with Dispersion Modelling

- Ambient Concentrations are Measured Downwind at Several Downwind Locations
- Samples - Analyzed Using Dynamic Olfactometry - According to EN137125
- Back up Calculations of Emission Rates using a Dispersion Model
- Large Number of Samples are Required to be Collected During Different Meteorological Conditions
- Sources Need to be Separated

A Back Up Calculation with Dispersion Modelling

Method Based On Mass Transfer from Liquid to Gas Phase

- Samples Collected Using a Flux Chamber acted as Capture Hood
- Assumption that Transfer of Gases Between Water and Air – Directed by Turbulent and Molecular Process
- Full Description of Methodology in the Paper: Liu H., Bokowa A. "Explore an Approach to Determine Odour Emissions from Water Surfaces", 2015 A&WMA

Ambient Odour Assessments-Ambient Sampling

- Ambient sampling with odour panel evaluations - very common approach used in Ontario, Canada to assess odours in residential and complaint areas - not expensive, reliable data, needs clean bags

- Downwind and upwind locations
- 3 samples collected at each ambient location
- All samples analysed by dynamic olfactometry using 8 trained and screened panelists

Ambient Sampling

Ambient Odour Assessments- Portable Units

- Odour monitoring using portable instruments such as the Nasal Ranger or Scentroid SM100 - inexpensive can be used as a screen tool.
- Provide peak instantaneous odours, whereas ambient sampling provides odour concentrations averaged (10 minutes, 30 minutes)
- Readings are based on one - person sensitivity

Ambient Odour Assessments- Electronic Noses

- Continuous odour monitoring using electronic noses
  - Very expensive
  - Not applicable for all types of sources
  - Calibration with odour panel
  - Frequent replacement of the sensors
  - Question? What to do when process changes

Ambient Odour Assessments- Specific Compound Monitoring

- Continuous specific compound or a group of compounds monitoring (H_2S, RSC monitoring systems)
- Some of these systems are easy to operate but most of them are complex and installation and operation require extensive technical expertise
- Limitations with detection limits
- Possible interference

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Ambient Odour Assessments- Grit or Plume Method

- Ambient monitoring using grit or plume method-observations are made by a panelist who performs odour observations for odour intensity following grit or plume methods.
- Very expensive method
- Requires large data base and therefore requires months of observations.
- Most data are based on a one - person observation and depends on his or her sensitivity.

Ambient Odour Assessments- Community Odour Surveys

- Community odour surveys - performed by screened and trained independent observers downwind from the potential source, namely the facility in question. Intensity, hedonic tone and character is recorded

- A large data set is required
- Odour adaption and fatigue
- Limitations with terrain

Ambient Odour Assessments- Community Odour Surveys

- Intensity Scale

- 0 - No odour - No Odour Perceived
- 1 - Slight Identifiable Odour
- 2 - Moderate Identifiable Odour
- 3 - Strong Identifiable Odour
- 4 - Extreme - Severe Odour. One Where the Observer is Compelled to Leave the Area

Community Odour Surveys

	Frequency of Occurrence of Odour (%) Distance (m)							
Category	**250**	**500**	**750**	**1000**	**1250**	**1500**	**1750**	**2000**
Stagnant Water	28	21	22	20	3	0	0	0
Raw Sewage	63	61	23	16	6	0	0	0
Burnt Sewage	4	9	22	12	2	12	0	0
Sulphur	2	0	0	0	0	0	20	8
Mercaptans	0	0	0	0	0	0	0	0
Acidic	0	0	0	0	0	0	0	0
Pungent/oily	2	0	0	7	4	2	0	0
Other	0	0	3	0	0	0	1	0
Total	99	91	70	55	15	14	21	14
No Odor	1	9	30	45	85	86	79	86

Community Odour Surveys

	Nominal Distance from Plant Centre (m)							
	250	**500**	**750**	**1000**	**1250**	**1500**	**1750**	**2000**
Average Intensity*	3.1	2.6	1.6	1.0	0.2	0.2	0.3	0.2
FREQUENCY OF DETECTION (AVERAGE INTENSITY)	99%	91%	70%	55%	15%	14%	21%	14%
Maximum Intensity**	4.0	4.0	3.0	3.0	1.7	2.0	2.0	1.0

Methodology Used for Case Study 1

- **Flux Chamber Method** - 2 locations, 3 samples each
- **Wind Tunnel Method** - 2 locations, 3 samples each
- **Mass Transfer Method Flux Chamber** - 2 locations, 3 samples each
- No Back Up Calculation Method Used

Methodology Used for Case Study1

- In Addition – Ambient Sampling at 3 Selected Sensitive Receptors
- One Upwind Location for Each Sensitive Receptor was Chosen for Sampling as a Background
- 2 Conditions
- 3 Samples Collected at each Ambient Location (Downwind and Upwind)
- All Samples Analyzed at EOC Laboratory using 8 Screened Panelists

Methodology Used for Case Study 1

- Samples Covered in Dark Containers to Prevent Any Photochemical Reaction
- Evaluations of Samples by Dynamic Olfactometry and Screened Panelists
- Evaluations According to EN 13725 Standard *(Some Exceptions)* and Ontario ON-6 Guideline
- Evaluations Within 8 Hours From Collection

Case Study 1-Results

Location/Condition	Measured Ambient Concentration ou	Predicted Ambient Concentration ou Flux Method	Predicted Ambient Concentration ou Wind Tunnel Method	Predicted Ambient Concentration Ou Mass Transfer Method
Sensitive Receptor1-Condition 1	13	2	12	14
Sensitive Receptor-2 Condition 1	10	1	6	14
Sensitive Receptor 2-Condition 2	69	7	43	63
Sensitive Receptor 3-Condition 1	55	5	30	45
Sensitive Receptor-3-Condition 2	138	14	64	73

Conclusions- Case Study 1

- Back Up Calculation Method Was not Used – It was Not Possible to Differentiate Area Sources - Some of Them were in Line with Specific Wind Directions
- Good Correlation Between Measured Ambient Concentrations and Concentrations Obtained by Mass Transfer Method and Wind Tunnel Method
- Flux Chamber Method – Underestimation of Odour Concentrations
- Careful Selection of the Methodology Should be Considered when Sampling for Odour at the Area Sources

Case Study 2

Sample No:	Dilution	Raw ODTV ou	Net ODTV ou
Sample 1	50	620	31,000
Sample 2	50	650	32,500
Sample 3	50	710	35,500
Sample 1	1	2,100	2,100
Sample 2	1	1,900	1,900
Sample 3	1	2,150	2,150

Case Study 3

Sampling Description/Location	Odour Detection Threshold Values (OU)		Factor
	Dynamic Dilution Method	Lung Sampler Method	
Hot Source-Location 1	34,294	2,075	16
Hot Source-Location 2	1,588	124	13
Humid Source-Location 1	9600	1100	9
Humid Source-Location 2	7200	850	8
Biofilter Inlet-Location 1	13272	3090	4
Biofilter Inlet-Location 2	15400	2435	6

Case Study 4

Condition	Odour Emission Rates based on Wind Tunnel ou/s/m2	Odour Emission Rates based on Flux Chamber ou/s/m2	Factor
1	61.99	5.19	11
2	69.29	5.44	13
3	67.16	5.30	13

Case Study 5

Process	Odour Emission Rate ou/s (m^3 basis)	Ratio Odour Emission Rates Stacks to that Estimated from Doors
Area 1- Stack- Fan On	175060	1.1
Area 1- Fugitive- Doors	158450	
Area 2-Stack- Fan On	949412	0.98
Area 2- Fugitive- Doors	964190	

Case Study 6

Location	Predicted by AERMOD Model Off- Site Odour Concentration OU	Measured Ambient Odour Concentration OU
Sensitive Receptor 1	41	80
Sensitive Receptor 2	46	72
Sensitive Receptor 3	15	18
Sensitive Receptor 4	82	126

Case Study 7

- Odour Removal Efficiency Study

	Consultant A	Consultant B
Condition 1	4%	98%
Condition 2	0%	96%
Condition 3	53%	79%
Condition 4	75%	96%

Conclusions

- Several factors should be considered before or during assessments and these include:
  - Selection of all potential odour sources in the facility (point, area, fugitive)
  - A careful selection of the methodology especially for fugitive and area sources
  - Determination of any odour background before assessment

A full odour assessment is recommended for wastewater treatment plants including source testing and ambient assessment

Conclusions

- Odour emissions may be underestimated if proper sampling methods are not used which may produce outgoing complaints
- Odour removal efficiencies may be underestimated if proper sampling methodology is not used

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