CASE STUDY: ENVIRONMENTAL MONITORING USING REMOTE OPTICAL SENSING [OP-FTIR] TECHNOLOGY AT AN INDUSTRIAL WASTEWATER TREATMENT PLANT

Tinker Air Force Base, Oklahoma

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INVESTIGATION OVERVIEW
Outline

- Introduction
- Project Overview
- Distinctive Elements of Effort
- Air Emission Model
- Air Dispersion Model
- Coupled Model Validation / Calibration Process
- Coupled Model Results
- Comparison to Remote Optical Monitoring System
- Application to Risk Assessment
- Summary and Conclusions
Tinker AFB covers 5,031 acres
  • Only 200 acres are undeveloped

765 Facilities
  • 15.3M feet\(^2\) of industrial operations

Three Creek Systems

700-plus Air Emission Sources

200 Underground Storage Tanks

11-Miles Industrial Wastewater Lines

Three Wastewater Treatment Plants

36 Restoration Sites

Provides Logistics Support to USAF Weapon Systems
  • B-1, B-52, E-3 Sentry, C/KC-135 aircraft
Tinker AFB performs Depot Level Maintenance

Process Assessment identified four Primary Processes
- Depainting, Painting, Electroplating & Cleaning
- Majority of processes discharge to an on-base treatment facility

Regulatory Requirement to quantify Air Emissions from Industrial Wastewater Treatment Facility [IWTF]
- Toxic Release Inventory and Air Emission Inventory
- Clean Air Act Title V permit requires source & emission information
- POTW NESHAP requirement

Efforts focus on Methylene Chloride and Phenol
- Both are CAA Title III Listed Hazardous Air Pollutants [HAPs]
- VOC and semi-VOC examples
- These chemicals account for majority of purchases / releases
Investigation will be presented in four Major Tasks

- Coupling of Emission and Dispersion Models represents a Cost-Effective and Environmentally-Responsible Approach
  - Coupling refers to sequential use of models [output is input]
  - Meet impact predictions, regulatory reporting requirements, and pollution prevention needs
  - Estimate emissions from IWTP process units
    - WATER8 air emission model developed by EPA
  - Estimate atmospheric dispersion concentrations
    - ISC-ST3 air dispersion model designed by EPA
  - Validate predictive accuracy of the coupled model
    - Comparison of coupled model predictions to field data
    - Comparison of coupled model predictions to OP-FTIR data
  - Demonstrate potential applications to include Risk Assessment
Distinctive Elements of Investigation

- Combined use of WATER8 and ISC-ST3
- Literature directed to specific applications
- Coupled model compared to MAAC
- Literature limited to single emission sources
- Literature focused at municipal wastewater treatment
- Detail and size of periodic canister data
- Investigation of three remote optical paths
- Multiple retroreflectors that bend optical path
- Evaluation of chemical depainting agents
- Coupled model used in risk assessment
- Completeness and comparative analysis
COUPLED MODEL OUTPUT
Maximum Methylene Chloride Concentrations, PPB
ENVIRONMENTAL MONITORING
Location of Periodic Canister Data

- RCRA Facility Investigation Data [A1-A13]
- 1993 Battelle Study [A1, A2, A3]
- OC-ALC Bioenvironmental Data [A1, A2, A3]
- Coupled Model Predictions [1984-91]
Open-Path Monitoring System measures Atmospheric Emissions

- Directing infrared optical energy along physical path that crosses downwind of emission source plume
- OP-FTIR system used for environmental monitoring

Pollutants modify Spectral Signal

- Allows for determination of identity and quantity of pollutants

OC-ALC Application consist of OP-FTIR Spectrometer

- Operated in monostatic configuration
- Designed to measure atmospheric dispersion concentrations along five distinct optical paths
- Primarily concerned with fenceline concentrations \([P_1, P_2, P_3]\)
- System installed in 1995 and operational roughly three months
  - 36 percent of collected FTIR data considered unusable
OPEN PATH MONITORING SYSTEM
Remote OP-FTIR Optical Monitoring Pathways

PC  OW-N  ST-W  ST-E  B62516  MIX  SCC-N  SCC-S  BIO  SC-N  SC-S

OW-S  D1  D2  P1  A1  A11  A2  P2  A3  P3  A4  A5  P4  P5
COUPLED MODEL OUTPUT
Maximum Methylene Chloride Concentrations, PPB
OPM SYSTEM COMPARISON

Methylene Chloride--Optical Path P1

Coupled Model Predictions [1984-93]
FTIR Predictions
RCRA Facility Investigation [A1, A11, A2]
1993 Battelle Study [A1 & A2]
OC-ALC Bioenvironmental Data [A1 & A2]
OPM SYSTEM COMPARISON
Methylene Chloride -- Optical Path P2

Coupled Model Predictions [1984-93]
FTIR Predictions
RCRA Facility Investigation [A3]
1993 Battelle Study [A3]
OC-ALC Bioenvironmental Data [A3]
OPM SYSTEM COMPARISON
Methylene Chloride--Optical Path P3

Coupled Model Predictions [1984-93]
FTIR Predictions
RCRA Facility Investigation [A4 & A5]
COUPLED MODEL OUTPUT
Maximum Phenol Concentrations, PPB

X-Coordinate, West to East

Y-Coordinate, South to North
OPM SYSTEM COMPARISON

Phenol--Optical Path P1

Coupled Model Predictions [1984-93]
FTIR Predictions
RCRA Facility Investigation [A1, A11, A2]
1993 Battelle Study [A1 & A2]
OC-ALC Bioenvironmental Data [A1 & A2]
OP-FTIR Ineffective Method of Predicting Field Data

- FTIR over-predicts field data along all three optical paths
- FTIR data gathered over 12 months
- FTIR over-predicts by orders of magnitude
- No visual trends for both components
- Clustering of data along optical path

Reliability of Technology

- Three months worth of data over five years
- 36% of data considered unusable

Potential Weaknesses

- Poor maintenance and oversight
- Weather data equipment and software
- No daily background spectra
- Significant water vapor impacts
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