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Project Summary

Field Assessment of Aerated Lagoon Emissions and Their Control Using an Inflated Dome

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The fate of volatile organic compounds (VOC*) in an industrial wastewater activated sludge system was investigated through a four-day sampling and analysis program. The system included an aerated lagoon which is covered by an inflated synthetic dome. The dome has a carbon adsorption column to reduce emissions of odorous organic compounds. Samples of air, water and sludge streams associated with the activated sludge system were collected, along with air samples at the inlet and outlet of the carbon adsorber. These were analyzed to determine the concentrations of individual volatile organic constituents. The effectiveness of the dome and carbon adsorber in reducing lagoon emissions of volatile organic compounds was investigated, as was the applicability of the Thibodeaux-Parker-Heck model to predicting emissions from the covered aerated lagoon. Approximate percentages of removal of VOCs by biodegradation, adsorption and volatilization in the aerated lagoon were determined.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Office of Air Quality Planning and Standards (OAQPS) of the U.S. Environmental Protection Agency is developing standards to control emissions from hazardous waste treatment, storage, and disposal facilities (TSDFs). The purpose of these regulations is to protect human health and the environment from impairment by emissions of volatile organic compounds (VOCs) and particulate matter. The Hazardous Waste Engineering Research Laboratory (HWERL) has the responsibility of providing technical support to OAQPS in the area of atmospheric emissions from hazardous waste management. Part of the research in the HWERL program involves studying emission control techniques applicable to TSDFs.

The objective of this project was to obtain field measurements of the effectiveness of emission controls for off-gases from an aerated lagoon. Specifically, the three primary objectives of the lagoon enclosure testing were to:

- measure the control efficiency of the activated carbon beds which were used in the treatment of the off-gases from the lagoon;
- measure the overall effectiveness of the dome and carbon adsorption system in controlling lagoon emissions; and
- determine the applicability of Thibodeaux's model to predicting emission rates from aerated impoundments.

* As used in this study the term volatile organic compound (VOC) applies to compounds which can be extracted from liquid wastes by a purge and trap method

As part of the assessment of lagoon emissions and their control, an approximate mass balance was performed around the lagoon to determine the fate of influent VOCs. Also, the effectiveness of 55 gallon drums of carbon used to control breathing and working losses in the waste pretreatment area was determined.

The TSDF site chosen for this study is the Upjohn Fine Chemicals facility in North Haven, Connecticut. At this facility Upjohn produces speciality chemicals as intermediates for other Upjohn divisions and for sale to other end users. At the time of this sampling, 1984, the wastewater was being treated in a series of processess (neturalization, primary clarification, and activated sludge) prior to being discharged (see Figure 1).

The site was chosen because of the emissions control system used at Upjohn to minimize odor.This system is located at the aerated lagoon that is part of the activated sludge system. Control consists of an inflated dome over the lagoon with carbon adsorption beds to remove odorous compounds (primarily orthochlorophenol) from the exhaust gases (Figure 2). While orthochlorophenol is very water soluble, but not highly volatile, the facility wastewaters do contain aromatic and halogenated organic compounds which are volatile. The dome and carbon adsorption system at Upjohn was studied to determine its efficiency in controlling emissions of these volatile compounds.

Approach

The nonmethane hydrocarbon (NMHC) content of the dome bleed-off gas was monitored at the inlet and outlet to the dome's carbon adsorption unit and inside the dome using on-site total hydrocarbon and gas speciation instrumentation. Canister samples were collected for gas specification off-site. Samples were also collected at the inlet and outlet of 55 gallon drum carbon adsorption units at the vents to the wastewater treatment system neutralizer tank. A screening of potential leak points around the dome was performed using a portable hydrocarbon analyzer.

Liquid and sludge samples were collected at selected points around the wastewater treatment system. These were analyzed for total NMHC content and for major volatile organic species. The resulting data were used determine the fate of volatile organi entering the aerated lagoon.

The composition data of the aerat lagoon effluent were utilized in tl Thibodeaux-Parker Hwang emissio model for aerated surface impoundmer to predict emissions with the dome place.

Findings

The volatile organics identified in tl influent stream to the aerated lago were classified as volatile paraffi (15%), aromatics (45%), and haloge (40%). Major volatile compounds inclu 1,2-dichloroethane, benzene, tolue and chlorobenzene. The approxima material balance performed around tl aerated lagoon indicated th approximately 60 weight percent (±20 of the influent VOCs are volatilized a exhausted from the dome structure. Tl volatilized organics are primari halogenated organic compoun (e.g.,1,2-dichloroethane). Twenty-eig percent (±4%) of the influent VOCs a discharged from the aerated lagoo These are predominately paraffins.

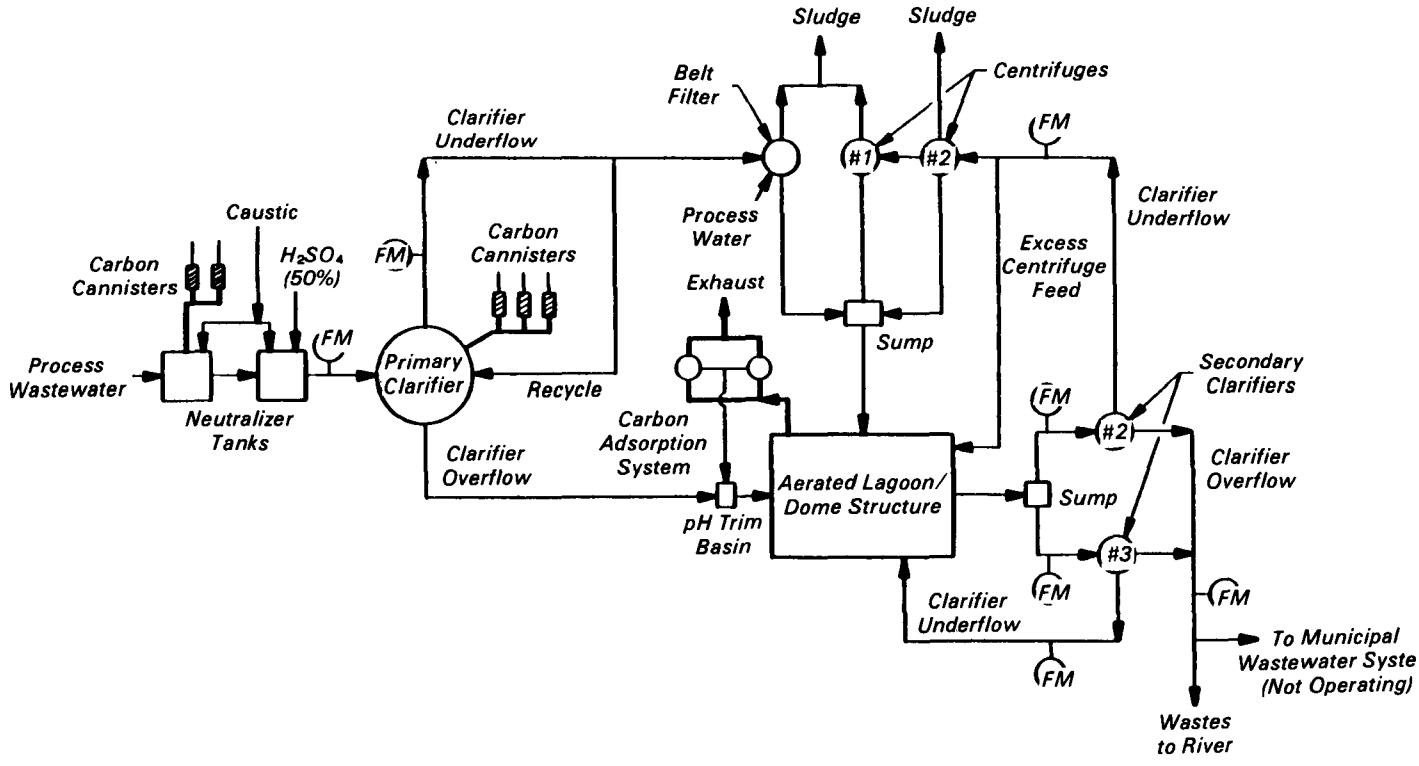
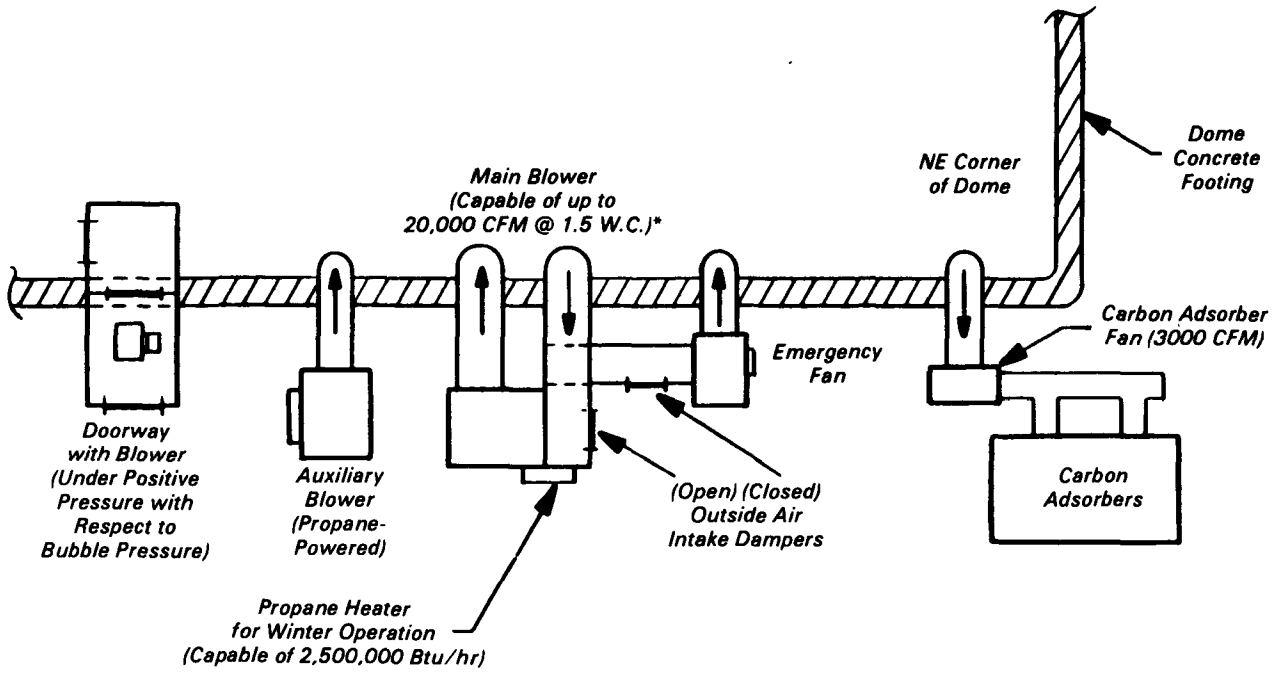


Figure 1. Wastewater treatment system.



*Has been shimmed and current air flow rate is unknown.

Figure 2. *Dome structure inflation fan and exhaust system.*

Due to the combined uncertainties in measured influent, effluent and emission rates, a large uncertainty was associated with estimating VOC biodegradation by difference. Biodegradation was the major pathway for aromatics removal, accounting for 65 percent (±20%) of aromatic fate. However, the amounts of paraffins and halogenated VOCs that were removed by biodegradation were smaller than the combined uncertainties of the measurements used to estimate them.

The Monte Carlo simulation uncertainty analysis performed on the material balances showed two weaknesses in the determination of the fate of organic compounds in the aerated lagoon. First, difficulties with the extraction of volatile organics from wastewater sludge streams led to an uncertainty of ±50% in their VOC content. Second, there was a large uncertainty (up to ±58%) in emissions measurements due to the variability in gas composition going through the carbon adsorber.

The inflated dome is estimated by the facility to have less than a 0.14 m3/sec (300 cfm) leakage rate, which is low compared to the purge gas bleed-off rate of 1.4 m^3/s (3000 cfm). A preliminary screening of the dome structure indicated that the largest leaks were small in number and had very low ($< 1 \times 10^{-4}$ m^3/s) flow rates.

The carbon adsorber on the dome exhaust provides virtually no (<1%) VOC removal. This is primarily because the extremely high (approximately 100 percent) relative humidity in the carbon adsorber inlet gas stream is believed to interfere with the adsorption capability of the carbon. The activated carbon bed system was originally designed for control of water soluble odorous compounds, and Upjohn feels that the system is performing this function effectively.

Fifty-five gallon drums of activated carbon are used on vented emissions from the neutralizer tanks and primary clarifier at the TSDF. Testing indicated that these drums work very well in removing NMHC emissions in the vent gas. Removals of over 99 percent were measured for specific hydrocarbon compounds.

Mathematical models developed by Thibodeaux-Parker-Heck models are inconsistent in their abilities to predict actual emission rates. Comparability of modeled and measured emission rates varied with compound. This appeared to be partially due to a significant concentration of VOCs in the dome atmosphere and due to the shallowness of the lagoon, which may have inhibited complete mixing of wastewater and led to nonuniform VOC concentrations within the lagoon. Also, the inability to empirically determine key model variables limits the accuracy of the models.

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***Benjamin L. Blaney** is the EPA Project Officer (see below).*
The complete report, entitled "Field Assessment of Aerated Lagoon Emissions and Their Control Using an Inflated Dome," (Order No. PB 87-145 942/AS; Cost: $24.95, subject to change) will be available only from:
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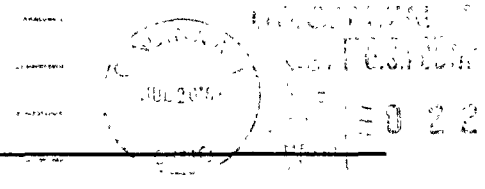

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