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Project Summary

Evaluation of a Liquid Scrubber System for Styrene Removal

Larry Felix, Randy Merritt, and Ashley Williamson

Manufacturing processes that involve the spraying of styrene-based resins have been identified as a possible significant source of volatile organic compound emissions that may affect human health and contribute to the ozone non-attainment problem.Until recently, no known cost-effective technology has been demonstrated toontrol such emissions of styrene. Now, several processes have been developed to control styrene emissions, and a short-term field evaluation was planned to characterize the styrene removal efficeincy of a pilot-scale version of a liquid chemical scrubbing process. This test was carried out at a facility (Eljer Plumbingware in Wilson, NC) that manufactures polyester bathtubs and shower stalls by spraying styrene-based resins onto molds in vented, open spray booths. A side stream of air exhausted from one of the spray booths in the gel coating part of the process was used for the test.

In this study the syrene removal efficiency of a pilot-scale version of the QUAD Chemtact™ scrubber was quantified by continuously measuring the toatl hydrocarbon (TCH) content of spray booth exhaust air entering and exiting the device with THC analyzers and, for some tests, by collecting EPA Method 18 samples (adsorption tube procedure) at the inlet and exit of the device. Average styren removal efficiencies approached but were never >55%.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, 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 report describes an evaluation of the QUAD Chemtact™ chemical scrubber for controlling styrene emissions at Eljer Manufacturing in Wilson, NC. The Eljer facility manufactures shower stalls and bathtubs by spraying styrene-based resins onto molds in vented, open spray booths. Approximately 200 of these types of facilities operate presently in the U.S. The manufacturing process consists mainly of four stages. Stage 1 is the gel coat application. The gel coat contains styrene, polyester resin, and pigment. In Stage 2, styrene and polyester resin are mixed with inert fillers and sprayed onto a previously prepared mold using a spray gun equipped with an attachment to add chopped fiberglass. Stage 3 includes the addition of fire retardant fillers and precut chipboard and corrugated paper used as structural supports. In Stage 4, the shower stall or bathtub is "pulled" or separated from the mold.

Test Configuration

Manufacturing processes that involve the spraying of styrene- based resins have been identified as a possible significant source of volatile organic compound (VOC) emissions that may affect human health and contribute to the ozone non-attainment problem. The mobile pilot unit used for this test was configured to treat approximately 100 cfm (2.8 m^3/min) of the air exhaust from a gelcoat spraybooth. The pilot unit consisted of three reaction chambers interconnected using plyvinyl chloride pipe. The QUAD Chemtact™ process removes styrene by spraying fine droplets (a mist) of diluted chemical solution into a styrene contaminated air stream. The manufacturer claims that the mist provides enhanced chemical reactivity and provides a large surface area where gas-liquid phase reactions take place that result in the removal of gaseous contaminants. Each reaction chamber was fed by a separate chemical metering pump so that a contaminated air stream could be treated with up to three different chemical solutions as it passed through the device. The styrene is apparently oxidized and absorbed into the scrubber liquor which is continuously collected and exhausted through the chamber drain. The treated air is then exhausted tangentially through the bottom of the reaction chamber.

Evaluation Results

Styrene removal efficiencies were determined by measuring the inlet and outlet concentration of the test unit using total hydrocarbon (THC) analyzers with flame ionization detectors (FIDs) and charcoal adsorption tubes (EPA method 18 and NIOSH method 1501). The liquid scrubber did not achieve styrene removable efficiencies >55%, although a number of additives were tried,including sodium hypochlorite, ethylene glycol, sulfuric acid, methyl ethyl ketone peroxide, hydrogen peroxide, and water. The tests were performed on 3 days (6/22/93 through 6/24/93). During the 3 days, 25 separate test conditions were completed. Costs associated with installing this technology at a source of styrene emissions were not addressed due to the failure of the manufacturer to supply any related information. Table 1 contains the inlet and outlet styrene levels and styrene removal efficiency for each test conditions.

In addition to the evaluation of the liquid chemical scrubbing process, it was possible to quantify styrene emissions in the spray booth exhaust to which the chemical scrubber was connected. These analyses revealed that styrene was the only Volatile Organic Compound (VOC) with measurable concentrations detected.

Section 2 of the full report contains a detailed description of the facility and sampling locations, the liquid chemical scrubbing device, experimental apparatus, and experimental methods and procedures. Data, results, and discussion are in Section 3. Section 4 contains the summary and conclusions. The quality assurance and quality control measures taken during this evaluation as well as the results of these measures are in Appendix B.

Samples of spent scrubber liquid were obtained from Reaction Chambers 1 and 2 on June 23 and from Reaction Chambers 1,2, and 3 on June 24. On June 23, only water was injected into Reaction Chamber 3, so no liquid sample was taken. In addition, a sample of the process water used to dilute the chemicals used for scrubbing was obtained on June 24. All liquid samples were preserved in 250 ml glass sample bottles with Teflon-sealed caps. It was originally intended to obtain more scrubber liquid samples. Unfortunately, because so many test conditions were tried, it was difficult to isolate a set of operating conditions (where reasonable styrene removal was obtained) that persisted for a long enough period to obtain a set of scrubber samples that were not contaminated by additives from a previous test condition.

Table 2 gives the results of the analyses carried out on the samples. The table shows that styrene was detected in only the sample from Reactor Chamber 1 on june 24. Considering that the liquid scrubber styrene removal efficiency was never >55% during the time these samples were taken, it is surprising that styrene was detected in only one sample.

Table 1. *Inlet and Outlet Styrene Level and Efficiency of Styrene Removal for Each Test Condition (6/23/93)*

Inlet condition	*Inlet styrene, ppm*	*Outlet styrene, ppm*	*Efficiency %*
1	74.8	41.4	44.7
2	82.3	37.7	54.3
3	75.6	39.0	48.3
4	78.8	40.8	48.1
5	80.2	41.2	48.5
6	109.9	55.0	50.0
7	86.9	41.0	52.8
8	95.1	55.1	41.2
9	109.0	60.2	44.8
10	91.8	52.9	42.3
11	85.4	49.9	41.5
12	97.3	51.1	47.4
13	105.9	48.3	54.5

Table 2. *Results of Analyses Carried Out on Scrubber Liquid Samples and a Process Water Sample*

Date	*Time*	*Origin*	*Compound*	*Concentration (µg/l)*	*Detection limit (µg/l)*
6/23	1340	Reaction chamber #1	Chloroform	23300	410
		Reaction chamber #2	Acetone	709	364
			Chloroform	39400	41
6/24	1040	Reaction chamber #1	Acetone	1910	728
			Carbon disulfide	104	280*
			2-butanone	534000	1460
			Chloroform	230	82
			Styrene	1022	141
		Reaction chamber #2	Acetone	2440	7.28
			2-Butanone	367	14.6
			Chloroform	1.65	0.82
		Reaction chamber #3	Acetone	7.41	7.28
			Chloroform	7.31	0.82
6/24	1015	Process water	Chloroform	55	0.82
			Bromodichloromethane	12.2	2.37

* Conservative estimate of detection limit based on previous mesurements of similar water samples.

L. Felix, R. Merritt, and A. Williamson are with Southern Research Institute, P.O. Box 55305, Birmingham, AL 35255-5305.
Bobby E. Daniel is the EPA Project Officer (see below).
The complete report, entitled "Evaluation of a Liquid Chemical Scrubber System for Styrene Removal," (Order No. PB95-XXX XXX/AS; Cost: $XX.XX; subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
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