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Project Summary

Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries

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This report is an addendum to a 1996 EPA report, *Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries*. This addendum presents additional evaluation of the biological treatment of styrene emissions, Dow Chemical Company's Sorbathene solvent vapor recovery system, Occupational Safety and Health Administration regulations and other policies that affect the fiber reinforced plastics/composites (FRP/C) and boat building industries, and secondary pollution and natural gas usage resulting from various emission control options.

This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, 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

In 1995 and 1996, Research Triangle Institute (RTI), under contract to the U.S. Environmental Protection Agency's (EPA's) Office of Research and Development, investigated end-of-pipe controls to reduce styrene emissions from the fiber-reinforced plastics/composites (FRP/C) and boat building industries. The types of controls that were evaluated included thermal oxidation (also called incineration), catalytic oxidation, biofiltration, and preconcentration/oxidation systems. In preconcentration/oxidation systems, styrene is typically adsorbed onto materials such as activated carbon, zeolite, and proprietary polymers, then desorbed (in a concentrated stream) for catalytic oxidation. Preconcentration/oxidation allows the oxidizer to run nearly autothermally (without additional fuel), even for the low styrene inlet concentrations typically found in the FRP/C and boat building industries. The results of RTI's research were published in a 1996 EPA report, *Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries*.

Objectives

Subsequent to completion of the original report, several additional issues regarding end-of-pipe controls for styrene were identified. The goals of this project were to address four additional issues:

1) Recently, studies on biofiltration/bioscrubbing of styrene have been identified that were not discussed in the original EPA report. The EPA requested further in-depth investigation of these studies.
2) The EPA also identified Dow Chemical's Sorbathene vapor recovery system as a possible styrene removal technology, and requested an evaluation of the Sorbathene process for removal of styrene emitted from FRP/C and boat building facilities.
3) The EPA requested further documentation and interpretation of Occupational Safety and Health Administration (OSHA) regulations that can affect the viability of end-of-pipe controls for styrene removal. The original report contained cost calculations that showed that, for a given styrene mass input to a control device, cost can be

substantially reduced if concentration to the control device can be increased (i.e., if air flow rate can be reduced). The EPA requested exploration of issues including operating spray booths above the allowable Permissible Exposure Limit (PEL) for styrene, with respirators being worn by the operators, and fresh air supplied to the operators in a "space suit."

4) In May 1996, a report containing calculations of the noneconomic impacts of incineration was prepared by Robert Haberlein (a consultant) for the Society of the Plastics Industry/Composites Institute (SPI/CI), a trade organization for the FRP/C industry. Noneconomic impacts, including energy usage and the generation of secondary pollutants (e.g., nitrogen oxides, sulfur dioxide, and carbon dioxide), were calculated, assuming thermal oxidation of an exhaust stream containing 20 parts per million (ppm) of styrene. The EPA requested an analysis of the assumptions in the report, and calculation of noneconomic impacts for other types of controls (such as preconcentration/catalytic oxidation).

Analyses and Results

RTI's further investigation of biofiltration/bioscrubbing included contacts with six biofiltration/bioscrubbing researchers and suppliers. Four researchers/suppliers provided information, including data on flow rates, emission sources, concentrations, control efficiencies, frequency of regeneration, and costs (capital and operating). Most of the installations that were identified were bench- or pilot-scale, with flow rates of less than 1,700 m^3/h (1,000 cfm). The largest system controlling styrene was a bioscrubber, operating on an automotive parts plant in Germany, with a flow rate of 20,000 m^3/h (11,774 cfm). The system capital costs for this application were given as $450,000 to $700,000. This can be compared to an estimated equipment cost and total capital investment of $301,000 and $619,000, respectively, from the biofiltration cost spreadsheet developed in the original styrene controls assessment. Most of the biofiltration systems were able to achieve a control efficiency of 90% or greater, except during acclimation periods (periods after prolonged shutdown), or process upsets.

Dow Chemical Company's Sorbathene process was evaluated as a means of controlling styrene emissions from FRP/C and boat building operations. The Sorbathene process is typically applied to recover organic vapors from process vents, storage tanks, and loading/unloading operations. The process can be designed to achieve 99.9% removal from vent streams ranging in flow rate from 34 to 5,100 m^3/h (20 to 3,000 cfm), with volatile organic compound feed concentrations between 1,000 and 500,000 ppm. RTI's investigation indicated that the Sorbathene process would not be economically feasible for the large flow rates and low styrene concentrations typically associated with FRP/C fabrication and boat building.

The principal OSHA regulations affecting the design and economics of end-of-pipe controls in the FRP/C industry deal with allowable employee exposure to styrene. Various organizations in the reinforced plastics industry voluntarily committed to meeting a 50-ppm 8-hr time-weighted average (TWA) concentration in July 1997. OSHA regulations require that administrative or engineering controls (e.g., enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials) must be considered and implemented, if feasible. If these controls are determined to be infeasible, or while these controls are being implemented, respiratory protection is required. RTI identified one boat building facility operating a paint booth where "space suits" with fresh air supply are used to protect spray gun operators.

Calculations of the noneconomic (energy and environmental) impacts of incineration were presented in a May 1996 report for the SPI/CI. These calculations were based on incineration (thermal oxidation) of an exhaust stream with a styrene concentration of 20 ppm. RTI's investigation indicated that a styrene concentration of 20 ppm would be uncharacteristically low for an FRP/C facility performing open mold spraying, and with annual polyester resin usage greater than 900 Mg (1000 tons, corresponding to a medium-to-large plant). Further, RTI's previous economic analysis indicated that preconcentration/catalytic oxidation systems have lower annualized costs than straight thermal oxidation, for styrene inlet concentrations below approximately 300 ppm. Therefore, it would be unlikely that a FRP/C company would choose a thermal oxidizer for an exhaust stream containing 20 ppm of styrene.

RTI conducted noneconomic impact analyses for three types of control devices (thermal oxidizer, catalytic oxidizer, and preconcentrator/catalytic oxidizer), over styrene inlet concentrations ranging from 20 to 260 ppm (the highest known exhaust concentration for any existing facility with spraying operations). It was found that natural gas usage and secondary pollutant generation were much lower for preconcentration/oxidation systems than for straight thermal oxidation. Since preconcentration/oxidation systems also appear to have lower annualized costs than straight thermal oxidation (below approximately 300 ppm), the choice of preconcentration/oxidation systems in this range reduces both economic and noneconomic impacts.

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The complete report, entitled "Addendum to Assessment of Styrene Emisssion Controls for FRP/C and Boat Building Industries," (Order No. PB97-121156; Cost: $21.50, subject to change) will be available only from:
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