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Project Summary

Test and Evaluation of a Polymer Membrane Preconcentrator

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The report gives results of an evaluation of the applicability of membrane systems as a preconcentrator and defines operating parameters of a membrane system. Advantages of such a system is a potential reduction in cost for subsequent control systems. The evaluation is part of a joint EPA/California Air Resources Board investigation of the potential of membrane technology on volatile organic compound (VOC) emissions Tests of various membrane materials and configurations have been conducted. A potentially innovative application of membrane technology may be to concentrate VOCs from exhaust gases such as solvent oven-drying exhaust. A preconcentrator membrane could be used to reduce the size and, in turn, the capital and operating costs of a conventional VOC control device such as a carbon adsorber or incinerator. Study results do not, however, verify that a membrane preconcentrator is a viable option to reduce overall pollution control costs.

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 polymeric membrane has been used for a number of years as a concentrating step for various liquid and gaseous streams, including removal of large molecule organics from waste water streams, hydrogen separation, and CO_2 recovery. A polymer membrane is an ultrathin layer of a selective polymer, supported on a porous sublayer. The membrane (active layer) selectively filters the pollutant molecules. Figure 1 is a diagram of a bench scale membrane system. A potentially innovative application of membrane technology may be the concentrating of volatile organic compounds (VOCs) from exhaust gases such as solvent oven-drying exhaust. A preconcentrator membrane could be used to reduce the size and, in turn, the capital and operating costs of a conventional VOC control device such as a carbon adsorber or incinerator. The overall result would be capital and operating cost savings, possible performance improvements, and reduced energy requirements.

The U.S. EPA and the California Air Resources Board initiated a joint program to investigate the potential of membrane technology on VOC emissions. Tests of

various membrane materials and configurations have been conducted. Objectives of those studies were to evaluate the applicability of membrane systems as a preconcentrator and to define operating parameters of a membrane system. The advantage of such a system is a potential reduction in cost for subsequent control systems.

Program Approach

Tasks completed for the study include:

(a) A detailed literature review of available data on membrane recovery of hydrocarbon vapors and gases. Relevant data and articles on the subject of membrane technologies are discussed in the report.

(b) Bench scale membrane modules were tested using six common solvents to define capability of membrane to retain solvents and to develop system operating parameters.

(c) Preliminary conceptual designs were developed from laboratory studies.

(d) Preliminary capital and operating cost projections for membrane augmented control options were developed.

To support these tasks a bench-scale polymeric system was designed and constructed. The spiral-wound membrane was supplied by a commercial membrane manufacturer. The bench-scale test processed dilute gas streams containing 20 to 2000 ppmv solvent.

Results and Conclusions

The membrane was shown capable of removing about 60% of the incoming solvent, and generated a permeate stream about 3 times as concentrated as the original feed. It was equally effective on all six solvents tested. No noticeable degradation in performance of the module was apparent after the tests, although an extended performance evaluation was not conducted.

Based on the test data and available cost data for two simple configurations, membrane technology does not appear to be a good alternative to carbon adsorption or other classical control options for low concentration (e.g., 100 ppmv) solvent-laden air streams at this time. The capital and annualized costs of the membrane-augmented system were consistently higher than for the carbon adsorber alone. Cost reductions for the membrane-augmented carbon adsorber (due to the reduced volume flow) were not sufficient to cover the added expense of the membrane and associated equipment.

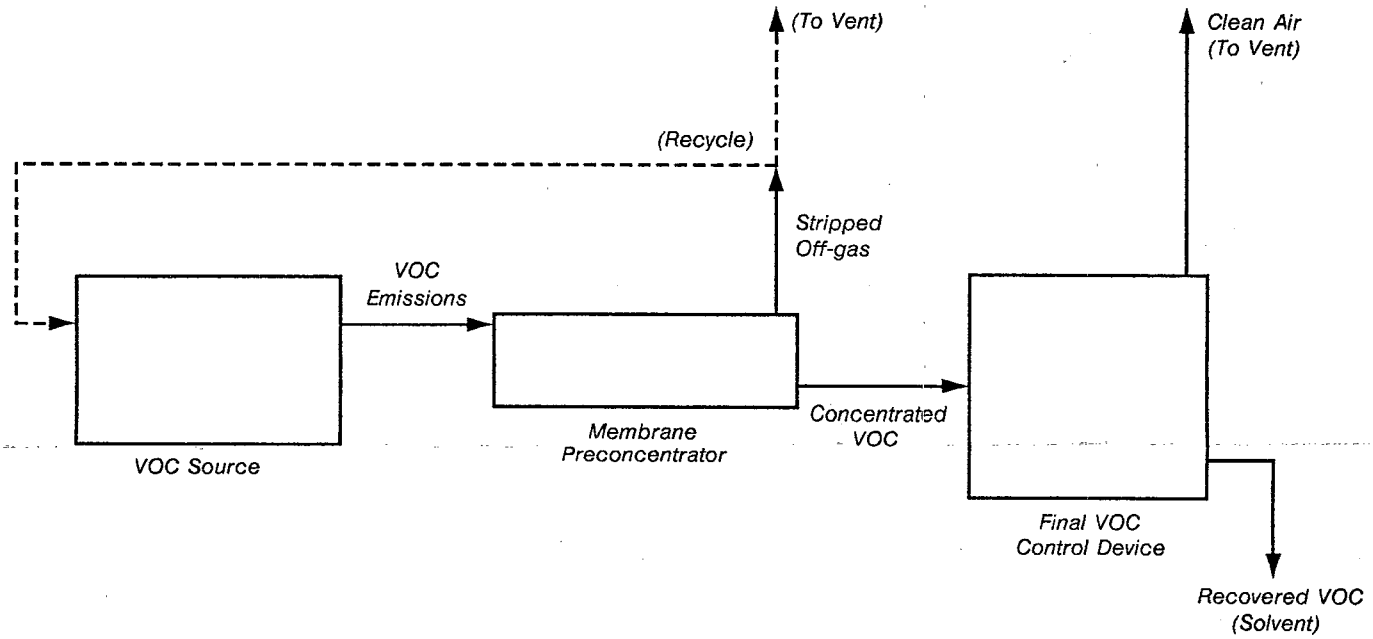

Figure 1. *Membrane preconcentrator system..*

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The complete report, entitled "Test and Evaluation of a Polymer Membrane Preconcentrator," (Order No. PB 90-188 905/AS; Cost: $23.00, subject to change) will be available only from:
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