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A Cross-Flow Pervaporation System for Removal of VOCs from Contaminated Wastewater

Wastewater Technology Centre

Technology Description: Pervaporation is a process for removing volatile organic compounds (VOC) from contaminated water. The performance of the cross–flow pervaporation system increases with temperature, with an equipment limitation of 35 degrees Celsius. Permeable membranes that preferentially adsorb VOCs are used to partition VOCs from the contaminated water. The VOCs diffuse from the membrane and water interface through the membrane and are drawn off by a vacuum pump. Upstream of the vacuum pump, a condenser traps and contains the permeating vapors, condensing all the vapor and allowing no fugitive emissions (see Figure 1). The condensed organic vapors represent only a fraction of the initial wastewater volume and may be sent for disposal at significant cost savings. Industrial waste streams may also be treated with this process, and solvents may be recovered for reuse.

A pilot pervaporation system has been developed that is skid-mounted, compact, and rated for Class I, Division I, Group D environments. The membrane modules used in this system consist of beds of hollow fibers (much like a carbon bed) with well-defined alignment that results in minimal pressure drop and operating costs per 1,000 gal of treated wastewater. The unit can reduce VOCs by 99%. Removal has been demonstrated to less than 5 parts per billion (ppb). For flow rates of less than 1 gal/min this unit can achieve 99.999% removal of VOCs. This high removal capacity plus containment of fugitive emissions are the primary advantages of this technology as compared with air stripping followed by gas-phase carbon adsorption.

Waste Applicability: Pervaporation can be applied to aqueous waste streams (groundwater, lagoons, leachate, and rinse water) contaminated with VOCs, such as solvents, degreasers, and gasoline. The technology is applicable to the types of wastes currently treated by carbon adsorption, air stripping, and reverse osmosis separation.

Test Results: A pilot plant with removal efficiency of 99% was built and evaluated with toluene and trichlorethylene. The pervaporation module used in this plant consisted of hollow fibers (540 µm OD) spaced 1 mm center to center in both lateral and

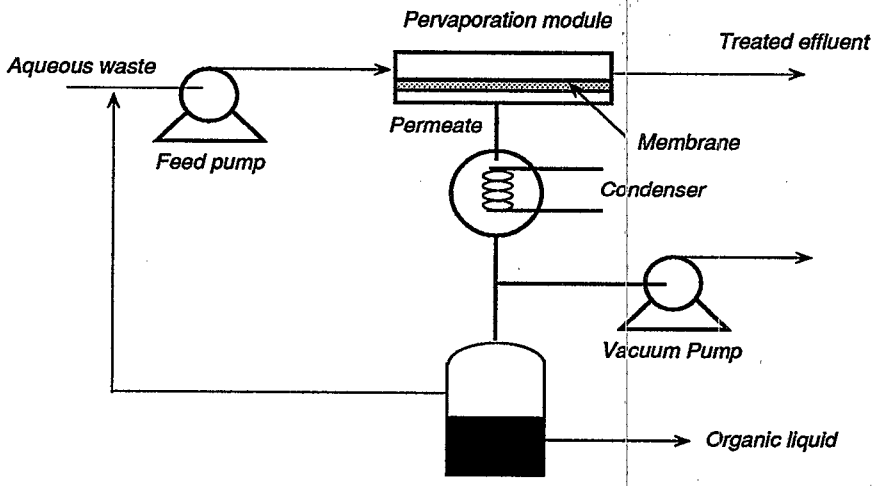

Figure 1. *Schematic of the Pervaporation process.*

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longitudinal directions. The hollow fibers themselves were constructed with a thick and selective outside layer of silicone rubber (125 μm). Throughout the testing program, there was no evidence of fouling or channelling of feed in the transverse modules. Removal rates were shown to increase beyond the rates reported in previous work.

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