**Hollow Fiber Membrane**

**Introduction**

A Hollow Fiber Membrane (HFM) is a device that can serve to transfer gases and hydrophobic vapors (e.g. volatile and semivolatile organic compounds) between two fluids, usually a gas (air) and a liquid (water). For more information on the HFM, visit [www.liqui-cel.com](http://www.liqui-cel.com), which has some really cool animations. It also has some detailed explanations of the membrane itself.

**Laboratory Setup**

The laboratory setup is shown in Figure 1. Become familiar with the various pieces of equipment, measuring instruments, valves and other components. Not all components are shown in this schematic diagram.

![Figure-1 Schematic representation of the experimental setup](image-url)
Laboratory Procedure

- Make sure that you have safety equipment (glasses, gloves, etc.) and are familiar with safety devices (eye wash, shower, etc.)
- Become familiar with all the components before starting.
- Determine the operating conditions for your experiments before you turn anything on. Make sure you decide on the frequency for taking samples, sample size and container, data needed, etc.
- Check that all valves are configured to deliver water from the contaminated tank to the treated water tank. The setup has additional valves so that we can pump backwards and reuse the water instead of contaminating more water every time. Check to make sure the valves are open in the correct direction.
- Turn on the water pump. Make sure that water flows from the tank with contaminated water through the HFM and into the tank with treated water.
- Three water flow rates will be used for the test: 1, 2 and 3 L/min. Your group will be assigned one water flowrate, but you will evaluate the effect of different gas flowrates (see below). (Be careful on the way you read flow rates from the measuring flowmeters).
- Samples to determine the initial toluene and MTBE concentrations can be collected from sampling port at the outlet of the membrane before turning on the vacuum pump. Without vacuum there is practically no removal. I recommend collecting 2-3 samples so that you can do some variation analysis later on. Collect samples into 100 ml beakers and immediately transfer into 40 ml amber or clear vials with clean caps and septa. Label all your sample vials before you start.
- The vials must be completely filled with liquid to prevent volatilization of organics into the headspace, which will affect your results. Do not forget to label the vials!
- When you are finished collecting the initial samples, turn on the vacuum pump. Use the following gas flowrates: 1.5, 2 and 2.5 scfm. You can vary the gas flowrates by turning the valve next to the vacuum pressure gauge on the vacuum pump.
- Run each condition for at least 3 minutes before taking samples, to allow the system to reach steady state (not equilibrium).
- Take 2-3 samples at each condition. Use the same procedure as before. You should keep track of the time since the beginning of operations, and note any discrepancies.
- Once you have completed your experiments at three gas flowrates, turn off the vacuum pump and then the water pump. Make sure the sampling valve is closed and clean any spills or drops.
- We will use GC/MS to analyze all of your samples, so transfer 1.5 ml of each of your samples to EPA 1.5 ml vials. Be sure to label each vial before you bring them to Peng.
Present your results in terms of removal efficiency as a function of air and liquid flowrates. Note the differences between MTBE and toluene; what is the key physicochemical property for this process?

The following information is provided for your reference:

1 SCFM = 1 standard cubic feet per minute = 0.472 L/s = 28.32 L/min
1 bar = 14.5 lbs/square inch (psi) = 1 bar = $10^5$ Pascal = $10^5$ N/m$^2$
1 gallon = 3.7854 L