**ESM 223: Slow Sand Filter Experiment**

**Introduction**

With the issuance of the Surface Water Treatment Rule by the U.S. Environmental Protection Agency and new filter requirements for all surface water systems to ensure removal of *Giardia* cysts, there is renewed interest in slow sand filtration technology. Slow sand filters can provide removal of suspended solids, turbidity, as well as microorganisms without the need for chemical addition or the use of electrical power. In general, a slow sand filter consists of two or more filter beds containing 1-1.5 m of sand placed over a gravel-supported underdrain. A slow sand filter relies on a large surface area to filter a relatively slow flow of water (per m² of filter area). Filtration rates of 1.5 to 6 L/min per m² of filter surface area are typical. Therefore, a relatively large surface area may be necessary to accommodate a realistic flowrate (for example, a 10-gpm flowrate requires between 60 and 250 square feet of filter surface area). It must be recognized that slow sand filters have their limitations in that they cannot remove high turbidity, high levels of microorganisms, nor all chemical contamination from water. A slow sand filter may contain a Granular Activated Carbon layer to remove organic contaminants.

**Laboratory Setup**

![Laboratory setup diagram](image)

Figure 1  Laboratory setup
Laboratory Procedure

1. Make sure that you have safety equipment (glasses, gloves, etc.) and are familiar with safety devices (eye wash, shower, etc.).
2. Become familiar with all the components before starting.
3. Determine the operating conditions for your experiments before you turn anything on. Make sure you decide on the frequency for taking measurements, data needed, etc.
4. Prepare 30 clear EPA 40 vials.
5. Turn on the valve at the bottom of the column and drain the water until the water level in the column is at Level 2 (just above the fine sand layer). Turn off the valve.
6. Add 500 ml of 1M KCl solution to the column using the delivery pump. Turn on the valve at the bottom and start the timer at the same time. When the water level reaches Level 2, add tap water to the column until the water level is at Level 1. Maintain the water level at about Level 1 at all times to keep a constant hydraulic head. The lower valve should remain open during the experiment.
7. After 1 min, use a 100 ml graduated cylinder to take a sample from the bottom of the column. After the first cylinder is filled up to 100 ml, replace with an empty one. The water sample in the filled cylinder will be measured for conductivity using the pH/ion/mV meter. After measuring the conductivity drain the graduated cylinder into a wastewater container, wash it with DI water and use it again. Samples should be taken consecutively for at least 10 min at 1 min intervals from the bottom of the column, until the conductivity reading is back to background.
8. After the KCl solution has passed, let the column drain for about 10 min. Close the inflow valve (tap water) and let the water level drop to Level 2. Turn off the lower valve to stop the water from draining.
9. Add 500 ml of the testing solution (mixture of toluene, diazinon and colloid solutions) using the delivery pump. Turn on the lower valve and start the timer at the same time. Once the water level drops down to Level 2, add tap water to the column until the water level is at Level 1. Maintain water at Level 1 at all times – you need to monitor it.
10. After 2 min, take a sample in a 40ml EPA vial from the bottom of the column. Take samples every 15 sec for 3 min. After that take samples every 30 sec until the vials are used up. For the purpose of comparison, every 4 samples, one additional sample should be taken at the same time as the one taken from the bottom of the column.
11. Transfer 1.5 ml of each sample to EPA 1.5 ml vial and bring them to Peng for analysis of toluene and diazinon. The remaining portion of each sample is analyzed for Percent Transmissivity (%T) at 900 nm using the spectrophotometer.
12. For the lab report, plot the tracer and colloid breakthrough curves (concentration vs. time). You will compare the three experiments to see if there is a shift in the breakthrough curve over time, as the column gets clogged with the colloids removed. Comment on changes in removal efficiency between runs.