Introduction

The objective of this experiment is to remove organic vapors from a contaminated soil using soil vapor extraction (SVE). SVE is a process that is used to remove volatile organic compounds (VOCs) from the vadose zone by applying a vacuum on the soil, which promotes the transfer of the contaminants from the soil to the air phase and removes the vapors through an extraction well. SVE systems include a vacuum pump to pull vapors through the extraction well(s), an air/water separator to remove the condensed moisture and a vapor treatment unit.

Laboratory Setup

For this experiment, a large compressor used for all labs generates the vacuum. A soil column has been setup and we installed a vacuum pressure gauge, a flow meter and a flow control valve to operate the system. The contaminated vapors coming from the column are passed through a granular activated carbon (GAC) vapor treatment unit. The mass of toluene removed from the soil is measured by the increase in mass of the GAC container. The scheme of the laboratory setup is presented in Figure 1.

![Figure 1 Scheme of laboratory 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 measurements, data needed, etc.
- Before adding NAPL, open the valves in the soil column and through the GAC container, then open the vacuum valve so that you have about 1.6 scfm flowing. Note the effect at the surface. Turn off the vacuum and close the valves after about 15-30 sec.
- Turn on the balance and zero it without the GAC container.
- Put on top of the balance the GAC container without connections and record the initial mass, to do a mass balance at the end.
- Reconnect the GAC container.
- Next, we need to contaminate the soil column. For that:
  - Turn off the vacuum pressure and carefully open the valve of proper injection port.
  - Using a 25 ml syringe, inject 25 ml of toluene into the column by penetrating the syringe needle into the sand through the injection port.
  - Immediately after the injection, remove the needle and close the injection port.
  - Let the contaminant migrate through the soil.
- Turn on the valve for the vacuum to obtain the desired airflow rate. Check with the instructor for the flowrate for your experiment. Each group will operate at a different flowrate. Record the flowrate and monitor flowrate over time. Note the variability (i.e. the range of values). Typical values are 1.2, 1.4, 1.6 and 1.8 scfm. Also record the vacuum pressure.
  - Every 10 min, turn off the vacuum, open the valve that connects the hose to the GAC trap and weigh the GAC trap.
  - Start again the vacuum extraction. Keep track of the time that the vacuum was turned off, to discount it in your report.

After 60 minutes, the experiment can be stopped, and the vacuum can be turned off.
- Close the vacuum first.
- Close the top and bottom valves on the soil column.
- Close the valves on the GAC container. Disconnect it and weigh it. Record the final change in total mass.
- Present your results in terms of mass captured in the GAC as a function of time and air flow rate.