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Environmental Health and Safety
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Vacuum Pump Factsheet

Vacuum pumps are used in various experimental settings at Iowa State University (ISU) to remove air and other vapors from a vessel or a system. If vacuum pumps are not properly installed, trapped, and exhausted, they may expose you to hazardous chemicals and vapors. A few guidelines will help in the safe use of these devices.

Operation Checklist

☐Yes ☐ No ☐ NA	Wear **safety glasses**, **lab coat**, **long pants**, **close-toed shoes**, and **gloves** when performing all vacuum operations.
☐Yes ☐ No ☐ NA	Pump has belt guards in place during operation.
☐Yes ☐ No ☐ NA	Electrical cords and plugs are free from defects.
☐Yes ☐ No ☐ NA	Pump is directly plugged into an outlet. Do not connect to an extension cord or power strip.
☐Yes ☐ No ☐ NA	When used with potentially hazardous materials, pump is used inside a ventilated cabinet (e.g., pump cabinet or fumehood).
☐Yes ☐ No ☐ NA	Pump is NOT in an enclosed, unventilated cabinet.
☐Yes ☐ No ☐ NA	Pump is NOT near containers of flammable or combustible materials.
☐Yes ☐ No ☐ NA	Solvents that might damage the pump are NOT used in the system without an appropriate trap.
☐Yes ☐ No ☐ NA	Pump is placed in a leak-proof tray, to contain any leaking or spilled oil.
☐Yes ☐ No ☐ NA	Check oil levels frequently to ensure it is not low or overfilled and change oil when necessary. Change the oil when it begins to darken or turn opaque.
☐Yes ☐ No ☐ NA	Have records of all pump maintenance.
☐Yes ☐ No ☐ NA	Pump oil is appropriate for the pump and compatible with vapors that will pass through.
☐Yes ☐ No ☐ NA	Use correct vacuum tubing (thick walls) and replace old tubing. Use the shortest length needed.
☐Yes ☐ No ☐ NA	Exhaust tubing is properly connected and no kinking.
☐Yes ☐ No ☐ NA	Pump inlet and outlet are connected properly. Reversing the flow direction can pressurize the apparatus leading to rupture, failure of the vessel, or oil contamination.
☐Yes ☐ No ☐ NA	Inspect vacuum glassware before and after each use for cracks or defects that lead to implosion. Consider shielding any glassware under the vacuum.
☐Yes ☐ No ☐ NA	If the vacuum pump cabinet has a cooling fan on the rear wall, ensure that the grate on the fan is free of dust and debris. This fan helps remove excess heat from the pump cabinet.
☐Yes ☐ No ☐ NA	A trap is in place on vacuum lines to prevent liquids from being drawn into the pump, house vacuum line, or water drain.

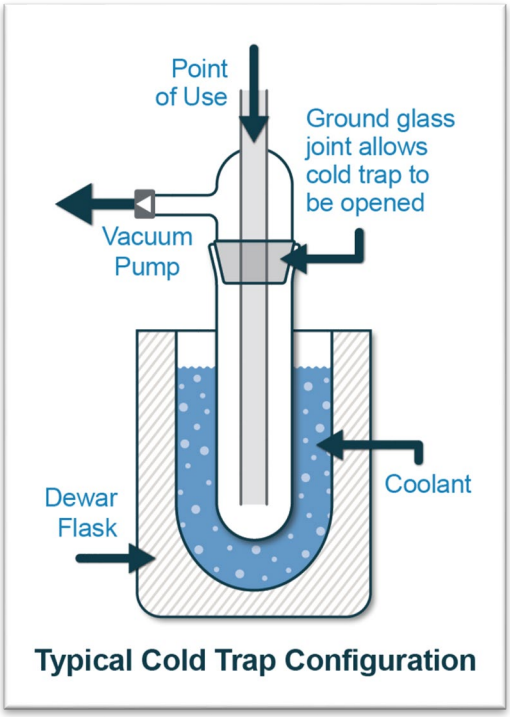
Vacuum pump operation: best practices

- Pump oil may be contaminated and must be disposed of as chemical waste. Submit a Waste Removal Form via the ISU Environmental Health and Safety (EH&S) website for proper disposal of chemical waste.
- Be aware of the risks and properties of the chemicals you are working with by referring to the chemicals' Safety Data Sheets (SDS). Refer to the ISU EH&S Safety Data Sheets web page.

Traps

It is vital to use a trap between the experimental setup and the vacuum. Traps protect the pump and the tubing from the potentially damaging effects of the chemicals, protect users who must work on the vacuum lines or systems, and prevent vapors and related odors from being released back into the laboratory. In some situations, it may be prudent to use a second cold trap between the pump and the experiment for additional protection.

If a vacuum pump is required, the system must include a cold trap. A cold trap condenses solvents and other volatile liquids to avoid exposure to these materials and damage to the vacuum pump. Always use a cold trap between rotary evaporators and the pump.

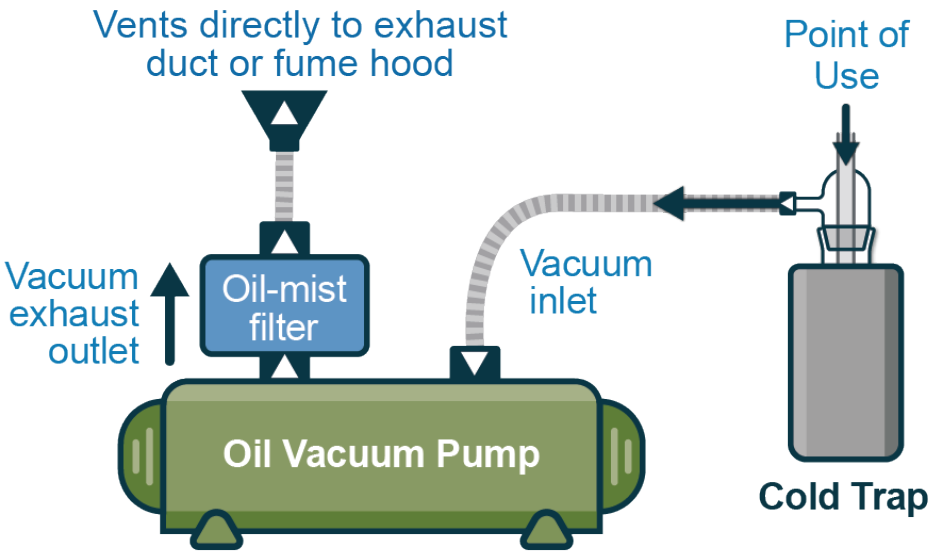


Typical Cold Trap Configuration

When using a cold trap:

- Place the cold trap between the system and the vacuum pump.
- Ensure that the cold trap is of sufficient size and cold enough to condense vapors present in the system.
- Check frequently for blockages in the cold trap. Attempting to use a cold trap with evacuation of highly concentrated solvent vapors can lead to blockage in the trap and loss of vacuum. Use other vapor trapping means (e.g., condensers) or appropriately sized cold traps to avoid this.
- Use isopropanol/dry ice or ethanol/dry ice instead of acetone/dry ice to create a cold trap. Isopropanol and ethanol are less expensive, less toxic, and less prone to foam.
- Use cryogenic gloves when handling cryogens or dry ice**.**
- **Do not** use dry ice or liquefied gas refrigerant bath as a closed system. These can create uncontrolled and dangerously high pressures.
- Liquid nitrogen (LN_2) should only be used with sealed or evacuated equipment **with extreme caution**. If the system is opened while the cooling bath is still in contact with the trap, oxygen may condense from the atmosphere and react vigorously with any organic material present.
- **Condensed oxygen has a distinct, pale blue color. If you remove the LN_2 bath and notice blue liquid in your trap, replace the LN_2 bath immediately. Turn off the vacuum, open the system to ambient air, and lower the bath until the trap is no longer touching the LN_2. Close the fume hood sash and evacuate the lab. Allow the condensed oxygen to slowly warm. Inform your research group and PI (everyone should leave the lab). Once all liquids in the trap have evaporated, check for peroxide formation (also explosive) by rinsing the trap with water and testing the water with a peroxide test strip. Submit a waste pickup request for the rinse.**

- **Do not** use liquid nitrogen as a trap coolant when pumping organic compounds, due to increased risk of expansion if O2 is condensed in the trap.
- Always close the valve between the vacuum vessel and pump before turning off the pump to avoid introducing oil into the system.
- Before disconnecting traps or other equipment, be sure to slowly bleed vacuum lines.
- Empty the trap after each use. If a trap becomes clogged, immediately shut off the vacuum, disconnect the trap, and ensure it is open to the atmosphere to prevent an explosion. Allow the trap to thaw in a fume hood to empty.
- Pumps for rotary evaporators using highly toxic chemicals (e.g., Chloroform) must be placed in a fume hood, vented to dedicated lab exhaust, or be equipped with adequate condensers and traps to prevent the emission of toxic vapors into the laboratory.
- For pumps used to evacuate highly reactive, corrosive, or toxic gases, use a sorbent canister or scrubbing device capable of trapping the gas when possible. This may be required in some cases, depending on the quantity and nature of gas released.
- Using an oil mist filter (purchased from the pump vendor) can prevent oil loss from the pump and exposure of lab occupants to aerosolized oil and contaminants.
- Use a liquid trap with an appropriate disinfectant when a vacuum is used with hazardous biological materials (Refer to Sharps and Biohazardous waste disposal flowchart for more info on how to dispose the liquid biohazardous waste).



Example of an oil-based vacuum pump used with potentially hazardous materials.

Additional Resources:

1. University of California, Berkley, Vacuum System Hazards and Precautions. https://ehs.berkeley.edu/sites/default/files/publications/vacuum-systems-fact-sheet.pdf

2. University of Pennsylvania, Fact Sheet: Vacuum Pump Use and Installation. https://ehrs.upenn.edu/health-safety/lab-safety/chemical-hygiene-plan/fact-sheets/fact-sheet-vacuum-pump-use-and

3. Universality of Massachusetts Amherst, Vacuum Pumps SOP https://ehs.umass.edu/vacuum-pumps

4. Washington State University, Laboratory Vacuum Pumps: Care and Use https://ehs.wsu.edu/ehs-training/factsheets/factsheets-faqlabvacuumpumps/