

VACUUM PUMP SAFETY

Vacuum pumps are used to remove air and other vapors from a vessel or manifold. The most common usages in laboratories are on rotary evaporators, drying manifolds, centrifugal concentrators, acrylamide gel dryers, freeze dryers, vacuum ovens, tissue culture filter flasks and aspirators, desiccators, filtration apparatus, and filter/degassing apparatus. Weak points in containers or systems under vacuum can create implosion or explosion hazards, and cause injury by violently spraying glass and hazardous materials. Choosing the appropriate vacuum pump for your work and putting the necessary hazard controls in place is important to maintain health and safety.

TYPES OF VACUUM PUMPS

Rotary vane (RV)

- Can reach deep ultimate vacuum levels and have high displacement capacity, making them a good choice for freeze drying applications.
- Use oil to ensure a tight seal, lubricate the working parts and remove heat to cool the rotors.
- Works especially well for aqueous samples and solvents with high boiling points whose vapors can be easily trapped before they reach the pump.
- Any rotary evaporator systems using RV vacuum pumps should be reviewed to determine whether the vacuum pressure is appropriate to the application and is well controlled.



Diaphragm

- Dry pump that operates using a pulsing motion that opens and closes valves to move air. No oil is required.
- Usually resistant to corrosives and less susceptible to damage from vapors.
- Can handle highly viscous liquids and be used with a wide range of samples, but applications are limited based on vacuum levels.
- A good choice for both evaporation and concentration, but can't be used for freeze drying.

Hybrid

- Combines both an RV and diaphragm pump together in the same vacuum pump. It keeps the oil under negative pressure to reduce or eliminate vapors going through it and condensing in the oil.
- Recommended for freeze drying corrosive or volatile samples as they can be used with acidic samples and those containing harsh chemicals such as TFA, acetonitrile, HBe and Nitric acid.

Scroll

- Dry pumps that use two spiral scrolls to compress air and vapors, and move them toward the exhaust. No oil is required.
- Only samples with acids below 20% are recommended.
- Can reach deeper ultimate vacuum levels and have higher displacement capacities than diaphragm pumps.
- Recommended for freeze drying as they can be used with aqueous and solvent samples including acetonitrile. May be used with concentration applications.

It is important to select the right pressure and temperature when condensing solvent vapor in rotary evaporation. For a sufficient condensation of the vapor, follow the [Delta 20 Rule](#) for evaporation.

PUMP TRAPS AND WASTE

The trap type used depends on the specific chemicals that need to be trapped by the apparatus.

When using volatiles, a cold trap must be placed between the pump and the experiment to minimize the amount of chemicals from reaching the pump oil. Pump oil will break down

if exposed to high concentrations of solvents from the vacuum line. This can result in pump damage. Pump oil must be compatible (i.e., do not use hydrocarbon pump oil with oxidizing gases or vapors) with the vapors that will pass through the pump.

Ensure that the cold trap is of sufficient size and cold enough to condense vapors present in the system. Locate the cold trap between the system and vacuum pump. Using a second cold trap between the pump and the experiment for added protection is recommended.

Use only heavy-walled round-bottomed glassware or glassware specifically designed for vacuum systems. All glass containers must be strong enough to handle the pressure differential without failure.

Empty the condenser trap immediately after evaporation is complete to eliminate the possibility that solvent will evaporate as the condenser warms to room temperature.

Extreme care must be exercised to prevent the introduction of room air into a trap containing liquid nitrogen. Liquid nitrogen condenses oxygen and this may cause an explosion.

Place a pan under pumps to catch any oil drips. Replace and properly dispose of vacuum pump oil that is contaminated with condensate. Used pump oil must be disposed as [hazardous waste](#) and collected by EH&S.

APPROPRIATE LOCATIONS

When choosing a location, consider that vacuum pumps should always be plugged directly into a power receptacle. Do not place pumps in an enclosed, unventilated cabinet, and do not operate them near containers of flammable chemicals or materials.

Stand-alone vacuum pumps should exhaust to a fume hood or other building exhaust; they should not exhaust into the room. This is essential when the pump is being used to evacuate a system containing volatile, toxic or corrosive chemicals.

Pumps for rotary evaporators must be located in a fume hood, vent to a dedicated lab exhaust, or be equipped with adequate condensers and traps to prevent emission of solvent vapors into the lab.

OPERATIONS CHECKLIST

- Mechanical pumps have belt guards in place.
- Service cords and switches are free from defects.
- Pump is plugged directly into an outlet. Do not connect to an extension cord or power strip.
- Cold trap has been checked for blockages.
- Vacuum glassware is inspected before and after each use. Discard any glass that is chipped, scratched, broken or otherwise stressed.
- Pump is on a tray so that spilled oil is contained.
- Scrubbing or absorbing the gases exiting the pump is recommended.
- Vacuum pump cabinet is located in a ventilated cabinet.
- Any glassware under vacuum is shielded.
- Combustibles are kept away from pumps. Diffusion pumps contain oil at very high temperatures.
- Pump inlet and outlet are properly connected. Pump connections can look the same, and errors can pressurize the apparatus leading to rupture, failure of vessel or oil contamination.

PUMP MAINTENANCE

Vacuum pumps must be serviced by an authorized vendor on the schedule recommended by the pump manufacturer. Keep detailed records of all pump maintenance including routine maintenance and vendor-provided services. Routine maintenance such as pump-oil changes may be performed by lab workers. Follow all manufacturer recommendations for oil changes and routine maintenance.

Never service a pump that is connected to power. Allow the pump to cool completely before venting or servicing, and disconnect it from power completely. Pumps may start automatically if connected to a power source. If the pump cannot be unplugged directly, contact EH&S for information about lock-out/tag-out before attempting to service the equipment.

Contact labcheck@uw.edu / 206.685.3993 for more information.