

# Standard Operating Procedure: Pumps

Last Updated: 11/16/2016 by C.Tichnell

## General Operation Description

There are four types of pumps around the lab—*water aspirator*, *diaphragm*, *direct-drive*, and *belt-drive*. For all pumps, you should always check glassware and other relevant equipment for breaks and other defects, be familiar with vacuum operation and safety hazards, and you should be mindful of what type(s) of sample you are subjecting to vacuum (is it volatile, is it sublimable, is it caustic or corrosive, etc.).

### ***Water Aspirators and Diaphragm Pumps***

Water aspirators are located in the back of the hood and sometimes in-between work benches, and these are typically used for filtration. General use begins by hooking up glassware to tubing that is connected to the aspirator (ALWAYS SLIP TUBING ONTO LUBRICATED GLASS PIECES; NEVER FORCE TUBING ONTO GLASS PIECES). Flasks should either be clamped or weighed down to prevent the setup from toppling over. It is recommended that a trap be added between the aspirator and your equipment of interest to prevent any backfilling from the aspirator or overflowing of your sample into the main water system. When everything has been hooked up, turn on the water (creating suction). Allow system to run until you are satisfied (all while keeping an eye on the setup to ensure liquid isn't creeping into the water system or back into your sample). Disconnect tubing from your sample, then turn off the water to the aspirator. If you used a trap, check for collected chemicals and dispose of it accordingly. If you have issues with achieving adequate vacuum or suction, check the aspirator connections and tubing for blockage.

Diaphragm pumps are located in the rotovap hood and next to the big glove box—these are typically used for filtration and removal of solvents with low to moderate-boiling points. When using this pump you want to expose vacuum to your sample slowly to avoid any bumping or vigorous activity. When done using the pump, let the pump run open to atmosphere for at least 30 seconds to purge the internal components. After the purge, simply turn off the pump. NEVER DISSASSEMBLE THE DIAPHRAGM PUMP UNLESS YOU HAVE TALKED TO THE POINT PERSON ASSOCIATED WITH THAT PIECE OF EQUIPMENT.

### ***Direct Drive Pumps***

Direct drive pumps are located underneath the glove boxes and used for evacuating the glove box ports. Since these are used for vital glove box operation they are powered and in use almost always, and operation of ports and evacuation procedures are covered in the glove box SOP document. As a general rule of thumb when employing this pump (i.e. evacuating the ports), vacuum should be supplied slowly to minimize excessive displacement and ejection of oil.

When replacing the oil for this type of pump, one should do the following procedure:

1. Unplug the pump
2. Place a catch reservoir at the oil drain outlet and opening the oil pour inlet (top of pump; to allow for better flow)
3. Open the drain valve to allow old oil to flow out. This step and the previous one should be done while pump (and oil) is warm. To ensure most of the oil has been removed tilt the back end of the pump upward till all oil has drained out or conduct the draining process with

the back end propped upward. Take note of the color and texture of the oil. Ideally the oil should be light yellow in hue and viscous. If it is highly colored and watery (or biphasic) this indicates contamination due to oil degradation. If solid particulate is present this could indicate pump degradation in which case pump repair should be considered and close attention should be given to pump maintenance and usage for future use.

4. When all oil is drained, the pump should be placed in a level position, the drain valve should be closed, and flushing oil should be added through oil pour inlet until the max oil level is achieved
5. Oil pour cap should then be placed back on, gas ballast should be in open position, exhaust should be capped, and pump should be powered on. Run times with flushing oil should be between 20-30 minutes.
6. The drain process detailed above should be repeated after the flush oil process.
7. Flush oil filling and draining should be repeated until old flush oil comes out of the pump as light, viscous oil free of sediment.
8. When flushing is complete, close the gas ballast, drain the flush oil as per the process above, refill the pump with regular vacuum oil as per the refill process, hook the vacuum inlet to the appropriate tubes, ensure that the exhaust is properly hooked up either to an exhaust line or oil mister, and power the pump on for use.

For this type of pump used in the way that it is, if adequate vacuum is not achieved, first make sure that the oil level is sufficient, second check all connections, and third check the condition of the oil. If those measures do not fix the problem, then something more serious could be going on.

### ***Belt Drive Pumps***

Belt drive pumps are located underneath the hoods and are primarily used for Schlenk Line work (Schlenk Line usage detailed in Schlenk Line SOP document). A belt drive pump is also located underneath the Rotovap station and details of its use can be found in the Rotovap SOP, but general maintenance information can be found in this SOP document. Maintenance for belt drive pumps is akin to that of the direct drive pumps. As a general rule of thumb when employing this pump, vacuum should be supplied slowly to minimize excessive displacement and ejection of oil along with prevention of sample bumping (bumping: when sample gets into lines or on glassware due to a vigorous bursting caused by fast evaporation of sample itself or trapped gasses).

Use the following procedure for replacing the oil for this type of pump:

1. Remove old oil by unplugging the pump, placing a catch reservoir at the oil drain outlet, disconnecting vacuum inlet and exhausts, and opening the drain valve to allow old oil to flow out. This sequence should be done while pump (and oil) is warm. To ensure most of the oil has been removed tilt the back end of the pump upward till all oil has drained out or conduct the draining process with the back end propped upward.
2. Take note of the color and texture of the oil. Ideally the oil should be light yellow in hue and viscous. If it is highly colored and watery (or biphasic) this indicates contamination due to oil degradation. If solid particulate is present this could indicate pump degradation in which case pump repair should be considered and close attention should be given to pump maintenance and usage for future use.
3. When all oil is drained, the pump should be placed in a level position, the drain valve should be closed, flushing oil should be added through the exhaust port until the max oil level is achieved, vacuum inlet should be capped with a stopper and exhaust should be covered with a kimwipe

and rubber band, gas ballast (if present on pump) should be in open position, and pump should be powered on. Run times with flushing oil should be between 20-30 minutes.

4. The drain process detailed above should be repeated after the flush oil process.
5. Flush oil filling and draining should be repeated until old flush oil comes out of the pump as light, viscous oil free of sediment (typically 2-3 times).
6. When regular flushing is complete, close the gas ballast, and drain the flush oil as per the process detailed above.
7. Leave the oil drain open and run about 1 cup of flush oil through the pump with the pump powered on.
8. Repeat this process once more with flushing oil and twice with regular vacuum oil.
9. Afterwards, close the oil drain valve, and refill the pump with regular vacuum oil as per the refill process, hook the vacuum inlet to the appropriate tubes, ensure that the exhaust is properly hooked up either to an exhaust line or oil mister, and power the pump on for use.

For this type of pump used in the way that it is, if adequate vacuum is not achieved, first make sure that the oil level is sufficient, second check the condition of the oil, and third check all connections. For connection checks, quick inspection can be done to assign obvious problems such as ungreased connections or open valves. When quick inspections does not fix the problem, systematic checks of vacuum pressures going from directly on the pump to the full system ensemble in a piecewise fashion can help assign vacuum leak sources. Additionally, soapy water on connections can be helpful for assigning sources of vacuum leaks.

### **Personal Protective Equipment**

Safety glasses, gloves, and lab jackets should be used during all pump operations.

### **Hazards:**

-Oil on floor can pose a slip hazard; keep area clean while doing oil changes by having drip trays, secondary containers, and drip pads.

-Oil can be ejected onto you if drain and refill processes are not properly done. In some cases oil can be hot and/or contaminated.

-Pumps provide vacuum so care should be taken to keep dangling objects clear of the vacuum inlet and/or moving parts. This includes long hair, shirt and pant sleeves, jewelry, etc.

-Pumps provide vacuum so parts subjected to this vacuum can be prone to implosion. Systems under vacuum should be operated in hoods with sashes opened when necessary.

### **Waste Disposal:**

Used pump oil can be contained in a 4L bottle and stored in the designated used oil area.

Contaminated used pump oil should be submitted as waste.

**Material Safety Data Sheets:**

Call the ORCBS (355-0153) or see lab copy for sample in question if available