# Water aspirator/vacuum pump

Posted by Anonymous on Sun, 2015-09-27 10:14

Water aspirator/vacuum pump: Hi ASSIST team. Can you please give advice for using the water aspirator/vacuum pump connection that is available in some schools. Also, the possible downside if not used correctly.

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10
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Laboratory Technicians

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# SOP for water aspirator/vacuum pump

Submitted by on 08 October 2015

Answer reviewed 11 February 2023.

It is important to consider safety when using any vacuum system, and also to consider the most appropriate vacuum pump for your needs.

All personnel operating vacuum pumps should have training and instruction on the safe use of the equipment and wear appropriate personal protective equipment (PPE), in particular, safety glasses or face shields. Science ASSIST recommends a risk assessment be conducted prior to the use of any vacuum system, and all appropriate control measures be identified and implemented. Science ASSIST has developed a one-page risk assessment template, see Risk Assessment Template.

## General safety considerations when using a vacuum system

- A system under vacuum is commonly conducted using glass containers and therefore runs the risk of an implosion. It is important to check that any glassware being attached is thick-walled, borosilicate and designed to withstand any pressure when using vacuum procedures, and does not show any signs of defects, flaws or other damage that may cause it to implode and generate flying glass fragments and chemical splatter. Glassware should also be checked after use for any damage.
- Any glass vessel that will be evacuated should be shielded either by:

1. surrounding the vessel with some cardboard, plastic or Perspex safety shields;
2. sticking adhesive film, tape or netting to the outside of the glass vessel; or
3. use of PVC coated glassware.

- If Bell jars are being used, check that they are intended for evacuation, suitable bell jars are thick-walled and often have a tap to which a vacuum line can be attached. Thin-walled bell jars are not suitable for sustaining a vacuum.
- Always use thick-walled vacuum grade tubing so that it doesn't collapse under vacuum. Use vacuum clamps to securely connect the vacuum apparatus to equipment/glassware. Tubing should be in good condition, free from cracks and other signs of degradation.
- Unless a non-return valve is provided, and particularly if a volatile, non-aqueous solvent is being used, a trap should be placed between the vacuum source and the experimental apparatus. A trap prevents the suck back of water into the evacuated flask, and can also prevent volatile substances from contaminating the pump or being flushed down the sink.
- At the completion of the filtration, the vacuum must first be stopped by either opening a bleed valve, if available, or disconnecting the tubing from the flask **before** turning off the vacuum apparatus. This avoids backflow into the filtration system.

The Australian Standards AS NZS 2243.6 2010 Safety in laboratories – plant and equipment aspects[1]

3.9.2 Use of vacuum apparatus states:

> *'Safety requirements in the use of vacuum apparatus as follows:*
>
> *(a) Where possible, vacuum apparatus shall be partitioned from the operator by a safety screen. Where a safety screen is impractical, full-face protection shall be worn by the operator.*
>
> *(b) Wide-bore glass tubing, bulbs and items of up to 1L capacity shall be strapped with cloth adhesive tape, or with cellulose tape covered with cloth mesh and varnished, or be sprayed with PVC. Larger items shall be encased in a wire screen.*
>
> *(c) The apparatus shall be examined for cracks and scratches, both before and after filling.'*
>
> *(d) Metal or plastic (PVC) tubing shall be used instead of glass tubing wherever practical, and flexible couplings shall be included in the apparatus when using*

*ground glass unions. Ball-and-socket joints are preferable to cone-and-socket joints.*

*(e) Rubber bungs shall be large enough to resist being sucked into a vacuum vessel.*

### Choice of vacuum pump

The choice of vacuum system depends on the type of activity being conducted and the level and speed of vacuum required.

The use of a vacuum system is generally required in chemistry and biology for fast filtration using Büchner funnels, sintered glass filters and side-arm flasks. They are also used in physics for demonstrating if sound waves travel in a vacuum using the ‘Bell in the Jar’ method.

The most common types of vacuum systems used in school science laboratories include water-operated vacuum pumps or aspirators and electric or hand-operated vacuum pumps sometimes associated with a bell jar. **Hazards are created from incorrect setup and weaknesses in the system.**

### Water operated vacuum pump (water aspirator)

These are the most common vacuum apparatuses found in school science laboratories. They are convenient to use, inexpensive to purchase, operate by water pressure and are used where a moderate vacuum is required (e.g., in chemistry to filter material via vacuum using side-arm flasks, porcelain Büchner funnels and sintered glass filters). They attach to the lab sink tap and the rapid flow of water through them creates a vacuum in a side-arm that is connected to a side-arm flask. Water operated vacuum pumps can be made from metal or polypropylene. If using an in-line unit, as distinct from a screw on unit, it is important that it is positioned in the correct direction for the water flow. Look for a marking such as a ‘v’ that indicates the direction of the water flow. This marking may be different depending on the brand used, so it is recommended to check with the manufacturer’s instructions.

Vacuum levels vary according to the water temperature and pressure provided, hence their capabilities are limited. They are not recommended for use with hazardous and volatile chemicals that may contaminate the wastewater and flow down the drain, but are suitable when the solvent is water, which is generally the case in school science laboratories.

Some disadvantages of use.

- They need to run with the water at full blast to obtain a reasonable vacuum.
- They use/waste a lot of water. Water conservation strategies in the future may involve consideration of changing to more water efficient models or to hand-held vacuum pumps that do not require water for use as discussed below.
- The vacuum pressure may fluctuate if other taps are in use.
- They have the potential to flood an area if not set up properly, therefore clamps may need to be used to secure the hose to the fitting
- If a solvent other than water is used, there is a risk of releasing hazardous chemicals down the sink and into the sewer system.

A trap can be used to prevent any fluid being sucked back into the line. Both the Büchner funnel and the trap should be clamped securely to retort stands with a four pronged clamp at the neck. A ring clamp can also be used to hold the body of the flask in place. Some water-operated vacuum pumps contain a non-return valve which eliminates the need for a trap. It is important to release the vacuum before turning off the water flow to equalise the pressure of the filter apparatus.

In a school situation a trap is generally not warranted as:

- filtration is conducted using water as a solvent; and
- hazardous and volatile chemicals are not used for filtration activities.

See the links below for demonstrations of best practice in how to set up a water-operated vacuum pump when hazardous and volatile chemicals are used and a non-return valve is not present in the vacuum pump.

https://www.flinnsci.com/how-to-set-up-a-vacuum-filtration/vht0020/ (Accessed 11 Feb 2023)

### Electric or mechanical vacuum pump

These are a costly item for school science labs and are generally used for demonstrations for example the 'Bell in the Jar' experiment. There are many types of electric vacuum pumps offering many different features and many different brands and manufacturers. It is therefore necessary to refer to the manufacturer's operating manual in order to correctly set up and use your vacuum pump.

The older traditional electric pumps used oil. They required a lot of maintenance to provide optimum performance, were very heavy and poorly guarded, if used incorrectly they provided chemical hazards and required the use of a trap. There are still laboratories that use this type of electric vacuum pump.

Today there are alternative electric pumps available on the market that are oil-free, require low maintenance and are light weight. They are suitable for all applications and can be purchased with chemical resistant components or built-in valves eliminating the need for a trap.

### Hand-held vacuum pump

A big advantage with this is there is no requirement for a water source. It is a much cheaper option than an electric vacuum pump, but is more expensive than the water aspirator. It is light weight and portable (able to be used in the field) with some models providing a gauge that displays the pressure. Some also have a release valve that allows you to release the vacuum without disconnecting from the line.

A disadvantage with this method is the time and effort required to create a vacuum. Due to being hand operated, they may not be suitable for evacuating large vessels or for adequately performing a filtration with ease.

### References

1 Standards Australia. (2010). *AS/NZS 2243:6 2022, Safety in Laboratories, Part 6: Plant and equipment aspects.* Sydney, Australia. This excerpt has been reproduced by ASTA with the permission of Standards Australia Limited under licence CLF1222asta. Copyright in *AS/NZS 2243:6 2022, Safety in Laboratories, Part 6: Plant and equipment aspects* vests in Standards Australia [and Standards New Zealand]. Users must not copy or reuse this work without the permission of Standards Australia or the copyright owner.

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