

Understanding Vacuum Filtration

Vacuum filtration is a process used to separate a solid out of a solution, which uses suction to draw out the liquid, then captures the solid in a filter. This process is important for all students to be familiar with, because all chemistry labs use this procedure. In this document we will discuss:

- Other types of filtration systems
- Vacuum vs. gravity filtration
- Safety gear
- Equipment needed
- The set up of vacuum filtration

Troubleshooting

Slow filtration

Make sure both ends of the tubing are connected appropriately so everything is air-tight. Also check the rubber adaptor to ensure it is tightly in the filter flask.

Cloudy filtrate

This means some of the solid got under the filter and into the solution. Make sure the filter paper is damp with the solvent before pouring the solution into the funnel.

Particles stuck in the beaker

If particles remain in the beaker after the last solution is poured into the funnel, simply flush them out using excess solvent. After the particles are free floating and not stuck, then pour it into the funnel.

Other Types of Filtration

Gravity filtration:

A different type of filtration commonly used in chemistry labs. Here a vacuum is not needed because it operates using gravity only to separate out the solid from the liquid. Gravity filtration's set up is simpler because it contains no vacuum. However, this type usually takes a significantly longer time to complete.

Hot filtration:

A specific type of gravity filtration that uses heat to ensure the crystals do not form on the walls of the funnel. The only difference consists of placing the flask on a hot plate. This is not a common procedure in basic chemistry.

Vacuum vs. Gravity Filtrations

Time

If time is a constraint, then vacuum filtration is preferred. This is because it takes a considerably shorter length of time to filtrate with the vacuum.

Particle Size

Vacuum filtration can be used for all types except when dealing with pore-sized particles. This causes a problem because the suction allows for some of the minute particles to contaminate the filtrate.

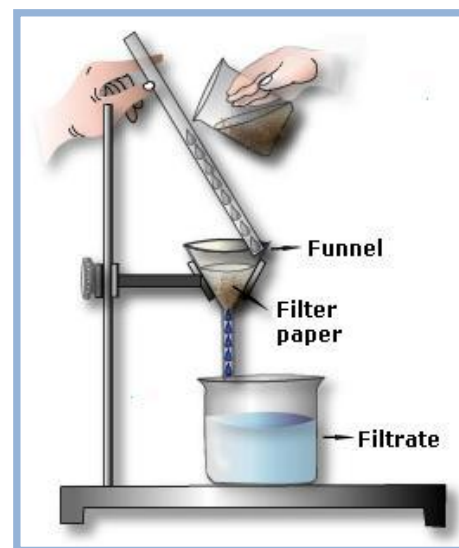


Figure 1: Gravity Filtration Apparatus
<http://image.tutorvista.com/content/chemistry-concepts/filtration-process.jpeg>

Funnel

Conical device having a small opening at the point, used to channel the flow of a liquid

Filter Paper

Used to sift out solids during filtration

Filtrate

The liquid that passes through the pores of the filter

Safety Gear

It is important to wear safety gear while conducting any experiments in a chemistry lab. Many chemicals used in these experiments can be harmful and dangerous to your body. Items that should be worn at all times include:

- Goggles
- Gloves
- Apron
- Pants
- Closed-toed shoes

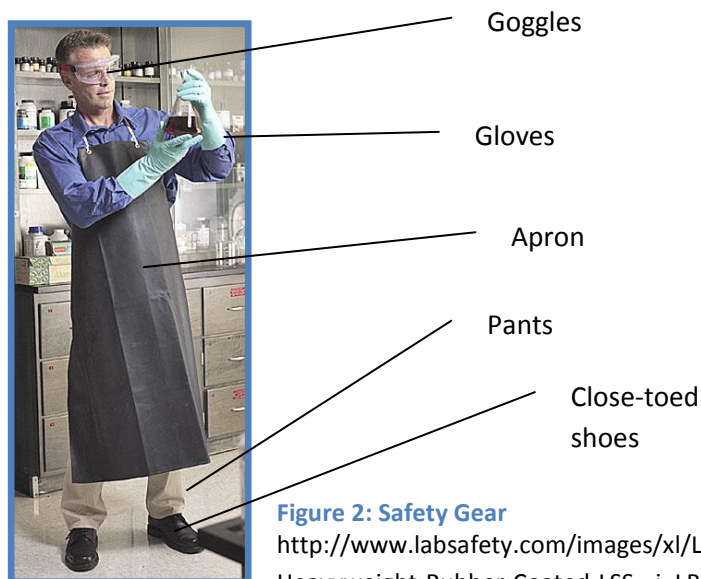


Figure 2: Safety Gear

http://www.labsafety.com/images/xl/LaCrosse-Heavyweight-Rubber-Coated-LSS-_i_LBC3003.jpg

Set up

1. Gather all of the equipment needed for the procedure
2. Take the pinch clamp and securely attach it to the ring stand
3. Place neck of the filter flask in between the clamp prongs and tighten until the flask will stay suspended by itself
4. Insert the Buchner funnel inside the rubber adaptor, keeping the wider end of the adaptor upwards so that it looks like a bowl
5. Press down firmly so there is no air in between the two parts
6. Insert the rubber adaptor with the Buchner funnel into the open mouth of the filter flask, again pressing down
7. Lay the filter paper inside the bowl of the Buchner funnel
8. Attach one end of the vacuum tubing to the side arm of the filter flask and the other end to the vacuum pump

Needed Equipment

1. Filter paper
2. Buchner funnel
3. Rubber adaptor
4. Clamp
5. Filter flask
6. Ring stand
7. Vacuum tubing
8. Vacuum pump

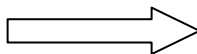
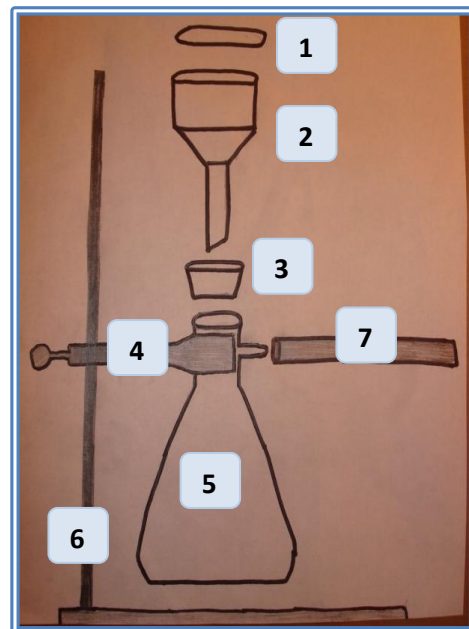






Figure 3: Vacuum Filtration Apparatus



With an understanding of when to use vacuum filtration and what you need to accomplish it, chemistry lab will be less difficult and tedious. Vacuum filtration is a common practice used in any chemistry lab and you should expect to see it in multiple experiments. Possible experiments that use vacuum filtration include:

- Preparation of aspirin
- Displacement of Copper to a Copper salt
- Crystallization
- Acid-base extraction

Chemistry Filtration Terminology

Buchner funnel	<p>A specific funnel used in large scale vacuum filtrations. It can vary in size and is usually made of porcelain, glass, or plastic. The top of the funnel looks like a dog dish, with a perforated bottom to place a piece of filter paper on. The bottom looks like an upside down triangle which then funnels down.</p>  <p>Figure 4</p>
Clamp	<p>Four or two finger-like parts that securely suspend a flask in the air. The other end is tighten onto the ring stand. Clamps are used to securely suspend flasks and test tubes in the air.</p>  <p>Figure 5</p>
Crystals	<p>Specifically aligned atoms that form a specific geometric pattern. Crystals are a specific type of solid.</p>
Drying oven	<p>Used to increase the rate of drying for samples and to ensure they are at a constant weight throughout. It is like your typical oven in your kitchen, which just produces heat.</p>
Filter flask	<p>Made of thick, glass walls and looks like a typical flask but has a side arm near the top. The side arm is used to connect vacuum tubing and create suction when the vacuum is on.</p>  <p>Figure 6</p>
Filter paper	<p>Used to sift out solids during the filtration. It is a circular piece of paper placed over the holes in the bottom of the Buchner funnel.</p>  <p>Figure 7</p>
Filter Paper Cone	<p>Large, circular piece of filter paper, which makes a cone that molds to the funnel when folded properly. The solution is poured into the cone and allowed to drip slowly through downwards into the flask. This type of filtration paper is used only for gravity filtration.</p>
Filtrate	<p>The liquid that passes through the pores of the filter. This liquid ends up in the filter flask.</p>
Filtration	<p>A process used to separate a solid from a liquid solution. The solution is sent through a filter causing the solid particles to get trapped while the</p>




	liquid passes through the small pores.	
Funnel rack	Used to support up to four funnels at one time.	
Hirsch funnel	A plastic funnel that has a polypropylene material used as the filter, so no filter paper is needed. It is used in small scale vacuum filtrations.	 <p>Figure 8</p>
Long-stem funnel	Usually made of glass and shaped as an upside down triangle. The bottom concentrates to a lengthy stem. This type of funnel is used only for gravity filtration.	
Percent Yield	A mathematical equation used to determine the percentage difference between the expected mass and the experimental mass created. This is used because during an experiment, an individual cannot collect 100% of the theoretical mass an experiment is expected to created. (Mass created/mass expected *100%)	
Ring stand	Used to support the filter flask and allows for the flask to suspend itself freely. The clamps are connected to the long, vertical bar.	 <p>Figure 9</p>
Rubber adaptors	Used to seal the connection between the Buchner or Hirsh funnels and the filter flask. The placement of the adaptor is over the stem of the funnel and into the mouth of the filter flask. Once the vacuum is turned on, the suction will seal any empty space between the funnel and flask.	
Rubber sheet	Forces the remaining liquid out of the solids in the top of the funnel. The sheet is stretched and held tight across the top of the funnel, creating a stronger vacuum.	
Silicone rubber hand protector	Used to handle hot lab equipment and to protect your hands from getting burnt. To wear a hand protector, place your thumb in the pocket at one end and your other four fingers in the other pocket.	 <p>Figure 10</p>
Solvent	Liquid solution that dissolves the solid at the beginning of the experiment. After the solid is dissolved it can be poured into the funnel to begin the filtration.	
Vacuum Tubing	Thick-walled rubber. This is the connection between the vacuum source and the filter flask.	
Washing	Rinsing the crystals with fresh solvent to remove any impurities. This normally happens three to four times.	

Figure 4: <http://www.bluffton.edu/~bergerd/classes/LabEquip/ceramic.jpg>

Figure 5: <http://www.bluffton.edu/~bergerd/classes/LabEquip/standardClamp.jpg>

Figure 6: <http://www.krackeler.com/graphics/0001/jpg/5360-sm.jpg>

Figure 7: <http://www.chem.uiuc.edu/chem103/aluminum/filterpaper.jpg>

Figure 8: http://www.pilotscientific.com/product/5005_s.jpg

Figure 9: <http://orgchem.colorado.edu/equipment/images/ringstand.jpg>

Figure 10: <http://app.infopia.com/img/image/fp/VPID/2219997/extra/2/size/250>

Websites referenced for project

<http://www.physicsforums.com/archive/index.php/t-155208.html>

<http://www.chemistry.sjsu.edu/straus/FAQ/Technique%20FAQ/VacFilterFAQ.htm>

<http://www.chem.ucalgary.ca/courses/351/laboratory/filtration.pdf>

