



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-L114

Vacuum Filtration Apparatus

Standard Operating Procedure

SOP Number	SOP-L114
Revision	0.1
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Date	2026-06-26
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Table of contents

1 Purpose	2
2 Scope	2
3 Definitions	2
4 Responsibilities	2
5 Safety and Hazards	3
5.1 Required PPE	3
5.2 Emergency Procedures	3
6 Equipment and Materials	3
6.1 Filtration Hardware	3
6.2 Funnel Types	4
6.3 Filter Media	4
7 Procedure	4
7.1 Assembly	4
7.2 Pre-Wetting or Pre-Combustion (If Required)	5
7.3 Filtration	5
7.4 Filter Handling	5
7.5 Filtrate Handling	5
7.6 Cleanup	6
8 Vacuum Pump Maintenance	6
9 Quality Control	6
10 Waste Disposal	6
11 References	7
12 Related SOPs	7
13 Training Record	7

1. Purpose

This procedure describes the assembly, operation, and maintenance of vacuum filtration systems used in the EA Program laboratory. Vacuum filtration separates suspended solids from liquids by drawing the liquid through a filter membrane or glass fiber filter under reduced pressure. It is used across many analytical methods, including soil and water extract filtration (SOPs L403, L409, L418), microplastics analysis ([SOP-L308](#)), chlorophyll extraction ([SOP-L310](#)), and eDNA concentration ([SOP-L700](#)).

2. Scope

- **Applies to:** All vacuum filtration in EA Program laboratories using filter flasks, filter funnels (Buchner, glass frit, analytical, or Nalgene disposable units), and Fisher Scientific Maxidry vacuum pumps or building vacuum lines
- **Does not apply to:** Syringe filtration (push-through, no vacuum); centrifugal ultrafiltration; field filtration of eDNA samples (covered in [SOP-F700](#))
- **Location:** SGM 133 and SGM 134

3. Definitions

- **Filter funnel:** The upper component of a vacuum filtration assembly that holds the filter membrane and directs liquid onto it; typically borosilicate glass or polysulfone.
- **Filtrate:** The liquid that passes through the filter membrane and collects in the side-arm flask; the fraction of interest in most dissolved-analyte analyses.
- **Glass fiber filter (GFF):** A depth filter composed of borosilicate glass microfibers; commonly 0.7 μm nominal pore size (GF/F); used for chlorophyll, particulate carbon, and TSS analyses.
- **Membrane filter:** A thin polymeric film with a defined pore size (typically 0.45 μm); used to separate dissolved from particulate fractions in water samples.
- **Nominal pore size:** The manufacturer-stated pore size of a filter; actual retention varies by manufacturer and depends on the particle size distribution of the material being filtered.
- **Retentate:** The material retained on the filter membrane; the fraction of interest for TSS, chlorophyll, and particulate analyses.
- **Side-arm (vacuum) flask:** A thick-walled borosilicate flask with a side arm for connection to the vacuum line; designed to withstand the pressure differential during filtration.
- **Vacuum trap:** A secondary flask or bottle interposed between the filtration funnel and the vacuum pump to catch filtrate overflow and protect the pump.

4. Responsibilities

Role	Responsibility
Lab PI	Approve SOP
Lab Manager	Maintain pumps, replace tubing

Role	Responsibility
Trained Personnel	Operate filtration systems per this SOP
New Students	Complete training before independent use

5. Safety and Hazards

Hazards

- **Glassware under vacuum:** Filter flasks (Erlenmeyer with sidearm) are under reduced pressure during operation. Cracked or starred flasks can implode. Inspect all glassware before each use; reject any with visible damage.
- **Chemical:** Filtrates may contain hazardous chemicals (acids, solvents). Handle filtrate according to the analytical SOP.
- **Biological:** Samples may contain pathogens. Wear gloves.
- **Sharp edges:** Broken glass fiber filters and fritted glass funnels can cut skin. Handle with forceps.

5.1. Required PPE

- ☐ Safety glasses (mandatory; protects against glass implosion)
- ☐ Nitrile gloves
- ☐ Lab coat

5.2. Emergency Procedures

If a filter flask implodes, do not touch the broken glass. Sweep up fragments with a brush and dustpan (not hands) and dispose in a sharps container or labeled “Broken Glass” box. If contaminated with hazardous chemicals, follow [SOP-L004 Chemical Spill Response](#).

6. Equipment and Materials

6.1. Filtration Hardware

Item	Qty	Location	Notes
Fisher Scientific Maxidry vacuum pump	4	SGM 134	Oil-free diaphragm pump
Filter flask (sidearm Erlenmeyer, 500 mL or 1 L)	Mul- tiple	SGM 134	Borosilicate glass; inspect for cracks
Rubber stopper with hole (matched to funnel stem)	Mul- tiple	SGM 134	Connects funnel to flask
Vacuum tubing (thick-wall rubber or silicone)	–	SGM 134	Check for cracks and kinks

Item	Qty	Location	Notes
In-line vacuum trap (flask or bottle between the filter flask and pump)	1 per pump	SGM 134	Prevents liquid from reaching the pump

6.2. Funnel Types

Funnel Type	Application
Buchner funnel (porcelain or polypropylene)	General filtration with flat filter paper or GF filters
Glass frit funnel (sintered glass, various porosities)	Fine filtration; reusable; requires careful cleaning
Nalgene analytical filter unit (disposable, sterile, 0.45 um PES)	Sterile filtration for microbiological and eDNA work
Millipore glass filter holder (47 mm)	Membrane filtration for water quality (TSS, chlorophyll, microplastics)

6.3. Filter Media

Filter Type	Pore Size	Application
Whatman GF/A (glass fiber)	1.6 um	General particulate filtration
Whatman GF/F (glass fiber)	0.7 um	Chlorophyll, DOC
Whatman 934-AH (glass fiber)	1.5 um	TSS, microplastics (SOP-L308)
Cellulose nitrate membrane	0.45 um	Bacterial enumeration, general
PES membrane (polyethersulfone)	0.45 um	Sterile filtration, eDNA
PVDF membrane	0.45 um	DOC filtration (low carbon blank)
PTFE membrane	0.45 um	Organic solvent filtration

i Note

Select the filter type and pore size specified in the relevant analytical SOP. Using the wrong filter can bias results (e.g., cellulose acetate filters leach DOC and are unsuitable for carbon analysis).

7. Procedure

7.1. Assembly

1. Inspect the filter flask for cracks or stars. Do not use damaged flasks.
2. Connect vacuum tubing from the flask sidearm to the vacuum trap inlet, and from the vacuum trap outlet to the pump
3. Place the rubber stopper into the neck of the flask

4. Seat the appropriate funnel into the stopper
5. If using a 47 mm filter holder: assemble the base, place the filter on the fritted support using forceps (avoid touching the filter with fingers), and clamp the funnel top in place

7.2. Pre-Wetting or Pre-Combustion (If Required)

- For gravimetric analyses (TSS): pre-dry and pre-weigh the filter per the analytical SOP
- For DOC filtration: pre-rinse the filter with 50–100 mL of sample or DI water and discard the first rinse (removes filter-leached carbon)
- For pre-combusted GF/F filters (chlorophyll, DOC): filters should have been fired at 450 C for 4 hours per [SOP-L111](#) and stored in a clean container

7.3. Filtration

1. Turn on the vacuum pump. Verify suction by briefly covering the funnel opening with a gloved hand (you should feel resistance).
2. Pour the sample into the funnel slowly and steadily. For particulate-laden samples, add in small aliquots to avoid overloading the filter.
3. Allow the liquid to pass through completely
4. Rinse the funnel walls with a small volume of DI water (or the matrix specified in the analytical SOP) to transfer any adhering particles to the filter
5. Continue vacuum for 10–30 seconds after the last visible liquid has passed through to remove residual moisture (do not over-dry if the filter will be extracted for chlorophyll or DOC)
6. Turn off the vacuum pump
7. Carefully disconnect the funnel from the stopper

7.4. Filter Handling

1. Remove the filter from the funnel using clean forceps
2. Transfer the filter to the appropriate container per the analytical SOP:
 - Aluminum tin (for drying/weighing: TSS)
 - Amber vial with extraction solvent (chlorophyll)
 - Extraction tube (eDNA, microplastics)
 - Petri dish (if storing before analysis)
3. Label the container immediately

7.5. Filtrate Handling

1. If the filtrate is the analyte of interest (e.g., dissolved nutrients, DOC), transfer it from the filter flask to a labeled sample vial using a clean graduated cylinder or by pouring
2. Acidify or preserve the filtrate per the analytical SOP
3. If the filtrate is waste, dispose per [SOP-L006](#)

7.6. Cleanup

1. Discard used disposable funnels and filters per the analytical SOP
2. Rinse reusable funnels, stoppers, and filter flasks with DI water immediately after use
3. For glass frit funnels: back-flush with DI water, then soak in an appropriate cleaning solution (acid bath for inorganic work, detergent for general use) per [SOP-L101](#)
4. Coil vacuum tubing loosely (do not kink) and store

8. Vacuum Pump Maintenance

Task	Frequency
Check vacuum tubing for cracks/kinks	Before each use
Empty and clean the vacuum trap	After each use session
Verify pump suction (should reach at least 20 in Hg / 500 mmHg)	Monthly
Replace vacuum tubing	Annually or when degraded
Service pump (diaphragm replacement)	Per manufacturer schedule or when suction declines

! Important

Always use a vacuum trap (secondary flask or bottle) between the filter flask and the pump. If liquid reaches the pump, it can damage the diaphragm and contaminate the pump internals.

9. Quality Control

- For analytical methods requiring pre-weighed filters (TSS), follow the weighing QC in the analytical SOP
- For DOC filtration, verify filter blanks by filtering DI water and analyzing the filtrate; blank DOC should be less than 0.5 mg/L
- Inspect all glassware for cracks before every use

10. Waste Disposal

Waste Type	Disposal Method
Used filters (non-hazardous)	Standard trash
Used filters (hazardous matrix)	Chemical waste per SOP-L006
Filtrate (hazardous)	Appropriate waste stream per SOP-L006
Filtrate (non-hazardous)	Drain with water if approved by EH&S
Broken glassware	Sharps container or “Broken Glass” box

11. References

- Fisher Scientific. *Maxidry Vacuum Pump User Manual*.
- APHA, AWWA, WEF. (2012). *Standard Methods for Examination of Water and Wastewater*. 22nd ed. Section 2540: Solids.

12. Related SOPs

SOP	Title	Relationship
L101	Glassware Cleaning	Cleaning funnels and flasks
L111	Muffle Furnace	Pre-combustion of GF filters
L308	Microplastics in Water	Filtration application
L310	Chlorophyll Extraction	Filtration application
L403	KCl Extraction	Extract filtration
L409	Microbial Biomass C	Extract filtration
L700	DNA Extraction	eDNA filter processing

13. Training Record

Before operating vacuum filtration systems independently, personnel must:

1. Read this SOP in full
2. Demonstrate proper assembly of the filtration system (flask, stopper, funnel, trap, pump, tubing)
3. Demonstrate correct filter handling with forceps
4. Perform one filtration under supervision
5. Be signed off by the PI or lab manager