Electrode Storage

Aqueous reference electrodes must be stored properly to prevent damage when not in use. The polyethylene frit should never be allowed to dry out. Follow these steps to properly store this reference electrode:

1. Rinse the external body of the reference electrode with distilled water (aqueous).
2. Ensure the storage bottle is ½ full of the same solution that is used as filling solution.
3. Remove the cap and O-ring from the storage container. Slide the white cap onto the PP body end followed by the O-ring (at least half-full with filling solution). Insert the reference electrode into the storage container so that the frit is safely below the solution level in the storage bottle.
4. Always store the reference electrode upright and never in direct sunlight.

Performance Verification

Reference Electrode Impedance

Reference electrode input impedance should be less than $10\ k\Omega$. The most likely cause of high reference electrode input impedance is a blocked or partially blocked polyethylene frit (**I**). Frits can become blocked by precipitation of salts in the microporous structure. *In some cases*, the frit clog can be cleared *but often*, the frit cannot be cleared, and the lower threaded end (containing the PE frit) must be replaced. Pine Research sells the end as a replacement (parts number RREF0038TIP).

Checking the Reference Potential

The standard potential of a reference electrode can be checked relative to another of the same reference electrode. Pine Research recommends that all users keep a "master" reference electrode that is never used in experiments and is always properly stored.

To check the reference potential of a reference electrode, submerge the experimental and master electrodes in filling solution. Measure the potential difference between the electrodes using either a simple voltmeter or a potentiostat in two electrode, open circuit potential mode. The difference should be less than $5\ mV$ if the reference electrode standard potential is correct. If the difference is $> 5\ mV$, the reference electrode should be disposed or refreshed.

Reference Electrode Conversions

From ▶ / To ▼	NHE	MOE 4.24M KOH	Ag/AgCl sat'd KCl	SCE sat'd KCl	MSE sat'd K_2SO_4
NHE	0	98	199	241	650
MOE 4.24M KOH	-98	0	101	143	552
Ag/AgCl sat'd KCl	-199	-101	0	42	451
SCE sat'd KCl	-241	-143	-42	0	409
MSE sat'd K_2SO_4	-650	-442	-451	-409	0

Add listed value (in mV) to convert.
NHE = Normal Hydrogen; MOE = Mercury Oxide;
SCE = Calomel; MSE = Mercury Sulfate

Optional Accessories

Additional reference electrodes are available from Pine Research, including aqueous, non-aqueous, and LowProfile applications. Ensure proper operation and lifetime of the reference electrode with a storage system. Use of an isolation tube or salt bridge when temperature or ion contamination are of concern.

Parts List

The following are included in the box:

- Single Junction Hg/HgO reference electrode
- 9.5 mm OD to 14/20 port PTFE adapter
  Reorder Part #: ACEP1420A3
- Plastic storage container

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Reference Electrode

Product Guide

This brief reference guide describes how to unpack, use, clean, store, and test the product. Please contact us with any additional questions.

Part #: RREF0038

Standard Size (9.5 mm)
Mercury/Mercury Oxide
Reference Electrode
(4.24M KOH)

Quick Facts

Reaction	$HgO_{(s)} + 2e + 2H_2O \rightleftharpoons Hg_{(\ell)} + 2OH^-$
Standard Potential (E°)	$+98\ mV\ vs.\ NHE^*$
Filling Solution	$4.24M\ KOH$
Temperature Tolerance	10°C *to* 100°C
Avoid Use With	Acids, cations that will form insoluble hydroxides
Ideal for Use With	Alkaline solutions
Typical Variance	$\pm 3 - 5\ mV$
Typical Input Impedance	$< 10\ k\Omega$

Junction potential for this electrode is significant. Therefore, there is a large uncertainty in absolute reference potential. Determine empirically based on conditions.

CAUTION! Contains Liquid Mercury!

Unpack the Electrode

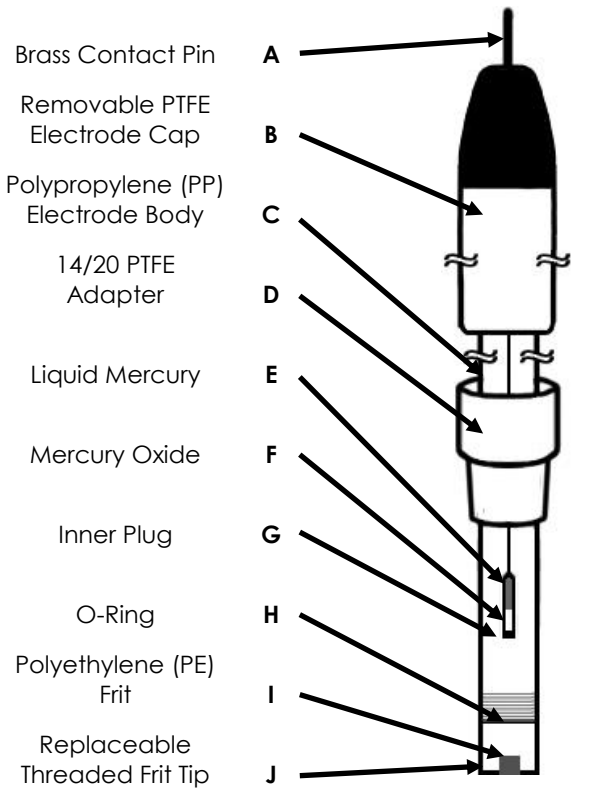
Newly purchased reference electrodes are packed to ensure safe shipment. The electrode is shipped filled with $4.24M\ KOH$. If this concentration of filling solution is appropriate for your uses (NOTE: reference potential is strongly dependent upon the species and concentration used as the filling solution), follow the next steps to unpack the electrode. Refer to the diagram on adjacent page. Wear appropriate personal protective equipment (including but not limited to gloves, lab coat, and goggles). Remove the Parafilm securing the removable PTFE electrode cap (**B**) to the polypropylene body (**C**). If you plan to use the $4.24M\ KOH$, you can keep the parafilm in place for an added seal to keep filling solution inside the electrode. Rinse the outer electrode body with distilled water to remove any solution that may have leaked during shipment. If you will be using a different electrolyte/concentration, remove the electrode cap (**B**) from the electrode body (**C**) and drain the fililng solution. Rinse the body with DI water 2-3 times. Refill the body with filling solution to at least 3/4 the height of the electrode body.

Electrode Usage Tips

For optimal use, review the following tips for proper reference electrode use:

1. During an experiment, ensure the polyethylene frit (**I**) is fully submerged in solution.
2. Ensure the clip connected to the brass contact pin (**A**) is not corroded and is firmly attached.
3. Ensure reference electrodes are always connected properly to the potentiostat. Current should never be allowed to pass through a reference electrode.
4. The 14/20 PTFE Adapter (**D**) can carefully be moved along the length of the polypropylene body (**C**) for optimal solution immersion depth.
5. This electrode is subject to significant junction potential. This junction potential is dependent upon the species and concentration of salt used in the electrolyte (filling) solution. You should empirically determine the reference potential frequently to avoid reporting incorrect potential values.
6. The PE Frit (**I**) has a higher leak rate than ceramic or porous glass frits.

Reference Electrode Diagram



Refresh Reference Electrodes

When the polyethylene frit has been plugged (by precipitates or crystals), a higher than normal input impedance may cause problems such as potentiostat instability. Thermal cycling may also result in crystallization. To refresh the electrode:

1. Drain the filling solution by removing the PTFE electrode cap (**B**) from the polypropylene electrode body (**C**). Rinse the electrode body with DI water 3-4 times.
2. Loosen and remove the Replaceable Fritted End by twisting it from the body.
3. Replace the threaded frit tip (**J**) and O-Ring (**H**) with new parts obtained from Pine Research Instrumentation, by twisting the assembly into the body.
4. Refill the body with the desired filling solution and slide the cap back on the body.

Other Reference Electrodes

Ag/AgCl Single Junction (saturated KCl)
- Part #: RREF0021
- $E^{\circ} = 199\ \text{m}V\ vs.\ NHE$*
- Filling Solution: $4M\ KCl\ with\ AgCl$
- Temperature Range: 10°C to 80°C

Ag/AgCl Double Junction (saturated KCl)
- Part #: RREF0024
- $E^{\circ} = 199\ \text{m}V\ vs.\ NHE$*
- Internal Filling Solution: $4M\ KCl\ with\ AgCl$
- External Filling Solution: $10\%\ KNO_3$
- Temperature Range: 10°C to 80°C

Calomel/SCE Single Junction (saturated KCl)
- Part #: RREF0022
- $E^{\circ} = 241\ \text{m}V\ vs.\ NHE$*
- Filling Solution: $4M\ KCl$
- Temperature Range: 10°C to 50°C

Mercury Sulfate Single Junction (saturated K_2SO_4)
- Part #: RREF0025
- $E^{\circ} = 650\ \text{m}V\ vs.\ NHE$*
- Filling Solution: saturated K_2SO_4
- Temperature Range: 10°C to 60°C

Mercury Sulfate Double Junction (saturated K_2SO_4)
- Part #: RREF0026
- $E^{\circ} = 650\ \text{m}V\ vs.\ NHE$*
- Internal Filling Solution: saturated K_2SO_4
- External Filling Solution: saturated K_2SO_4
- Temperature Range: 10°C to 60°C

Ag/Ag+ Pseudo Reference Electrode Kit
- Part #: AKREF0033
- Ideal for use in non-aqueous solvents
- Unstable reference potential unless made into a $Ag/AgNO_3$ reference

LowProfile (3.5 mm) Reference Electrodes
- $Ag/AgCl$ in $60\ mm$ and $74\ mm$ lengths
- Ag/Ag^{+} in $60\ mm$ and $74\ mm$ lengths

*Double junction electrodes are subject to additional potential drop across the second frit. **Junction potential for this electrode is significant.** Reference electrodes must be filled with proper filling solution to function correctly. Occasionally electrodes are shipped without filling solution inside chamber. Frit should be allowed to soak with filling solution overnight prior to use if electrode was dry for extended time.