Electrode Storage

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

1. Slide the access door up to close the filling port.
2. Rinse the reference electrode with distilled water (aqueous) or clean solvent (non-aqueous).
3. Remove the cap and O-ring from the storage container. Slide the white cap onto the glass 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 in contact with the wetted sponge inside. Tighten the threaded cap of the storage container.
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 ceramic frit (**L**). Ceramic 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 electrode must be replaced.

Checking the Reference Potential

The standard potential of a reference electrode can be checked relative to another of the same reference electrode. Pine 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 ►	NHE	MOE 4.24M KOH	Ag/AgCl sat'd KCl	SCE sat'd KCl	MSE sat'd K_2SO_4
To ▼ 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 an isolation tube or salt bridge when temperature or ion contamination are of concern.

Parts List

The following are included in the box:

- Double junction MSE reference electrode
- 3 oz. bottle of external filling solution
- 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 #: RREF0026

Standard Size (9.5 mm) Double Junction Mercury/Mercury Sulfate Reference Electrode (Saturated K2SO4)

Quick Facts

Reaction	$Hg_2SO_{4\,(s)} + 2e \rightleftharpoons 2Hg_{(l)} + SO_4^{2-}$
Standard Potential (E°)	$+650\ mV\ vs.\ NHE^*$
Internal Filling Solution	$saturated\ K_2SO_4$
External Filling Solution	$saturated\ K_2SO_4$
Filling Solution Part #	RRSLN0006-250 (250 mL)
Temperature Tolerance	10°C to 60°C
Avoid Use With	Non-aqueous/organic solvents, perchlorate solutions
Typical Variance	$\pm 3 - 5\ mV$
Typical Input Impedance	$< 10\ k\Omega$

CAUTION! Contains Liquid Mercury!
Internal Filling Solution Inaccessible.

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Unpack the Electrode

To unpack the electrode (refer to diagram on adjacent page): Remove the Parafilm around the filling port (**C**) in the cap (**B**). **Slide** the access door (**D**) up to close the filling port (**C**). See the diagram below. Rinse the reference electrode with distilled water to remove any solution that may have leaked during shipment (white solid).

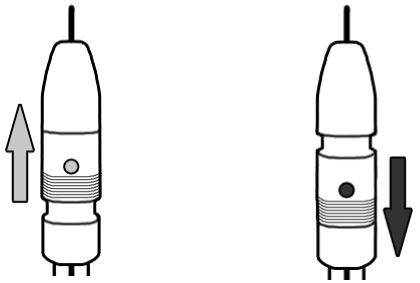
Refreshing Reference Electrode Tips

Most often, the ceramic frit becoming blocked or partially blocked (by precipitates or crystals) is the cause of increased reference electrode impedance that results in potentiostat instability. Thermal cycling may also result in crystallization. To refresh the electrode frit, try the following:

1. Replace the internal filling solution with distilled/ deionized water and store the electrode in distilled/deionized water instead of filling solution for $24 - 48$ hours.
2. Replace the internal filling solution with distilled/ deionized water, and soak the frit portion of the electrode in 80℃ distilled/deionized water for up to 1 hour. Apply an aspirator to the frit to pull a slight vacuum in addition if desired.
3. Dip the frit in distilled/deionized water and sonicate for several minutes.

Filling Port Use

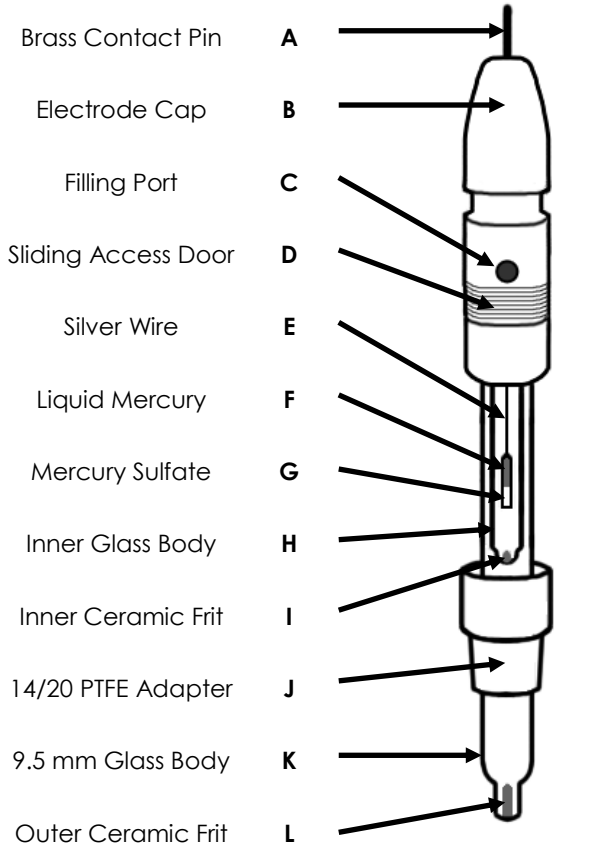
The electrode cap (**B**) is permanently sealed to the glass body (**K**). Do not attempt to disassemble this reference electrode as permanent, irreversible damage may occur. Access to the filling solution is only possible through the filling port (**C**) in the cap.



Slide access door (D) up to close the fill port for storage

Slide access door (D) down to open the fill port during use and to fill or drain

Reference Electrode Diagram



Electrode Usage Tips

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

1. During an experiment, ensure the ceramic frit (**L**) 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 pass through a reference electrode.
4. The 14/20 PTFE Adapter (**J**) can carefully be moved along the length of the glass body (**K**) for optimal solution immersion depth.

Other Reference Electrodes

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

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

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

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

Mercury Oxide Single Junction ($4.24M\ KOH$)
- Part #: RREF0038
- $E^{\circ} = 98$ m$V\ vs. NHE$*
- Filling Solution: $4.24M\ KOH$
- Temperature Range: 10℃ to 80℃
- Ideal for use in alkaline solutions

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. 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.