Part Number AFREF010192

Standard Non-Aqueous Glass Frit Reference Electrode Product Guide

Warnings

Usage Notes:

Avoid storage in direct sunlight. Typical input impedance should be $< 10\ k\Omega$.

Thermal Stability:

Exact temperature range will depend on usage mode. Extreme temperatures may damage electrode.

Chemical Compatibility:

Exact chemical compatibility will depend on usage mode. Electrode body is made from borosilicate glass.

Contact Us / Support

2741 Campus Walk Ave, Building 100
Durham, NC 27705 USA

www.pineresearch.com

pinewire@pineresearch.com

+1 (919) 782-8320

DRP10263 / REV001 (MAY 2023)

Reference Electrode Conversions

From ▸ / To ▾	NHE	MOE 20% KOH	Ag/AgCl sat'd KCl	SCE sat'd KCl	MSE sat'd K_2SO_4
NHE	0	98	199	241	650
MOE 20% 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

Electrode Storage

1. Following an experiment, fully rinse and then dry the silver wire and inner cap components.
2. Rinse the fritted glass tube with clean solvent used in the experiment, and ensure the frit is not clogged. Then dry.
3. Prevent damage to the silver wire by attaching a glass tube and storing in the original packaging. No solution is needed during storage.
4. Always store the reference electrode safely and never in direct sunlight.

Photograph

Electrode Usage Modes

Ag/Ag⁺ Pseudo (Electrolyte)

$$Ag_{(s)} + e \rightleftharpoons Ag^{+}_{(aq)}$$

For this reaction, $E^{\circ} = 0.799\ V\ vs. NHE^{‡}$, which is strongly dependent upon pH, condition of electrode materials, analyte solution, temperature, etc. This mode is the most simple and uncomplicated reference electrode used. It is ideal for measuring potential differences where an absolute, calibrated reference potential is not required, yet a three-electrode cell is used. Roughen/clean the surface of the silver wire using 600-grit sandpaper. Rinse the silver wire with deionized water and dry it. Ensure that the cell electrolyte has diffused into the fritted tube and is in contact with the silver wire.

Ag/Ag₂O Pseudo (Electrolyte)

$$Ag_2O_{(s)} + H_2O + 2e \rightleftharpoons 2Ag_{(s)} + 2OH^{-}$$

For this reaction, $E^{\circ} = 0.344\ V\ vs. NHE^{‡}$, which is strongly dependent upon pH, condition of electrode materials, analyte solution, temperature, etc. This mode is ideal for measuring potential differences where an absolute, calibrated reference potential is not required, yet a three-electrode cell is used. Soak the silver wire in concentrated acid for 1-2 minutes to form a layer of silver oxide on the surface. Rinse the silver wire with water, then ethanol, and wipe dry. Ensure that the cell electrolyte has diffused into the fritted tube and is in contact with the silver wire.

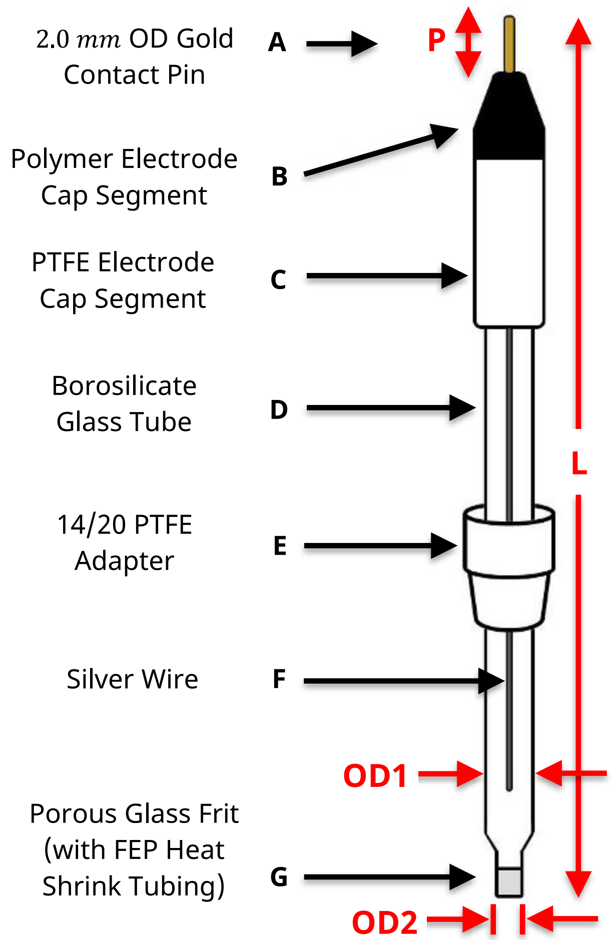
Ag/AgNO₃ ($10\ mM\ AgNO_3\ in\ MeCN$)

$$AgNO_3 + e \rightleftharpoons Ag_{(s)} + NO_3^{-}$$

For this reaction, $E^{\circ} = 0.541\ V\ vs. NHE^{‡}$. This mode requires the user to prepare $0.1M\ AgNO_3 + 100\ mM\ TBAPF_6\ in\ MeCN$ filling solution. Polish the Ag wire with 600-grit sandpaper, rinse completely with water, then with ethanol and wipe dry. Fill the fritted glass tube with this solution, then place the silver wire/cap onto the tube. You may consider a salt bridge to minimize Ag^{+} leakage. This reference electrode should be calibrated on a daily basis vs. a well-behaved couple, such as ferrocene.

‡Approximate values, will differ based on environment.

Reference Electrode Diagram



Electrode Diameter (OD1):	$9.5\ mm$
Glass Frit Diameter (OD2):	$3.4\ mm$
Overall Electrode Length (L):	$192\ mm$
Contact Pin Length (P):	$9\ mm$

Parts List

The following are included with each Non-Aqueous Glass Frit Reference Electrode:

- PTFE-capped silver wire electrode
- Glass tube, porous glass frit, FEP heat shrink
- 14/20 PTFE adapter

Electrode Applications

This reference electrode has a glass tube with an individual length of $130\ mm$. It comes with a PTFE adapter that fits into a 14/20 taper port that is present on many standard size electrochemical cells. This electrode is ideal for use with standard size electrochemical cells often for performing non-aqueous tests.

Performance and Porous Glass Frits

The porous glass frit (**G**) is affixed to the bottom of the borosilicate glass tube (**D**) via a short length of FEP heat shrink tubing. The frit measures $3.2\ mm$ OD x $3.2\ mm$ L and has average pore sizes of around $10\ nm$.

Reference electrode input impedance should be less than $10\ k\Omega$. The most likely cause of high reference electrode impedance is a blocked porous glass frit (**G**). In some cases, the frit can be cleared, but often it cannot and needs to be replaced.

Refreshing the porous glass frit: if the frit has become blocked, the following steps may be taken:

1. Fill the glass tube with distilled/deionized water and store the electrode in water for 24-48 hours.
2. Place the electrode in a small container of water and sonicate the frit.
3. Using a small bulb or other suction device, forcibly pressurize the inner volume of water slightly to cause drainage out the frit. This may help dislodge any contaminants that are stuck in the frit.

Replacing the porous glass frit: if the frit cannot be refreshed, it can be manually removed from the glass tube and replaced via the following steps:

1. Obtain a set of replacement porous glass frits and FEP heat shrink tubing (part number AKFRIT125).
2. Cut existing heat shrink to remove blocked frit.
3. Place new frit onto end of glass tube and slide FEP heat shrink tubing around both. Lightly apply heat until locked in place (shrink temperature is 180℃).

Other Reference Electrodes

Ag/AgCl Single Junction (saturated KCl)

- Part #: RREF0021
- $E^{\circ} = 199\ mV\ vs.\ NHE$
- Fill Solution: $4M\ KCl$
- Temperature Range: $10℃\ to\ 80℃$

Ag/AgCl Double Junction (saturated KCl)

- Part #: RREF0024
- $E^{\circ} = 199\ mV\ vs.\ NHE$*
- Outer Fill Solution: 10% KNO_3
- Inner Fill Solution: $4M\ KCl$
- Temperature Range: $10℃\ to\ 80℃$

Calomel/SCE (saturated KCl)

- Part #: RREF0022
- $E^{\circ} = 241\ mV\ vs.\ NHE$
- Fill Solution: $4M\ KCl$
- Temperature Range: $10℃\ to\ 50℃$

Mercury Sulfate Single Junction (saturated K_2SO_4)

- Part #: RREF0025
- $E^{\circ} = 650\ mV\ vs.\ NHE$*
- Fill Solution: saturated K_2SO_4
- Temperature Range: $10℃\ to\ 60℃$
- Contains no chloride ion

Mercury Sulfate Double Junction (saturated K_2SO_4)

- Part #: RREF0026
- $E^{\circ} = 650\ mV\ vs.\ NHE$*
- Inner Fill Solution: saturated K_2SO_4
- Outer Fill Solution: saturated K_2SO_4
- Temperature Range: $10℃\ to\ 60℃$
- Contains no chloride ion

Mercury Oxide ($4.24M$ KOH)

- Part #: RREF0038
- $E^{\circ} = 98\ mV\ vs.\ NHE$*
- Fill Solution: $4.24M\ KOH$
- Temperature Range: $10℃\ to\ 100℃$
- Contains no chloride ion
- Ideal for use in alkaline solutions

*Double junction electrodes are subject to additional potential drop and impedance across the second frit.

Be prepared! Always have a spare reference electrode to use!