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Kwik-Tip™

Ion-selective electrodes

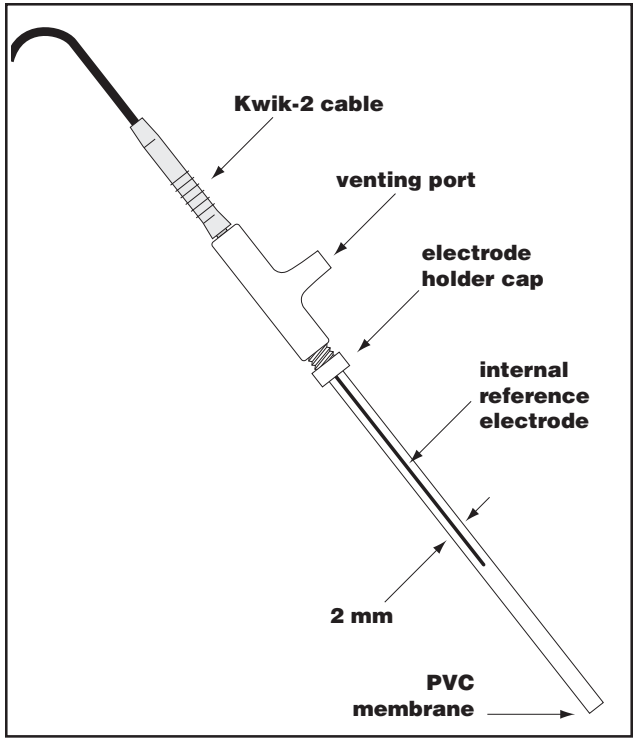
INSTRUCTION MANUAL

Serial No._____

071802

World Precision Instruments

Kwik-Tip™ Electrodes are superior PVC-membrane electrodes suitable for measurement of ion concentration in solution. An ion-selective membrane covers one end of a 2 mm diameter tube.The tube, when filled with an electrolyte, acts as a salt bridge to an Ag/AgCl half cell electrode. If the sensitivity of the PVC membrane degrades, the electrode tube can easily be removed and replaced with another.



A venting hole on the electrode holder protects the membrane from bursting by relieving the pressure when tightening the electrode holder cap. Although it can be left uncovered, sealing it with Parafilm after the electrode is installed will reduce the evaporation of the electrolyte. (When working over a long period at higher temperature such as 37°C, this becomes important.)

Instructions

1. Connect the cable to the electrode holder. Remove the protective sleeve from the Ag/AgCl electrode. Loosen the electrode holder cap several turns to make it ready for the insertion of the electrode.

2. Using the syringe and the flexible **MicroFil** filling needle supplied with the kit, carefully half-fill the electrode with the appropriate filling solution (see table below). The PVC membrane of the electrode is at the opposite end from the color identification dot. The membrane is very fragile. Do not puncture it with the tip of the MicroFil while filling with solution.

WARRANTY

WPI (World Precision Instruments, Inc.) warrants to the original purchaser that this equipment, including its components and parts, shall be free from defects in material and workmanship for a period of 30 daysfrom the date of receipt. WPI's obligation under this warranty shall be limited to repair or replacement, at WPI's option, of the equipment or defective components or parts upon receipt thereof f.o.b. WPI, Sarasota, Florida U.S.A. Return of a repaired instrument shall be f.o.b. Sarasota.

The above warranty is contingent upon normal usage and does not cover products which have been modified without WPI's approval or which have been subjected to unusual physical or electrical stress or on which the original identification marks have been removed or altered. The above warranty will not apply if adjustment, repair or parts replacement is required because of accident, neglect, misuse, failure of electric power, air conditioning, humidity control, or causes other than normal and ordinary usage.

To the extent that any of its equipment is furnished by a manufacturer other than WPI, the foregoing warranty shall be applicable only to the extent of the warranty furnished by such other manufacturer. This warranty will not apply to appearance terms, such as knobs, handles, dials or the like.

WPI makes no warranty of any kind, express or implied or statutory, including without limitation any warranties of merchantability and/or fitness for a particular purpose. WPI shall not be liable for any damages, whether direct, indirect, special or consequential arising from a failure of this product to operate in the manner desired by the user. WPI shall not be liable for any damage to data or property that may be caused directly or indirectly by use of this product.

Claims and Returns

Inspect all shipments upon receipt. Missing cartons or obvious damage to cartons should be noted on the delivery receipt before signing. Concealed loss or damage should be reported at once to the carrier and an inspection requested. All claims for shortage or damage must be made within ten (10) days after receipt of shipment. Claims for lost shipments must be made within thirty (30) days of receipt of invoice or other notification of shipment. Please save damaged or pilfered cartons until claim is settled. In some instances, photographic documentation may be required. Some items are time-sensitive; WPI assumes no extended warranty or any liability for use beyond the date specified on the container

Do not return any goods to us without obtaining prior approval and instructions from our Returns Department. Goods returned (unauthorized) by collect freight may be refused. Goods accepted for restocking will be exchanged or credited to your WPI account. Goods returned which were ordered by customers in error are subject to a 25% restocking charge. Equipment which was built as a special order cannot be returned.

Repairs

Contact our Customer Service Department for assistance in the repair of apparatus. Do not return goods until instructions have been received. Returned items must be securely packed to prevent further damage in transit. The Customer is responsible for paying shipping expenses, including adequate insurance on all items returned for repairs. Identification of the item(s) by model number, name, as well as complete description of the difficulties experienced should be written on the repair purchase order and on a tag attached to the item.

The following steps will help isolate the defect in the system.

1. Remove the electrode from the holder. Dip the holder's internal reference electrode (Ag/AgCl wire) together with the reference electrode into an electrolyte solution (*e.g.*,100 mM NaCl). Check the reading on the pH meter. It should be very stable. If one of the electrodes (reference electrode or the KWIK holder) is pulled out of solution, the reading should drift. The reading should come back to the same value when the electrode is dipped in again. If this is the case, the problem will be in the ion-selective electrode section (see "3" below). If the reading is unstable, then the reference electrode or the KWIK holder is bad (see "2").

2. Replace either the KWIK holder or the reference electrode with another reference electrode or a piece of silver wire that has been chloridized. If the reading becomes stable when the reference electrode is replaced, the problem is the reference electrode. If the reading becomes stable when the KWIK holder is replaced, the problem is the holder.

3. There are two possibilities. Most often, an air bubble will be visible in the electrode tip. If there is no air bubble, the problem will be the electrode membrane. *Normally, the electrode has a shelf life of six months.* With age, the impedance of the electrode increases and selectivity decreases. There is no easy method to positively ascertain that the electrode membrane is bad except to destroy it. If you punch a small hole in the membrane and reading becomes very stable, the electrode membrane was bad. Naturally, we do not recommend doing this until everything else is checked.

Complete Kits

KWIKCAL-2	Cable, Holder, 3 Calcium Electrodes, Filling Syringe & Needle
KWIKH-2	Cable, Holder, 3 Hydrogen Electrodes, Filling Syringe & Needle
KWIKPOT-2	Cable, Holder, 3 Potassium Electrodes, Filling Syringe & Needle
KWIKTPP-2	Cable, Holder, 3 TPP (Tetraphenylphosphonium) Electrodes, Filling Syringe & Needle

Holders and Replacement Tips

KWIK-2	Electrode Holder, BNC Cable, Filling Syringe & Needle
TIPCA	Calcium Electrode Tips (3)
TIPH	Hydrogen Electrode Tips (3)
TIPK	Potassium Electrode Tips (3)
TIPTPP	TPP^+ Electrode Tips (3)

3. Hold the electrode vertically (membrane tip down) and gently tap the side with your finger to remove any air bubbles trapped between the membrane and filling solution. (If an air bubble is left in the tip region, it may cause an open circuit in the system, resulting in unstable readings.

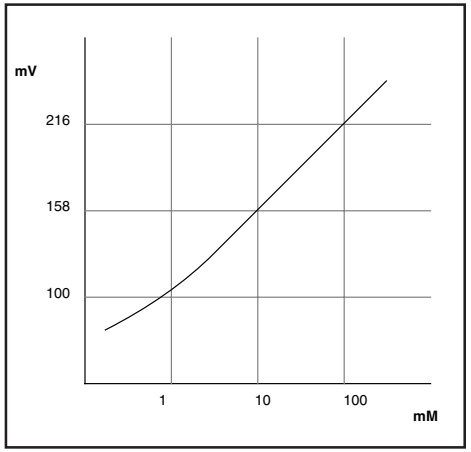
4. Continue filling the electrode tube with the same solution; leave only about 1 to 2 cm unfilled.

5. Carefully insert the Ag/AgCl internal reference electrode into the tube, and then slowly insert the electrode into the holder. Tighten the cap of the electrode holder to secure the electrode.

6. Connect the electrode holder to a pH meter. The KWIK-2 holder cable has a BNC connector. If your meter has a US Standard Connection you can use WPI's US Standard-to-BNC Adaptor (part #**3508**). For other connections, contact the manufacturer of the pH meter. A separate reference electrode — such as WPI's **Dri-Ref** or **SUPER-Dri-Ref** — must also be connected to the reference input of the pH meter.

Calibration

Figure 2



Immerse the Kwik-Tip electrode, together with a reference electrode, in a solution of known concentration. With your pH meter on the mV scale, wait for the reading to stabilize (typically 5 to 10 seconds) and record the potential. Rinse the electrode briefly with distilled water and immerse the electrode pair into a second solution of different concentration. Record the mV reading as before.

The readings may be used to plot a calibration chart, an example of which is shown in **Fig. 2**. Note that the x-axis is the log of the ion concentration, while the y-axis is the mV reading. For every decade of change in the ion concentration the potential should change by approximately 58 mV for a monovalent ion or 29 mV for a divalent ion. The potential increases with increase in concentration of cations (for example, Na^+) and decreases with increase in concentration of anions (Cl^-).

Selecting a different filling solution

The filling solution recommended in the table can be changed if necessary. There are three requirements for the filling solution:

1. It must have some chloride ions so the internal reference electrode can stabilize.

2. It needs to contain a stable concentration of the ion (primary ion) to be measured. For example, the filling solution of the calcium electrode should contain calcium ions and its concentration needs to be stable. This can be done either using high concentration of $CaCl_2$ (0.01-0.1 M) or a buffered Ca solution. Normally, a higher internal primary ion concentration will reduce the response time but also reduce the sensitivity of the electrode at lower concentrations. A buffered primary ion concentration that is close to the range of the concentration the electrode is going to measure will provide the best sensitivity and linearity. Further reducing the primary ion concentration in the filling solution to lower than the working concentration range will cause the super-Nernstian response. A recent article (*Analytical Chemistry.* 1999, 71. 1204-1214) is a good reference for the effect of primary ion concentration in the filling solution. In that report, a $3x10^{-8}$ M of Ca gives the best result for the Ca ion selective electrode.

3. It needs enough conductivity so that the impedance of the electrode body will not become too high, causing instability. For the Kwiktip electrode, 100 mM of total salt concentration is sufficient. Any solutions that meet the three criteria can be used as filling solution.

FILLING SOLUTIONS

Part No.	Electrode	Color Code	Recommended Filling Solution	Min. Slope / Decade	Concentration Range	Selectivity Coefficients (-log)
TIPCA	Calcium	Green	0.1 M $CaCl_2$	28 mV	0.1 M - $10^{-6.75}$ M	Na^+ 5.5, K^+ 5.4, Mg^{++} 4.9
TIPH	Hydrogen	Orange	1 M Citric Acid, 0.01 M NaCl, pH 5.6	54 mV	pH 5.0 - 12	Na^+ 10.4, K^+ 9.8, Ca^{++} 11.1
TIPK	Potassium	Yellow	0.1 M KCl	54 mV	0.1 M - $10^{-4.5}$ M	Na^+ 4.0, Ca^{++} 3.9, Mg^{++} 3.0
TIPTPP	TPP^+	Purple	10 mM TPP^+	54 mV	0.001 M - 10^{-4} M	K^+ 6.0

Troubleshooting

Inability to get a stable reading is the most common problem of with Kwik-Tip electrodes, especially for new users. This may be due to electrical interference or a defect in the system. When fluctuation is caused by a system defect, the reading will vary — it will jump all over the range. When the fluctuation is caused by electrostatic interference, the reading will jump around a fixed value. When the calibration solution is changed to a different concentration, the reading will jump around a different value. The average of the slope vs. the concentration will still be close to what is specified in the table above. Since the PVC sensor membrane has very high impedance, the reading will be sensitive to static interference. If you move a charged object close to the electrode, the reading will fluctuate no matter how good the electrode is. (This can be demonstrated by rubbing a plastic pen with a cloth and moving it near the electrode: the reading will fluctuate when the pen gets close to the electrode.) Electrostatic interference can be avoided by moving system away from the electrostatic source or by proper shielding and grounding. Using aluminum foil to wrap the electrode and holder then grounding it with an alligator clip will help the stability.

With age, however, the impedance of the electrode will increase due to the leaching of the ionophore. Eventually, the impedance becomes so high that the electrode must be replaced. ***Average lifetime of a Kwik-Tip™ electrode is about six month after shipping.*** Storing the electrode in a cool, dry place may increase its lifetime slightly.

Assuming the pH meter is in good working condition, an unstable reading may mean that there is an open circuit in the system. The problem may be with the reference electrode, the internal reference electrode of the KWIK holder, an air bubble in the electrode, or a faulty electrode membrane.

WORLD PRECISION INSTRUMENTS