HOW TO PREPARE AND MAINTAIN RE-2.5U & RE-5U M. C. MILLER COPPER SULFATE REFERENCE ELECTRODES

WARNING! M. C. Miller reference electrodes use Copper Sulfate crystals. Copper Sulfate should be handled with care. Rubber gloves, safety glasses or face shields, waterproof aprons and inhalant protection are highly recommended when working with copper sulfate. Please read the Materials Safety Data Sheet (MSDS) for Copper Sulfate Pentahydrate Crystals (M. C. Miller's MSDSID#25) for proper handling information.

Electrode Preparation Steps:

When rejuvenating or setting up a new electrode, follow these steps:

1. Unscrew the orange Lexan tube (with the ceramic plug attached) from the copper rod assembly, which will reveal the copper rod.

2. Burnish the copper rod to a shiny metallic finish using a new, unused, non-metallic scouring pad or sandpaper. Green 3M scouring pads are recommended for this procedure. When green scouring pads are unavailable, sandpaper can be used. Oxide type sandpaper must be avoided as oxide sandpaper will introduce unwanted metals into the surface of the copper rod.

   Once the copper rod has been fully burnished, avoid any contamination that may occur before the rod assembly is reattached to the tube. The MCM copper rod assemblies are made with the highest purity copper available; however, they can become contaminated by ungloved fingers, dirt, oil or any other foreign substance.

3. Inspect the rubber o-ring and replace the ring if it appears to be damaged. Copper Sulfate is a corrosive mineral and should be handled with care. Leaking reference electrodes may result if the o-ring is damaged.

4. Screw the orange Lexan tube back onto the rod assembly, being careful not to over-torque.

5. Turn the electrode upside down and unscrew the plug assembly.

6. Add Copper Sulfate crystals (if not already added) to the orange Lexan tube. **Use only high purity copper sulfate crystals, such as those available from M. C. Miller**. Weight guidelines for the crystals are indicated below for each electrode type:

   RE-2.5U and RE-5U 0.042 lbs / 20 grams $CuSO_4$

7. Add **Deionized or Distilled Water** up to the bottom of the threads on the Lexan tube. Be sure to remove any crystals that may have stuck to the threads. If copper sulphate crystals are present on the threads when the plug assembly is reattached, the electrode may leak at this threaded junction.

8. Re-install the ceramic plug assembly, being careful not to over-torque.

9. Shake the electrode vigorously until the copper sulfate crystals dissolve and the solution becomes fully saturated with copper sulfate. The saturation point is reached when no more crystals can be dissolved into solution. At this point, the solution should be a rich blue color and there should be some crystals remaining out of solution. Add additional crystals until this condition is reached.

10. Turn the electrode upside down, with the ceramic plug on top, and examine the solution level. The solution level should be above the bottom on the ceramic tube extending into the orange Lexan tube. At least about half of the ceramic tube should be immersed in the solution with the electrode in the upside down configuration in order than the electrode will function in the upside down configuration. If this is not the case, remove the ceramic plug assembly and add addition deionized or distilled water to the Lexan tube.

11. Allow the electrode to set for a 24-hour period before use. The electrode ceramic plug assemblies are presoaked at the factory in a copper sulfate solution and allowed to dry. Before using the electrode, the

ceramic plug assembly must become moistened by the solution contained within the electrode. Failure to allow the ceramic plug assembly to moisten for at least 24 hours could cause the electrode to indicate false readings.

Note 1: *Under average conditions, the electrode should be emptied and cleaned out every two or three months. However, if the electrode is allowed to remain in prolonged contact with low resistivity soil or water, more frequent rejuvenation may be desirable. For consistent results, we recommend using the highest purity copper sulfate crystals available.*

Note 2: *Always use the orange plastic plug cover when an electrode is not being used to help prevent the plug from drying out due to evaporation.*

Electrode Maintenance

Short Term Maintenance:
The ceramic plug should be cleaned after each use by rinsing the plug under water to remove any residual soil material, and wiping the plug with a clean cloth. After the cleaning process, the orange plastic plug cover should be applied to the plug to limit evaporation (to prevent the plug from drying out).

Long Term Maintenance
If the electrode is not to be in-service for a significant period of time (say, at least a month), it is recommended that the copper sulfate solution be emptied out of the Lexan tube and the inside of the tube be rinsed out using distilled or de-ionized water to remove any residual copper sulfate crystals. ***Please consult your local hazardous waste disposal authority for recommended disposal procedures for copper sulfate solution and copper sulfate crystals.*** When it is time to re-use the electrode, follow the preparations for use steps outline above, beginning with the copper rod burnishing step, since the copper rod will have accumulated an oxide film.

Low Temperature Precautions:

When the ambient temperature in which the electrodes are used or stored is below freezing, the copper sulfate solution within the electrode may freeze, since it's a water-based solution. Frozen copper sulfate solution will cause the internal resistance of the electrode to become very high. As a result, it is virtually impossible to obtain a correct reading. Further, as the solution freezes, it is possible that the expansion of the solution may cause the ceramic plug assembly to split. M. C. Miller's Copper Sulfate Anti-Freeze Solution or GEN II Leak Stop Gel should be used if freezing conditions are expected. The Anti-freeze solution and GEN II Leak Stop Gel can be used in all temperatures (not just low temperatures). Since both the M. C. Miller Anti-Freeze and GENII Gel products are super-saturated solutions, there is no need to add copper sulfate crystals to the Lexan tube when using these products.

Testing Electrodes for Accuracy:

After prolonged use, the copper sulfate solution can become contaminated by outside elements (reverse osmosis) leading the faulty readings. To check the condition of an in-service electrode, the following procedure is recommended. A new electrode should be prepared as a "standard". An LC-4 voltmeter is recommended for the test procedure with the DC voltage range set to 200mV and the input impedance set to 200MΩ. Attach the "standard" reference electrode to the negative (or common) side of the meter and the electrode to be tested to the positive side. Place the plug ends of the two electrodes (the "standard" and the in-service electrode) in a plastic bath containing tap water (not de-ionized or distilled water). If the electrodes are evenly matched, the voltmeter should read zero ±10mV. Since copper sulfate electrodes are affected by temperature, it is necessary to allow both electrodes to equilibrate at the same temperature prior to the test. 72 degrees F is ideal. When it is found that an in-service electrode has a reading that is outside the acceptable tolerance range, the electrode should be rejuvenated using the procedures outlined above.

Common Sources of Reading Error:

Voltmeter Parameters:
The voltmeter used in conjunction with a reference electrode should have a sufficiently-high input impedance setting, at least 10 MΩ, although 200MΩ is recommended in high soil resistance conditions, so that source resistance does not affect readings. If the source resistance (the total resistance "seen" by the voltmeter) is significant with respect to the input impedance of the voltmeter, the voltage reading will be lower than it should be. Consequently, the higher the input impedance value of the voltmeter, the better, with respect to voltage reading accuracy.

Poor (Electrical) Contact:
When taking readings with a reference electrode, the ceramic plug must be in good electrical contact with the soil. Vegetation, such as grass should be moved out of the way. Grass or other items will add resistance and result in inaccurate readings. M. C. Miller reference electrodes are designed to be durable, but over time, the ceramic plug assembly will become contaminated by foreign materials and become worn or cracked. At this point, the replacement of the ceramic plug assembly is highly recommended. If the copper sulfate solution within the electrode becomes cloudy white, reverse osmosis has occurred and rejuvenation is recommended.

Submerging Electrodes: When using a reference electrode completely submerged in water, the electrode tube should be kept completely filled with copper sulfate solution or gel. This will limit the possibility of outside water being forced into the electrode through the ceramic plug assembly. Even when the tube is completely filled, some reverse osmosis will occur. Submerging the electrode in areas where the water is highly contaminated, such as that found in manholes, lift stations or in seawater, the copper sulfate solution should be changed more frequently. The solution should be changed every other day under such conditions. You will be able to tell how contaminated your electrode has become by testing its potential against a “standard” electrode.

Note: When using gel or antifreeze solution with an RE series portable electrode, there will be a 12mV shift in the potential. This should be noted when interpreting the resulting readings.

Tel: 772-794-9448 ~ Fax: 772-589-9072
sales@mcmiller.com ~ www.mcmiller.com