



Reference Cell Contamination

A study into the effects that commonly found soil contaminants have on Cu/CuSO₄ reference cells, the variances include, temperature, pH, salinity, chloride levels, and moisture. The aim of the investigation is to allow the user to successfully interpret results from reference cells in known variable, or contaminated ground and, still have confidence to use this data to manage a Cathodic Protection System. The report will also detail typical points as to when reference cells should be considered unusable.





Contents

- Cell Technologies & Build Styles.
- Effects of External Contamination & Variances.
- Advice on Use.
- The Ultimate Reference Cell, what do we need for the future.





Cell Technologies

- All have copper element.
- All have copper sulphate media.
 - Gel
 - Plaster
 - Cement
- All have porous outer barrier.
 - Ceramic
 - Terracotta
 - Vyon





Cell Technologies

Weaknesses:

Media can become easily contaminated by chlorides.

Soil temperature, salinity & pH can cause a variance in readings.

Modern design cells have less CuSO_4 than traditional terracotta pot.

High moisture environments or running water significantly reduce life.





Why Do Cells Fail / Show Errors

Cell or Cable is Damaged During Installation

No Contact Between Cell and Backfill or Ground

Media becomes depleted

Media becomes contaminated

Environmental Factors

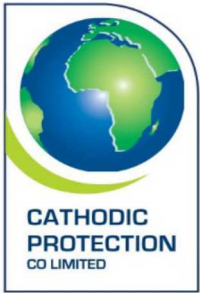
Salinity of ground – Up to 10% variance

Temperature variations – Up to 15% variance

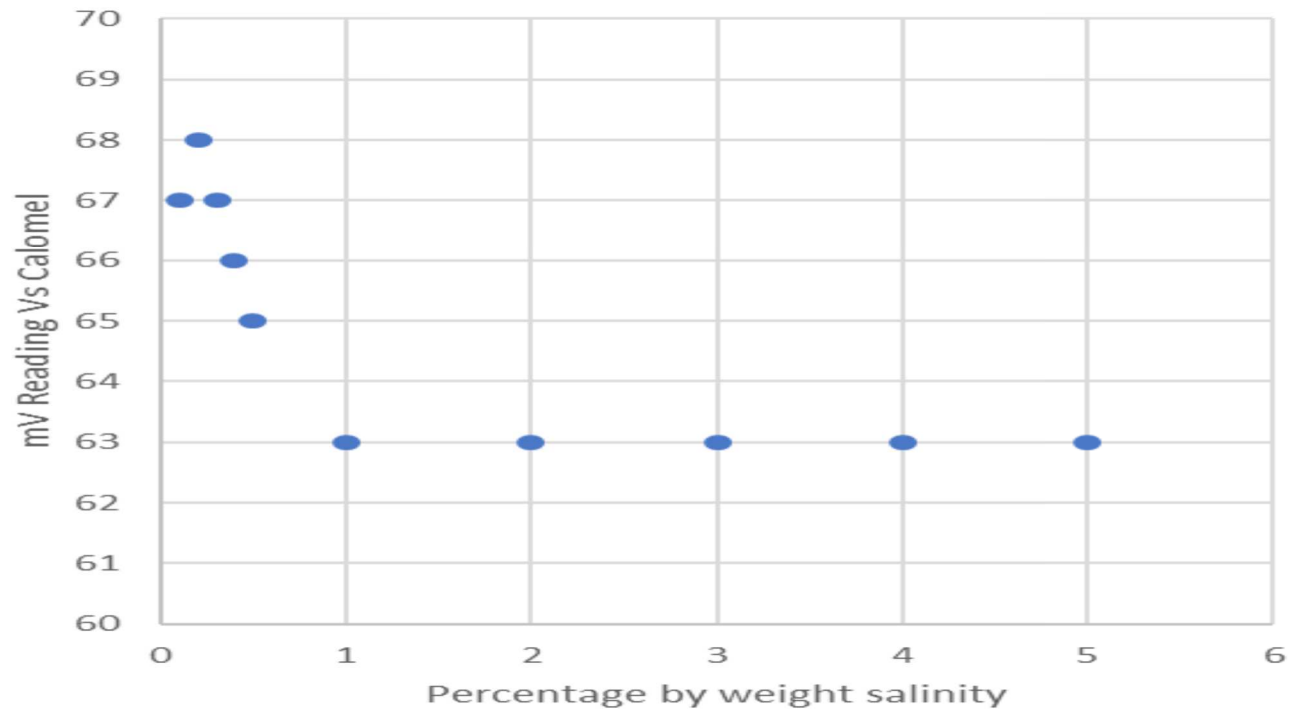
Chloride Levels – Up to 200% variance

Sunlight Levels – Up to 20%





Effect of Salinity Variations





Effect of Sunlight Variations

- Copper salts are photo-sensitive so light has an effect on the reference potential.
 - Summers day -52 mV vs a element in total darkness.
 - In open shade, 42mV vs an element in total darkness.
 - In fluorescent light, 50mV vs and element in total darkness.

Over a period of time the element becomes de-sensitized and a maximum shift of ~10mV was witnessed.





Effect of pH Variations

Increasingly acidic ground conditions will change the chemistry of the media inside a cell, converting copper sulphate into copper hydroxide and copper oxide, this in turn will change the reaction of a copper sulphate reference cell.

An increase in acidity causes a negative change in potential Vs a CSE, from pH 7 to pH 4 approx. 10mV variation between a portable CuSO₄ cell and a CSE

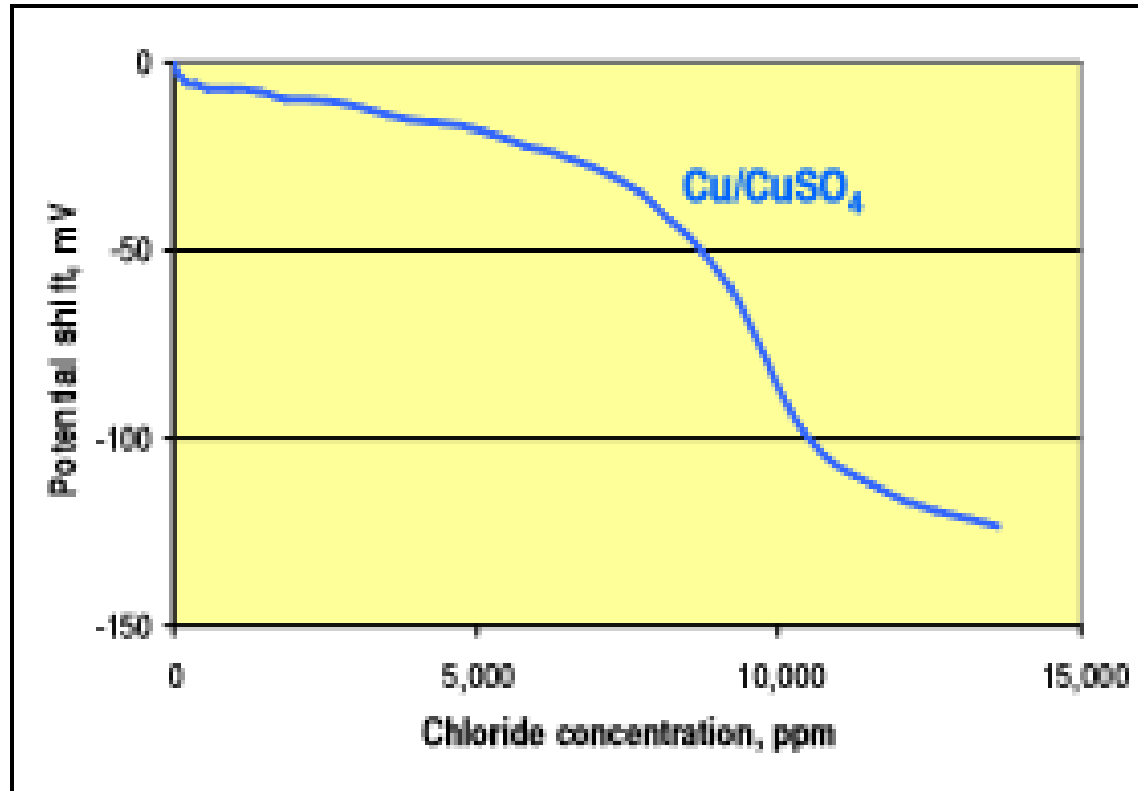
An increase in alkalinity causes a positive change in potential Vs a CSE, from pH 7 to pH 10 approx. 15mV variation between a portable CuSO₄ cell and a CSE

This is short term and proved to be reversible, longer term extremes in either will destroy the chemistry of the cell.



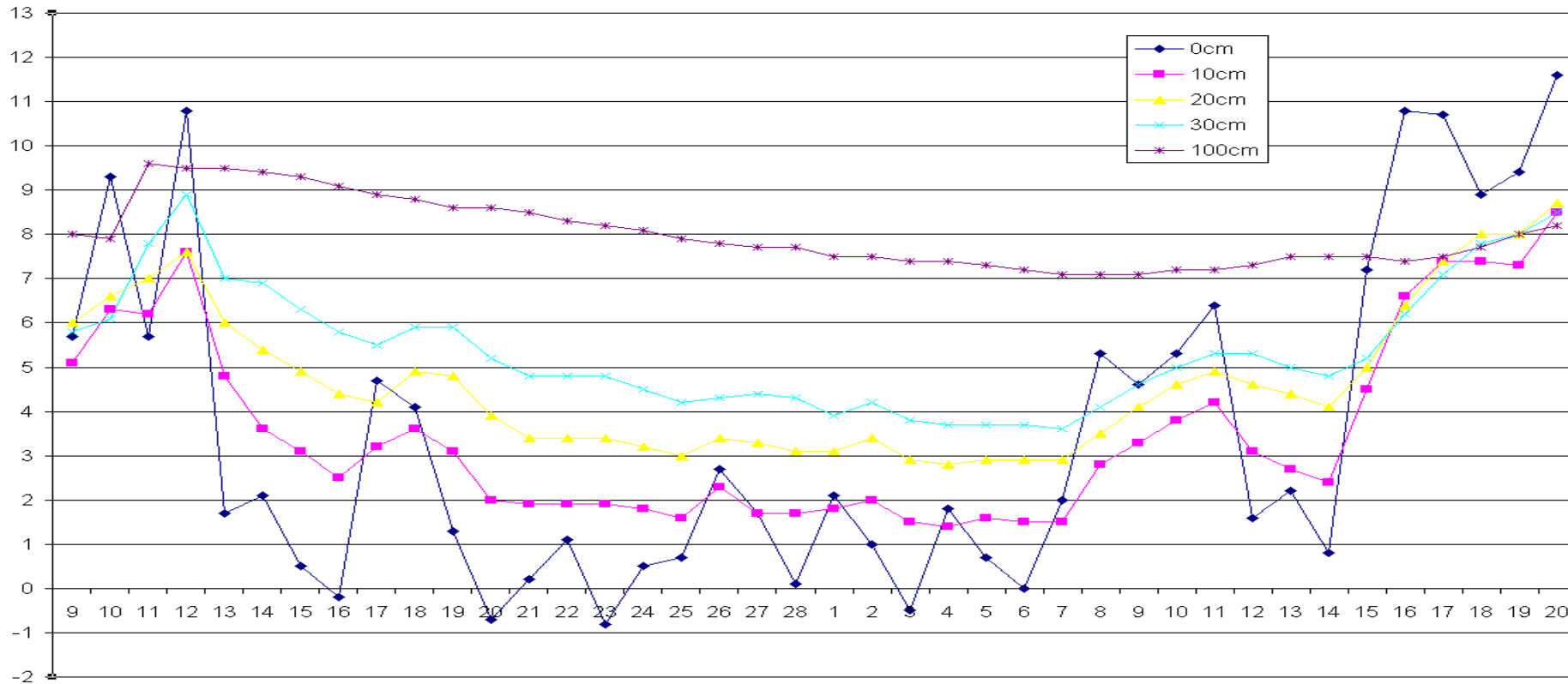


Effect of Chlorides





Ground Vs Air Temperature



February – March
0.5 mV/°F or 0.9 mV/°C - Variation





Advice on Use

- Don't specify cells based on their physical characteristics.
- Know your soil chemistry / environment.
- Know your site history.
- Know site environmental specifics.
- Ensure good ground contact.
- Take multiple readings after installation in the first few days.
- Watering the hole is useful but could provide false assurance on the installation.
- Take care that you measurement equipment is sufficient.





The Ultimate Reference Cell

- In a world that is moving more and more to remote monitoring can we rely on a technology that we all accept is inaccurate or in reality we struggle to manage it's accuracy
- Why aren't combined cells with a 2nd method of verification being more widely accepted?
- Is CuSO₄ the best chemistry for a pipeline cell, should we consider Zinc, Manganese, Palladium etc.

