



# USER GUIDE

CALTRODE +400 & CALTRODE +400T

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Models: CALTRODE +400 & CALTRODE +400T

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## WARRANTY AND LIABILITY

Caltrode Reference Electrodes are covered by a 30 days limited warranty. This warranty does not include replacement of a mishandled product due to misuse or accident. This warranty does not include repairs as reference electrodes cannot be repaired.

Caltrode Reference Electrodes are consumable products and will refuse to remedy the goods if concludes that the goods have not be used with due care or have been mishandled or handled not in compliance with this User Guide provided on our website [www.caltrode.com](http://www.caltrode.com).

In no event will Caltrode be liable for defects in the goods supplied if they are caused by normal wear and tear. Any warranty will be void if operating or maintenance instructions are not observed or if modifications are made to the product.

The Customer shall be obliged to notify defects in writing by email to our Customer Service at [support@caltrode.com](mailto:support@caltrode.com) providing as much detail of the defect as possible including pictures.

Goods claimed to be defective should be returned for examination in their original or equivalent packaging. Caltrode should remedy defects if the warranty claim is valid and within the warranty period and will only bear the costs necessary to remedy the defect. Caltrode may refuse to remedy defects if the customer has not complied with the request to return the goods claimed to be defective

In no event will Caltrode be liable for any direct, indirect, consequential or incidental damages, including but not limited to incidental damages, lost profits or any claim by any third party, arising out of the use, the result of use, or the inability to use this product.

Specifications of goods, especially pictures, drawings, data about weight, measure and capacity contained in offers and brochures are to be considered as average data. Such specifications and data shall in no way constitute a quality warranty but merely a description or labeling of the goods.

Unless limits for variations have expressly been agreed in the order confirmation, such variations shall be admissible that are customary within the trade.

Caltrode will replace products that have been damaged during shipment provided that the customer sends a written notification via email to [support@caltrode.com](mailto:support@caltrode.com) within 24 hrs. of receiving the product, the product has not been used and the product is correctly packed and returned to Caltrode within 15 days of the claim.

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**CALTRODE**  
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## PRODUCT

CALTRODE Ag/AgCl, Silver/Silver Chloride Reference Electrode for Electrochemical Measurements at Ultra High Temperatures

## FUNCTIONS AND CAPABILITIES

### *Temperature Range*

This reference electrode is suitable for electrochemical measurements (such as Corrosion potential monitoring, Potentiodynamic polarizations, Potentiostatic polarizations, Galvanostatic polarizations, Electrochemical impedance spectroscopy (EIS), etc.) in a temperature range of 20°C to 400°C. In this temperature range (20°C to 400°C), the reference electrode can be directly immersed in the test electrolyte providing that the test electrolyte has an ionic conductivity sufficient to conduct the electrochemical measurements.

This reference electrode can also do electrochemical measurements at temperatures lower than 20°C, (20°C to -10°C), providing that: 1) the reference electrode is immersed in saturated aqueous solution of potassium chloride (KCl) and connected to the test electrolyte through a salt bridge (a half-cell for the reference electrode), 2) the test electrolyte has an ionic conductivity sufficient to conduct the electrochemical measurements.

**\*\*Caution:** Do not subject this reference electrode to temperatures higher than 420°C. This will result in melting the internal components and will totally destroy the reference electrode.

### *Testing Medium*

The reference electrodes can be directly immersed in the test electrolyte providing that the test electrolyte has an ionic conductivity sufficient to conduct the electrochemical measurements.

The testing medium can be aqueous such as saline solution or non-aqueous such as molten salts. If the reference electrode was used in an **aqueous medium**, it **should not** be used for any **non-aqueous medium**. Additionally, if the reference electrode was used in a **non-aqueous medium**, it **should not** be used for any **aqueous medium**.

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## USE INSTRUCTIONS

### *Position and Setup*

It is recommended that the electrode position in the testing medium is vertical between 45 and 90 degrees during testing.

### *Electrode Immersion*

For reliable testing, it is required that the electrode tip (~2 cm) is completely immersed in the test electrolyte. The minimum recommended length of the electrode in the test electrolyte is about 5 cm including the electrode tip. It is also recommended that the electrode to be immersed in the test electrolyte for about 45 minutes before starting the testing for establishing the electrochemical connection between the electrode and the sample under test.

### *Electrochemical Connection*

The connection can be verified by monitoring the open circuit potential (OCP) of the metal sample under testing. This 45-minute time is just a guidance and not always a fixed time. This means that the electrochemical connection between the electrode and the sample under test can be established at a shorter or longer time depending on the nature of the test electrolyte and test conditions. The most important point is to verify the connection of the electrode before starting the measurements.

## SAFETY GUIDELINES AND PRECAUTIONS

### *Electrode Tip*

The most important part of this electrode is its tip. It can be easily broken if mishandled. Consequently, utmost care should be taken when handling this electrode to avoid hitting any solid surfaces.

### *Avoid Thermal Shock*

On testing at high temperatures, the electrode should be immersed in the testing electrolyte at lower temperatures then the temperature can be raised gradually.

Sudden immersion from room temperature to high temperature will result in thermal shock for the electrode body and it will break under this condition. For example, if the electrode is to be used for tests at 400°C in a molten salt which melts at 300°C, the electrode should be conditioned at about 150°C for about 30 minutes (outside the molten salt), then can be immersed in that molten salt at 300°C then stays there while the temperature is raised gradually to 400°C. The same care should be taken when taking the electrode out after testing because the electrode will also break under sudden cooling conditions.

It is required not to leave the electrode in the testing electrolyte if that electrolyte freezes at room temperature. If the electrode is left in a molten salt until it freezes, the electrode will break on re-melting the molten salt again.

## STORAGE AND MAINTENANCE

Electrode storage after a non-permanent use depends on the type of the testing medium.

*If used in an aqueous medium:*

In this case, the electrode should be taken out of the testing solution and lightly washed with deionized water (DI water) to remove all leftover parts of the testing solution. After that, it should be immersed in saturated KCl solution and stored in a safe and clean area at room temperature to be ready for the next use.

*If used in a non-aqueous medium (such as a Molten Salt):*

In this case, the electrode should be taken out of the testing medium and lightly cleaned with a lab wiper which is lightly wetted with DI water to remove all salt residuals from the electrode body. In this case, no immersion or soaking in water at all is needed, only very light cleaning with a lab wipe. The electrode should be kept in a safe and clean (dust free) area at a vertical position at room temperature to be ready for the next use.

## TROUBLESHOOTING

If significant noise in the measurement curve is seen during testing, it can be because of one or more of the following:

- Bad wiring connections between the electrochemical cell and the measuring instrument. All wiring connections should be properly verified before starting testing.
- The electrode tip is not properly immersed in the test electrolyte.
- The electrode tip is broken, if this is the case the test should be started from the beginning with fresh test electrolyte and a new electrode must be used. In this case the electrochemical cell must be cleaned well before using the new materials.
- The metal sample under testing is not properly immersed in the test electrolyte