

Electrochemical tools

Water-chemistry and electrochemical sensors operating in high-temperature high-pressure environments expand the capabilities of corrosion scientists and chemists. The corrosion phenomena and chemical processes can be studied in the relevant environment, which makes tests valid and reproducible.

Ag/AgCl reference electrode

The external pressure balanced Ag/AgCl reference electrode is suitable for most aqueous applications for temperatures up to 300 °C. The internal Ag/AgCl electrode rod is immersed in KCl solution, which is separated from the environment using a porous ceramic frit. The KCl concentration is chosen according to the operation environment: 0.01 M KCl is used in clean-water applications, whereas saturated KCl is used in concentrated solutions, mostly in a H₂S salt-water environment.

The Ag/AgCl reference electrode lifetime depends on the operating environment and parameters. A high

operating temperature and pressure as well as frequent temperature and pressure transients shorten the lifetime of the electrode. A typical damaging mechanism is the dilution of the internal KCl solution and contamination of the Ag/AgCl rod. Fortunately, the electrode is easy to open and service.

Ag/AgCl reference electrodes are manufactured with various dimensions and fittings. Existing ports in your autoclave can be used to add a Cormet electrode. They can be connected to high input impedance amplifiers or potentiostats.

Pd/H₂ reference electrode

A Pd/H₂ reference electrode acts as a reversible hydrogen electrode (RHE). The electrode follows the H₂/H⁺ equilibrium line as long as the environment is non-oxidising and the pH is known. The palladium electrode is a solid-state electrode with a very easy maintenance procedure. The electrode is manufactured in two versions: 300 °C and 360 °C temperature versions.

High temperature pH sensor

The operation of the pH sensor is based on a zirconia membrane and an Ni/NiO or Cu/Cu₂O electrode that measures the oxygen partial pressure of the testing solution. The pH is calculated using the Ag/AgCl reference electrode signal and temperature as additional input signals. The pH sensor can also be used as a reference electrode in an environment with a known pH. The operating temperature of the pH sensor is from about 180 °C to 360 °C, but the maximum operating temperature of the Ag/AgCl reference electrode limits the pH measurement to a temperature of 300 °C.

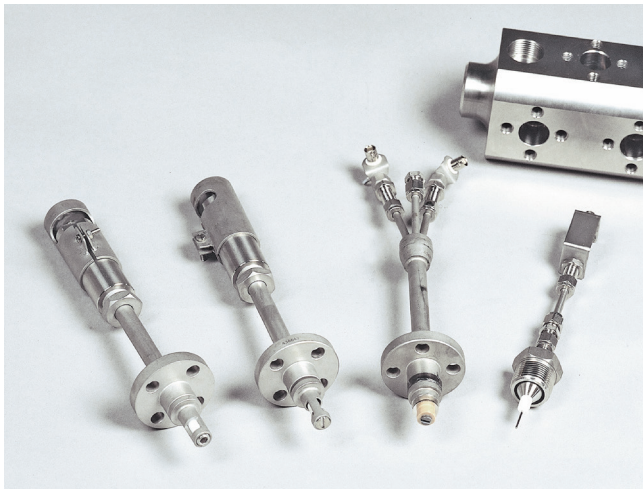
Conductivity sensor

High-temperature conductivity measurement is a powerful on-line tool for clean-water environment impurity monitoring. Because the sampling lines and cooling are not needed, all the dissolved species remain in the solution and can be monitored. The conductivity measurement is based on a four-plate method, which is immune to sensor contamination.



Corrosion probe and redox electrode

The corrosion probe is a \varnothing 2 mm rod installed in Cormet's standard specimen holder. Redox measurement is performed using a platinum rod or plate attached to the same specimen holder.



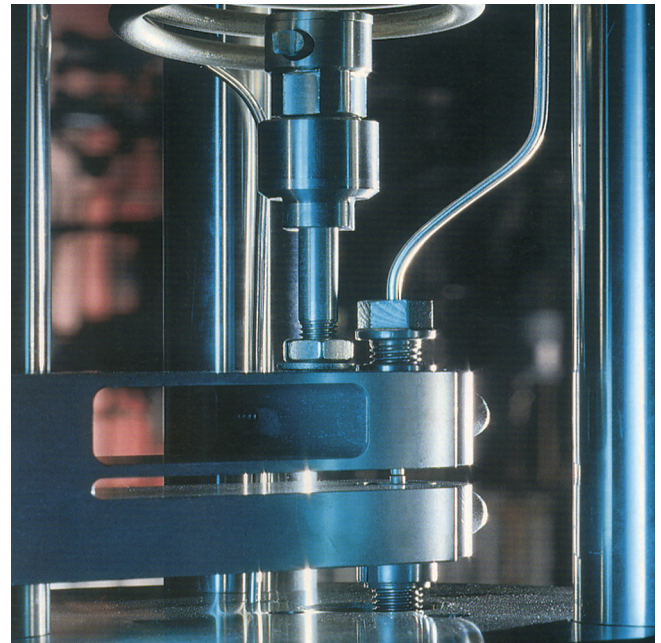
Trendchem

Trendchem is a water-chemistry monitoring tool for on-line high-temperature high-pressure water-chemistry monitoring purposes in the laboratory and field. Typically, a Trendchem product consists of Cormet's various high-temperature high-pressure sensors (e.g. reference, pH, redox, conductivity, corrosion probes, etc.), a flow-through cell, temperature measurement, data-acquisition unit and PC for data display and recording.



CER technique

The Contact Electric Resistance (CER) technique is used for studying the electronic properties of surface films. Technically, it measures the DC electronic conductivity of surface films.

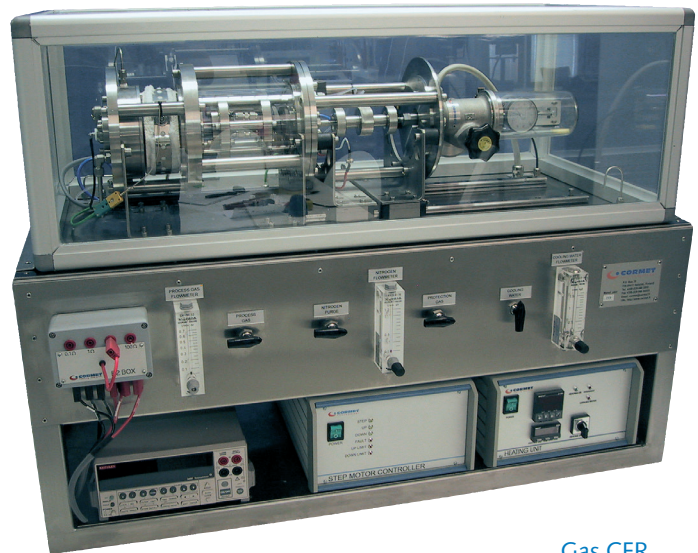


The CER technique can be used in a vacuum, gases, liquid water, supercritical water and high-temperature gas.

A typical CER test is a surface-film resistance measurement that gives information on surface-film stability, film growth or destruction kinetics and film semiconductive properties. Contact Electric Impedance (CEI), as a combination of CER and Electrochemical Impedance Spectroscopy (EIS), is an on-line tool for solid-state electrochemical studies of surface films. The CER instrument can also be used as a testing rig for electrochemical tests in poorly conducting solutions (Thin Layer ElectroChemistry).

Hydrogen permeation method

Interaction between molecular hydrogen and the pipeline tube material in marine and oil & gas industry applications is interesting to many scientists. Cormet manufactures Devanathan cells for hydrogen-permeation studies for high-pressure applications. The operating temperature can be controlled from subzero temperatures up to 80 °C. Stress can be applied to the permeation specimen using a PC-controlled loading device.



Gas CER

High Temperature & High Pressure electrodes in a flow-through cell

Electrode	pH sensor	Reference electrodes		Conductivity
Operating principle	Ni/NiO in zirconia membrane	Ag/AgCl rod immersed in KCl	Pd charged with hydrogen	Four-point measurement
Temperature range	180 °C – 360 °C	Up to 300 °C	Up to 360 °C	Up to 300 °C
Average lifetime	> 1 year	2 – 12 months	> 1 year	> 1 year
Construction material	Stainless steel Alloy / Hastelloy C-276 Titanium			



Cormet manufactures material- and corrosion-testing instruments for the laboratory and field environments. We specialise in high-temperature high-pressure applications. Cormet delivers instruments to university and industrial laboratories including the power-generation, chemical, transportation and oil & gas industries. Nearly all the products are tailored according to customers' needs.