MPM Technologies, Inc.

ECP Probes

INTRODUCTION

Electrochemical Corrosion Potential (ECP) measurements are made in the nuclear industry to determine whether stress corrosion crack (SCC) propagation is likely to occur. In particular, if the ECP level decreases below about – 230 mV_{SHE}, SCC crack growth rates are not significant. Above – 230 mV_{SHE}, the crack growth rate increases as the ECP increases. In fact, quantitative correlations between ECP and crack growth can be established. In normal water chemistry (NWC), ECP measurements can be used to monitor water chemistry changes which lead to unacceptable crack growth rates. In plants which are using noble metal coatings and hydrogen injection, ECP measurements can be used to verify that the hydrogen water chemistry (HWC) mitigation is effective. Verification of the benefits of HWC is necessary for plants with cracked components (ex., shroud cracking) to establish meaningful inspection schedules.

SYSTEM OPERATION

ECP measurements require a reference electrode and a working electrode both of which are exposed to the water chemistry of interest. The measurements should be made in the primary system near the component or piping of interest so that a representative water chemistry is measured. The MPM ECP probes can be placed in welding neck flanges in primary system piping, in vessel lower head drain lines, or can be connected to the water cleanup system using stainless steel tubing. A typical frame which has been designed for connection to the water cleanup system is shown in Figure 1. The frame is a seismically qualified structure which contains tubing and flow velocity control valves. The frame has also been designed to accommodate a small pressure vessel which houses a crack growth monitor. The crack growth monitor technology is currently being developed and will be available for plant applications in the near future. Since ECP depends on flow rate at low oxygen concentrations, the flow rate should be adjusted to match the surface flow velocity of the component of interest. The system shown in Figure 1 contains tubing which has been sized to provide a desired nominal flow velocity. The flow control valves can be adjusted during plant operation to give a range of flow velocities which cover several components of interest.

ECP data are acquired continuously during plant operation. The MPM data acquisition computer is contained in a protected equipment rack as shown in Figure 2. The cabinet is equipped with a slide out keyboard and monitor so that the ECP data can be reviewed and analyzed in the plant. The system also has a modem and network connection so that the data can be transferred to computer terminals outside the plant. MPM offers a monitoring service which includes periodic monitoring and reporting on a weekly or monthly basis. An alternative approach is for the utility

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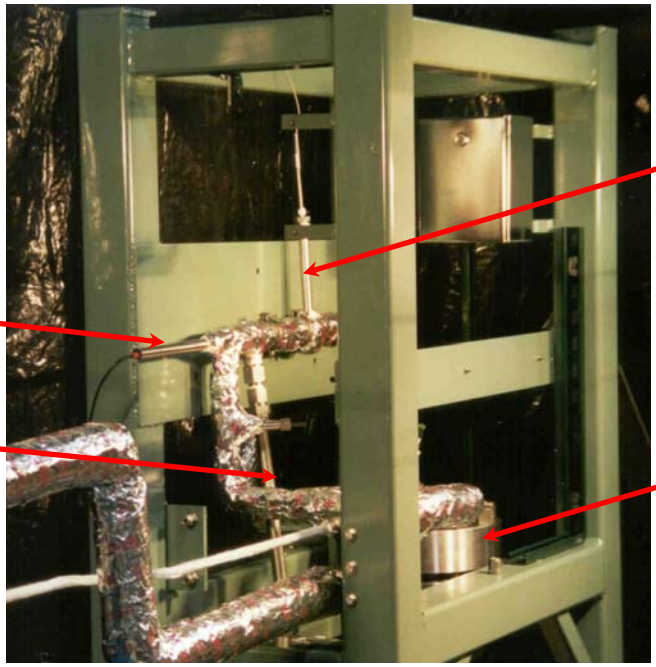
to take over operation of the system. In this case, MPM offers an on-site training course to enable the utility to operate the acquisition system.

ECP is a measure of the oxidation/reduction (REDOX) reactions which occur on the metal surface. These reactions depend directly on the dissolved oxygen, hydrogen, and hydrogen peroxide concentration of the water. Laboratory data for an experiment where the oxygen concentration of the water was decreased is shown in Figure 3. As the oxygen concentration is reduced below about 2 ppm, the ECP begins to decrease. Below about 1 ppm, flow velocity effects become strong. The ECP continues to decrease monotonically and, as shown in Figure 3, the ECP drops below – 230 mV_{SHE} at an oxygen concentration of about 25 ppb. As mentioned earlier, this is the threshold where SCC crack growth can be considered to be negligible.



Seismically Qualified Frame Showing ECP Probe, Sensitized 304SS Working Electrode, and Pressure Vessel Containing SCC Crack Growth Rate Monitor

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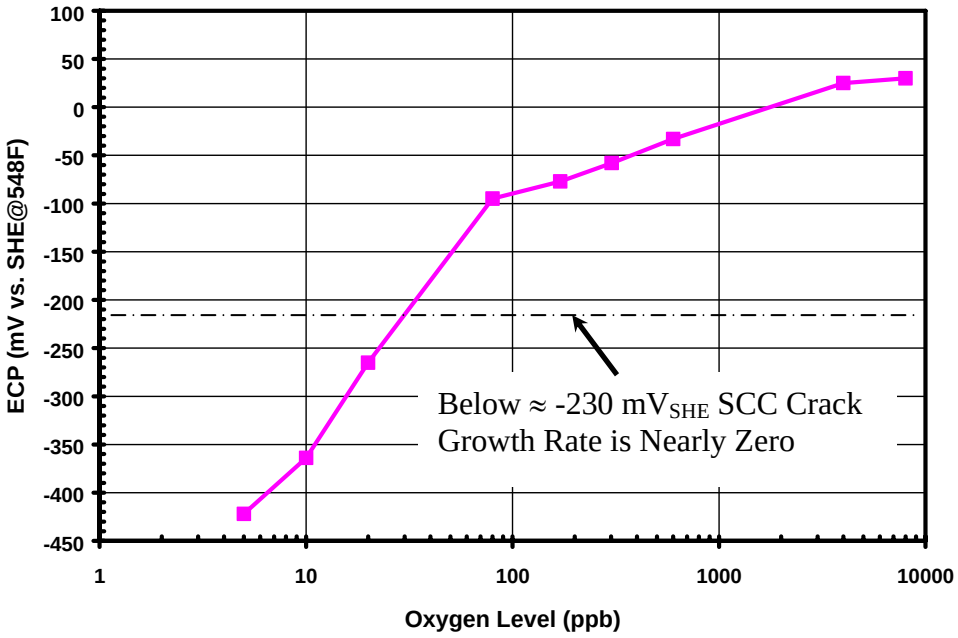

Typical ECP Data Showing Oxygen Level Dependency. Measurements were Made at 548 °F in Simulated BWR Water (Conductivity of 0.3 μS/cm) at a Flow Velocity of ≈ 0.065 ft/sec

FOR MORE INFORMATION

If you would like a price quotation or additional information concerning MPM's services or products, please contact us at the below listed address:

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