TCR Advanced Engineering P. Ltd

Experts in Metallography, Failure Investigation and RLA

Metallurgy for Industries

Power | Petrochemical | Fertilizer | Chemical | Refinery | Engineering | Automobile

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Linear Polarization Resistance (LPR)

Technique for monitoring corrosion rate

When any metal specimen is exposed to a corrosive medium, both reduction and oxidation processes occur on its surface. Typically, the specimen oxidizes (corrodes) and the medium (solvent) is reduced. In acidic media, hydrogen ions are reduced. The metal functions as both anode and cathode and both anodic and cathodic currents flow within the metal. Any corrosion processes that occur are usually the result of anodic currents.

During service, when metal is in contact with a conducive environment (such as cooling water) its surface becomes active with electrolytic potential difference, termed as the corrosion potential, E_{CORR}. A specimen at E_{CORR} has both anodic and cathodic currents present at sub-surface. However, these currents are exactly equal in magnitude so there is no net current which can be measured. Thus, at E_{CORR} it is the potential at which the rate of oxidation is exactly equal to the rate of reduction and result is metal wastage in terms of corrosion which becomes detectable only after prolonged exposure of the metal.

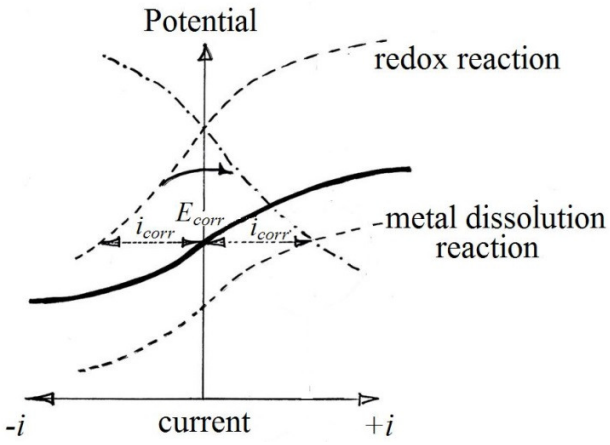
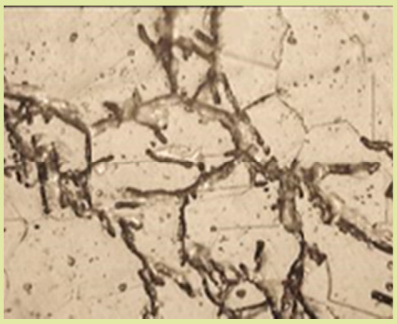


Figure shows current flow (anodic and cathodic) resulting in metal dissolution at E_{CORR}

Microstructure of the Month



Magnification: *400X*

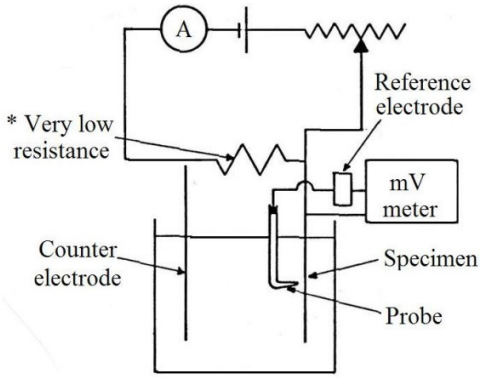
MOC: *ASTM A240 TP 316L*

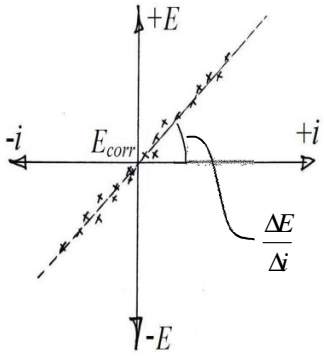
Etchant: 10% Ammonium persulphate

Observation: Microstructure shows fine-grained worked austenitic structure with twins. No carbide precipitation is observed along the grain boundaries. Presence of heavy trans-granular SCC crack is observed.

Cause: The onset of TGSCC seems to be from Chloride attack on account of chloride found in EDS analysis.

Special technique can be adopted to detect the I_{CORR} by polarizing the corroding surface and applying slightly positive higher potential than E_{CORR} to form directional (anodic) current. The current from each half reaction depends on the electrochemical potential of the metal and it balances with applied positive current. This counteracts the initial perturbation of the system and facilitates measurement of the instantaneous internal current. The Figure below shows schematic of measurement of external current.





The ratio of potential to current (slope) would provide measure of electrical resistance; which remains linear to the applied anodic and cathodic potentials. Portable instrumentation using a potential-step method +/- 10 mV to the E_{CORR} provides Rp (polarization resistance) and hence facilitates instantaneous measurement of corrosion of metal in given system.

Generally, in cooling water system COC (cycle of concentration) is an essential tool to balance the cost of water treatment. The greater quantity of dosing chemical makes the cooling water treatment programme costly and also results in fouling of the heat exchanger tubes. It may also result in higher blow-down rates and lower COC. Avoidance of fouling requires dosing of anti-fouling chemicals. Any biocide treatment such as chlorination would make the system conducive and to balance its effect, inhibitor dosing becomes necessary. All these result in possible under or over dosing of chemicals resulting in loss of asset by corrosion.

TCR has developed an instrument–that can provide real time corrosion rate of metal–which becomes useful-essentially in cooling water system where the use of dosing chemicals can be moderated based on instantaneous measure of corrosion by LPR method. The instrument has capability of high tech interface with SMS alerts and graphical presentation of corrosion rates on daily/weekly/monthly basis. In combination with the dosing pattern and LPR measurements, most effective asset integrity programme can be achieved that would result in financial benefits in terms of optimum use of chemicals as well as reliable and longer service of the static equipment such as piping and heat exchangers – requiring minimal fouling and hence lower cleaning frequency.

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