High Pressure, High Temperature Rotating Cylinder Electrode for Electrochemical Corrosion Studies in Flowing Systems

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A wider adoption of electrochemical methods for corrosion research and testing led to increased interest in working electrode designs that allow simulating flowing conditions for real applications. However, up until recently, such electrodes were limited to near-ambient pressures and a normal liquid water temperature range. For years there has been an interest to perform electrochemical studies at the conditions that occur in real systems like pipelines, plants, i.e. wherever the corrosive liquid flows at elevated pressures and temperatures.

A novel rotating cylinder working electrode (RCE) has been developed by Parr Instrument Company to address industry demand to study corrosion processes in flowing systems at high pressures and temperatures using electrochemical methods. This novel RCE design is based on the well-established Parr high-pressure reactor magnetic drive and is incorporated into a classical Parr reactor. Bundled with high pressure, high temperature Ag/AgCl reference and platinum counter electrodes this Parr RCE system allows studying flowing systems at pressures up to 200 bar and temperatures up to 200 °C. A standard configuration accommodates 0.5 in (~ 13 mm) OD coupons with 5 cm^2 surface, at rotational speeds up to 2000 rpm. The coupon is located between PEEK components and is attached to the isolated rotating shaft. Rotating electrode is integrated into a standard reactor with 1 L volume, with all wetted components made of Alloy C276. This system was developed with running both DC and AC electrochemical corrosion methods in mind, primarily linear polarization resistance (LPR) and electrochemical impedance spectroscopy (EIS).

For demonstration purposes a series of LPR and EIS experiments were performed. Corrosion rates of metal coupons in NaCl solutions were studied at various pressures and temperatures, and the dependence of corrosion rate on the rotational speed was estimated. The obtained results show a typical performance of the developed HPHT RCE system.