SOLUTION CONDUCTIVITY DEPENDENT CRACK SIZE EFFECT IN STRESS CORROSION CRACKING AND CORROSION FATIGUE

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The chemical crack size effect on environmentally assisted crack growth was first demonstrated experimentally by Gangloff [1] and supported on a more robust theoretical framework by Turnbull et al. [2,3]. It is probably better dubbed the electrochemical crack size effect since the potential drop in the crack was a critical factor in determining the solution chemistry and the sensitivity to crack size. In recent experimental studies [4] we have focused on the growth rate of small and long stress corrosion and corrosion fatigue cracks in 12Cr steam turbine blade steels in low conductivity water containing 35 ppm Cl- (simulating upset steam condensate chemistry). A large effect of crack size on growth rate was observed for the same mechanical driving force. However, the crack-size effect disappeared in lower conductivity solution, 300 ppb Cl- and 300 ppb SO42- (corresponding to normal steam condensate chemistry). Furthermore, corrosion fatigue long crack growth rates were the same in aerated and in deaerated solutions for the two environments but stress corrosion cracks arrested in deaerated solution. An explanation for these varied results will be presented based on the concept of the solution conductivity dependent crack size effect and its impact on potential drop and the crack-tip potential. To underpin this conceptual idea and to explore further the scale of this effect for varied crack size and solution conductivity combinations, modelling of crack electrochemistry is being undertaken and the preliminary results will be discussed.

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3.   A. Turnbull and D.H. Ferriss, "Mathematical modelling of the electrochemistry in corrosion fatigue cracks in steel corroding in sea water". Corrosion Science, 27 (12), 1323-1350, 1987.
4.   S. Zhou, M. Lukaszewicz and A. Turnbull, Small and short crack growth and the solution-conductivity dependent electrochemical crack size effect, Corros. Sci., 97 (2015) 25-37.