Our investigations into new closed loop corrosion inhibitors revealed that the main driver for corrosion in closed loops is chloride. Ideally, operators would fill their loops with demineralized water; however, the reality is that more closed loop operators are filling their loops with higher chloride waters as water scarcity and water recycle become more prevalent. As such, a corrosion inhibitor that can tolerate the higher chloride content of today's loops is desirable.

By using LPR probes installed in the recirculating loop of the pilot closed loop, it was possible to evaluate the impact of different chloride/sulfate concentrations on incumbent corrosion inhibitors (nitrite and molybdate) as well as AC/DC. The corrosion data from these chloride tolerance experiments are shown in Figure 3. The first water investigated was W2 (150 ppm chloride, 200 ppm sulfate); in Figure 3, the data to the left of the dashed line was collected using W2.

As expected, based on the jar testing and pilot closed loop testing reported earlier, AC/DC showed excellent corrosion inhibition results using W2. The nitrite-based corrosion inhibitor also displayed excellent corrosion inhibition using W2. The molybdate-based incumbent corrosion inhibitor, however, displayed very poor corrosion inhibition, exhibiting unacceptable corrosion rates >0.025 mm/y (1 mpy). The chloride and sulfate content of the loop was then increased to 500 ppm chloride and 667 ppm sulfate (right side of dashed line). The molybdate-based treatment continued to display very poor performance with corrosion rates exceeding 1.27 mm/y (50 mpy), whereas the nitrite-based treatment continued to exhibit excellent corrosion inhibition in the higher chloride water. The AC/DC program did display a slight increase in corrosion rate; however, corrosion rates remained <0.013 mm/y (0.5 mpy) even in highly corrosive water with a Cl^-/SO_4^{2-} concentration of 500 ppm/667 ppm, respectively. It should be noted that digital recording of the corrosion rate of AC/DC was lost after 1OCT; however, manual data recording showed the final corrosion rate by LPR on 3OCT was 0.5 mpy.

Conclusions

Closed cooling loops are a critical component of most industrial plants. The incumbent closed loop corrosion inhibitors are based on toxic components such as nitrite, molybdate, and borate that are coming under more SH&E scrutiny. New closed loop corrosion inhibitors are necessary that maintain corrosion inhibition performance while not containing toxic components. A novel AC/DC inhibitor was developed to mitigate corrosion in mild steel closed loops. AC/DC was formulated with azoles for copper alloy corrosion control. AC/DC does not contain nitrite, heavy metal, boron, phosphorus, or filming amine. Data presented in this report show that AC/DC offers superior corrosion inhibition performance when compared to incumbent closed loop corrosion inhibitors based on molybdate and filming amines.

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