Announcing the Final Examination of Samantha Jeffery for the degree of Master of Science

Title: In-Plant and Distribution System Corrosion Control for Reverse Osmosis, Nanofiltration, and Anion Exchange Process Blends

The integration of advanced technologies into existing water treatment facilities (WTFs) can improve and enhance water quality; however, these same modifications or improvements may adversely affect finished water provided to the consumer by public water systems (PWSs) that embrace these advanced technologies. Process modification or improvements may unintentionally impact compliance with the provisions of the United States Environmental Protection Agency’s (USEPA’s) Safe Drinking Water Act (SDWA). This is especially true with respect to corrosion control, since minor changes in water quality can affect metal release. Changes in metal release can have a direct impact on a water purveyor's compliance with the SDWA’s Lead and Copper Rule (LCR).

In 2010, the Town of Jupiter (Town) decommissioned its ageing lime softening (LS) plant and integrated a nanofiltration (NF) plant into their WTF. This operational change subsequently decreased the pH in the reverse osmosis (RO) clearwell, where RO permeate and anion exchange (AX) effluent blend. The AX-RO mixture is transferred to the new NF primary clearwell where the AX-RO water blends with NF permeate. The Town requested that the University of Central Florida (UCF) conduct research evaluating how to mitigate negative impacts that may result from changing water quality, should the Town place its AX into ready-reserve.

The research presented in this document was focused on the evaluation of corrosion control alternatives for the Town, and was segmented into two major components:

1. The first component of the research studied internal corrosion within the RO clearwell and appurtenances of the Town’s WTF. Research related to WTF in-plant corrosion control focused on blending NF permeate with RO permeate and pH-adjusting the resulting mixture to reduce corrosion in the RO clearwell.

2. The second component was implemented with respect to the Town’s potable water distribution system. The distribution system corrosion control research evaluated various phosphate-based corrosion inhibitors to determine their effectiveness in reducing mild steel, lead and copper release in order to maintain the Town's continual compliance with the LCR.

The primary objective of the in-plant corrosion control research was to determine the appropriate ratio of RO to NF permeate and the pH necessary to reduce corrosion in the RO clearwell. In this research, the Langelier Saturation Index (LSI) was the corrosion index used to evaluate the stability of RO:NF blends. Results indicated that a pH-adjusted blend consisting of 70% RO and 30% NF permeate at 8.8-8.9 pH units would produce an LSI of +0.1, theoretically protecting the RO clearwell from corrosion.

The primary objective of the distribution system corrosion control component of the research was to identify a corrosion control inhibitor that would further reduce lead and copper metal release observed in the Town's distribution system to below their respective action limits (ALs) as defined in the LCR. Six alternative inhibitors composed of various orthophosphate and polyphosphate (ortho:poly) ratios were evaluated sequentially using a corrosion control test apparatus (apparatus). The apparatus was designed to house mild steel, lead and copper coupons used for weight loss analysis, as well as mild steel, lead solder and copper electrodes used for linear polarization analysis. One side of the apparatus, referred to as the “control condition,” was fed potable water that did not contain the corrosion inhibitor, while the other side of the corrosion apparatus, termed the “test condition,” was fed potable water that had been dosed with a corrosion inhibitor. Corrosion rate measurements were taken twice per weekday, and water quality was measured twice per week. Inhibitor evaluations were conducted over a span of 55 to 56 days, varying with each inhibitor. Coupons and electrodes were pre-corroded to simulate existing distribution system conditions. Water flow to the apparatus was controlled with an on/off timer to represent variations in the system and homes. Inhibitor comparisons were made based on their effectiveness at reducing lead and copper release after chemical addition. Inhibitor 1, a 50:50 ortho:poly
blended inhibitor, and Inhibitor 3, an 80:20 ortho:poly blended inhibitor, were most successful in reducing both lead and copper release. Results indicated that Inhibitor 1 reduced the average lead and copper corrosion rates from 0.71 to 0.22 mpy and 4.43 to 1.54 mpy, respectively, after being added to the test side of the corrosion apparatus. Inhibitor 3 reduced the average lead and copper corrosion rates from 0.52 to 0.27 mpy and 6.04 to 2.08 mpy, respectively, after being added to the test side of the corrosion apparatus.

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Approved for distribution by Dr. C. David Cooper, Committee Chair, on September 25, 2013.

The public is welcome to attend.