USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Project ID: 2005MT69B

Title: STUDENT FELLOWSHIP: Towards sustainable materials for drinking water infrastructure

Project Type: Research

Focus Categories: Water Supply, Water Quality, Treatment

Keywords: biofilm, copper, corrosion

Start Date: 03/15/2005

End Date: 06/30/2006

Federal Funds: $1,500

Non-Federal Matching Funds: $0

Congressional District: At Large

Principal Investigators:
Anne Camper

Mohammed Rahman

Abstract

Corrosion in distribution system is a global problem that needs to be investigated to find out a workable solution. Mostly my research is focused on the corrosion of copper. Copper is known for its long lasting and corrosion resistant qualities. Though other materials are gaining popularity still most of the distribution system is made of copper pipes. A survey in 1999 found that 90% of the house hold plumbing is made of copper and only 4% has PVC pipe (Marshutz, 2001). Recently the copper pipe failure rate increased dramatically in some areas of USA. For example there are around 400,000 customers in the Maryland/DC area and 27-50% of customers have 1 pinhole leaks from corrosion. Basic repair or replacement of pipe cost is about $100-2000, replacement of the entire plumbing usually cost $5000-9000 and the resulting water damage could be greater than $25,000.So corrosion incurs lot of financial burden.

Corrosion of copper involves both complex chemical and microbiological process. Most of the research in corrosion investigated the chemical aspect and very few researched is focus on the microbial influenced corrosion (MIC). Water flow in home plumbing system

can be constant to stagnant depending upon the use pattern. Considering the seasonal variation and the cold water lines in refrigerator and hot water lines in heater the water temperature can vary from 0 to above 1000C.The redox potential can be reducing (≈-2.9V) because of the atomic hydrogen near the corroding metal surface to extremely oxidizing (≈+1.5V) because of the presence of disinfectants such as free chlorine, chloramines or chlorine dioxide. So the water inside the pipes has extraordinary complex characteristics. Because of such characteristics of the water microbial species commonly found in pipes are generally more diverse than untreated water. As not much researched is done on the MIC so we don't have good understanding of the microbial process involve in corrosion of the copper pipes in our houses. In my research I am going to investigate the microbial aspect of copper corrosion. This is a joint project with Virginia Tech. Our counter part in Virginia is investigating the Chemical aspect of the corrosion. So after the completion of the project it will give us a better understanding of the chemistry and microbiology of corrosion.

To investigate the MIC in copper the commonly use CDC reactors are modified in such way that the coupon surface and the water volume ratio is equal to the surface volume ratio of a 6' long ¾" diameter copper pipe. The rotation of the stirrer in the reactor is set at 300 rpm to simulate water flow inside the pipe at 3fps.Tap water is pretreated in granular activated carbon to remove background disinfectant and then with a biological carbon column to remove the organic carbon and have a consistent population natural heterotrophic bacteria. This treated water is diluted with ultra pure water is use in these reactors. Reagent grade chemicals are added to the ultra pure water to achieve desire chemical chrematistics such as pH, alkalinity, hardness etc. The pH of the water is 7.5 and four different alkalinities (15, 50,100 and 250mg/L as CaCO3) are being tested. Disinfectant residuals and organic carbon have significant impact on MIC. As a carbon source for the microbial population humix is supplied to the reactor. Three sets of reactors are use, two of them with disinfectants (Free chlorine, and chloramines) and the third one is control, with no disinfectant. For the disinfectant dosed reactor the humix is dosed with disinfectant. To simulate the flow characteristics in home plumbing system the reactors are run for 5 minutes and than stops for 8 hours of stagnant period and this alternate period of flow and stagnation is being repeated for the entire period of the experiment. The total and dissolved copper concentration, conductivity, ORP, color, turbidity and HPC of the effluent water from the reactors are now measured on every week. When a considerable biofilm is established on the coupon, it will be examined to understand its complexity using denaturing gradient gel electrophoresis (DGGE).This DGGE technique is able to identify different species of micro organism. Also we are planning to change the limiting nutrient condition to see the effect of nutrient on the species and corrosion. The equipments necessary for conducting all this test is provided by my supervisor Dr.Anne Camper.