Testing the effect of disinfectants and water temperature on biofilm formation by different bacteria in three pipe materials

Bita Kolahi Kouchaki, Civil, Environmental and Sustainable Engineering
Mentor: Morteza Abbaszadegan
School of Sustainable Engineering and Built Environment

Abstract

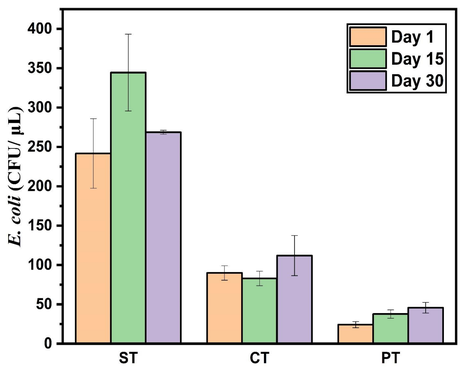
With the increase in world population, waterborne diseases are also increasing. Drinking water distribution systems (DWDS) biofilms can harbor pathogens, and opportunistic pathogens such as *Legionella spp.* and *E. coli* potentially release them back into the water, resulting in human exposure. In addition, water quality conditions can affect water pipes and water mains due to corrosion of metal surfaces which can be enhanced by the activity of sulfate-reducing and other bacteria in these biofilms. Therefore, we constantly need new and improved methods and treatments to bridge the gap in improving our understanding of the DWDS microbiome.

One way to increase biofilm and biomass quantity and get a more diverse community is the presence of a chlorine or chloramine residual to suppress biofilm accumulation. However, biofilms in drinking water distribution systems could exacerbate pathogens and bacteria' persistence and associated risks. This research aims to detect Legionella, E. Coli, and heterotrophic bacteria in the biofilms formed in a bioreactor system with three pipe materials like Stainless Steel, Copper, and Cross-linked polyethylene (PEX). Using different disinfectants to eliminate biofilm or prevent biofilm from further growth while measuring the effect of temperature on formation, in each pipe, by using standard aquarium heaters.

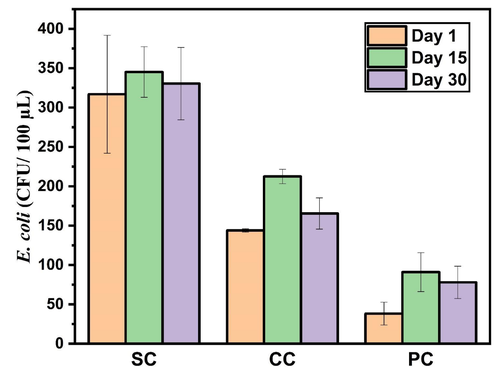
The positive results of biofilm reduction through water distribution systems will play a key role in improving the world's water safety and lessening contamination. Following the engineering research theme, 'Sustainability.'

material

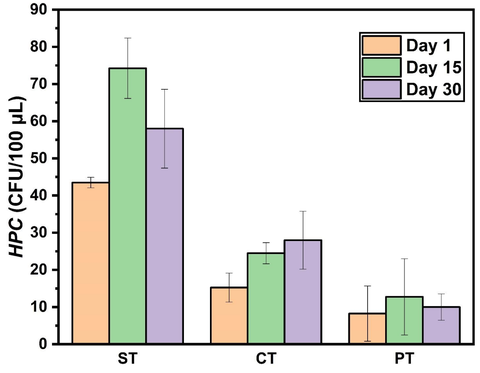
Method and Results



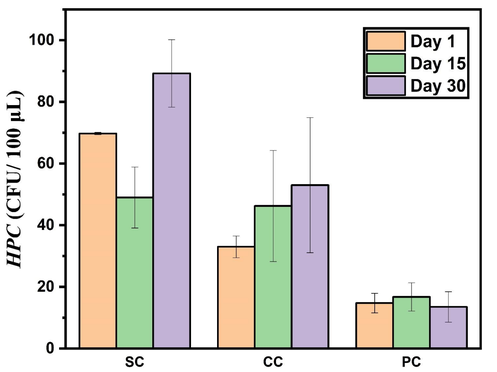
A) Plate counting results for *E.coli* on test pipes within three different set of experiment



B) Plate counting results for *E.coli* on control pipes within three different set of experiment



C) Plate counting results for *HPC* on test pipes within three different set of experiment



D) Plate counting results for *HPC* on control pipes within three different set of experiment

Discussion and Conclusion

The focus of this research is to determine the influence of pipe material and chlorination on biofilm formation and bacterial community with the effect of temperature on the result of a 31-day simulated bioreactor using Tempe town water. In this study, different coupons in the same pipe material were used to imitate better full-scale systems containing a diversity of the material.

Using Brilliance and R2A agar (Reasoner's 2A agar) media to detect specific bacteria such as E.coli and HPC using the spread plate method and colony-forming unit (CFU) calculation after incubation, for approximately 24hr for Brilliance and six days for R2A. The system operates with three different pipe materials on each shelf, and each pipe includes two sections as control and test. The tests have the aquarium heaters to indicate the temperature factor effect on growth.

Based on the literature review, it is anticipated that the temperature acts like a disinfectant and can kill bacteria at a specific range. The comparison between the two top graphs for E.coli shows a reduction on all the test pipes in three sets within a month, as expected. Comparing the bottom graphs for HPC indicates a reduction on all the test pipes in three sets within a month apart from the “Steel Test” on the second run. This error might be caused by cross-contamination and biofilm roughness on that specific coupon or pipe material.

The general observation is that PEX is better than copper and steel piping for several reasons. First, PEX is a type of polymer which is inexpensive compared to copper and is quicker to install. Second, PEX tubing is more flexible and does not corrode like copper pipe. Third, although steel pipe materials are mainly used cause of the lower cost and better quality and last longer compared to copper, the intensive disadvantages of it are Corrosion problems and Differential heat transfer.

references

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