Difficulty in dislodging biofilms from inner surface of drinking water pipelines

Wenfa Ng

Unaffiliated researcher, Singapore, Email: ngwenfa771@hotmail.com

Abstract

Microorganisms tend to adhere to any surface in contact with water and forms architecturally complex community of organisms known as biofilms. Biofilms reside on many environmental surfaces and has been utilized in wastewater treatment. However, their presence in drinking water pipelines is undesirable and is the subject of intense research effort aimed at characterizing their cellular composition, mechanical and physiological properties, and susceptibility to various environmental and antimicrobial challenges. Subsisting on the small amount of assimilable organic carbon in drinking water, biofilms in drinking water pipelines are difficult to dislodge via a variety of methods such as pulsating flow and elevation of residual disinfectant concentration. Indeed, potable drinking water poses severe constraints to the use of chemical additives for inhibiting the growth of biofilms. Hence, mechanical methods such as increasing hydraulic pressure for enabling biofilm dislodgement through elevated shear stress are preferred. However, periods of stagnation are unavoidable in drinking water pipelines, and microbes have been known to repopulate to areas of pipelines where biofilms have previously been dislodged. More importantly, possibility exists that microbes in biofilms have adapted to fluctuating shear stress through a combination of secretion of adherent extracellular polymeric substances (EPS) and activation of cellular responses to mechanical stress sensed by the cell envelope. So, how do we dislodge biofilms from the inner surfaces of drinking water pipelines? Or, if dislodgement of biofilm is difficult to achieve, how do we manage the problem? One approach to mitigate the problem would be to maintain sufficient residual disinfectant in drinking water to both ensure the safety of drinking water as well as imposing a constant survival pressure on microbes in drinking water biofilms. Even if live cells are dislodged from biofilms into drinking water, presence of a high residual disinfectant concentration would render the cells inactivated. Beyond approved residual disinfectant such as monochloramine, use of other antimicrobial agents appear limited due to concerns for public health and safety. Hence, there exists a narrow operating window in which only residual disinfectant concentration and frequency and strength of pulsating flow could be used as levers to control biofilm growth on inner surfaces of drinking water pipelines. Overall, the problem of dislodging drinking water biofilms from pipelines is an important one, but there is paucity of new methods for controlling biofilm growth and facilitating their dislodgement due to constrains imposed by drinking water safety. Hence, focus has shifted to development of new pipelines surfaces that prevent the adherence of microbes and biofilm formation. Efforts in this direction may provide answers in resolving the long-standing question of preventing biofilm growth in drinking water pipelines.

Keywords: biofilm, monochloramine, drinking water pipelines, assimilable organic carbon, microbes, shear stress, growth inhibition, residual disinfectant, dislodgement, surface engineering,

PeerJ Preprints | https://doi.org/10.7287/peerj.preprints.27628v1 | CC BY 4.0 Open Access | rec: 2 Apr 2019, publ: 2 Apr 2019

Subject areas: biotechnology, biochemistry, microbiology, aquatic and marine chemistry, cell biology,

Conflicts of interest

The author declares no conflicts of interest.

Funding

No funding was used in this work.