Extended biostability of potable water through sustainable non-chemical treatment

Xiaoxia Liu
xiaoxia.liu@wetsus.nl

Motivation

Magnetic water treatment (MWT) has been employed to improve water quality and fouling prevention in the past years [1]. However, since the specific mechanism remains unclear, the application is controversial. Recently, a mechanism proposed by Coey [2], the enhanced formation of dynamically ordered liquid like oxyanion polymers (DOLLOPs) in water after MWT with strong magnetic gradients was experimentally verified (Fig.1). It brought a breakthrough in the understanding of MWT from the perspective of water physics [3]. Because microbial activities have been shown to intensively participate in the fouling process of drinking water distribution systems (Fig.2), the microbiological effect of magnetic water treatment can be further explored. Since widely applied chemical disinfection processes cause problems such as recontamination, antibiotic resistance development etc., microbial resource management by MWT may provide possibilities for a sustainable alternative of current drinking water treatment methods. Therefore, the aim of this study is to investigate the effect of MWT on microbial communities and its role in affecting water quality.

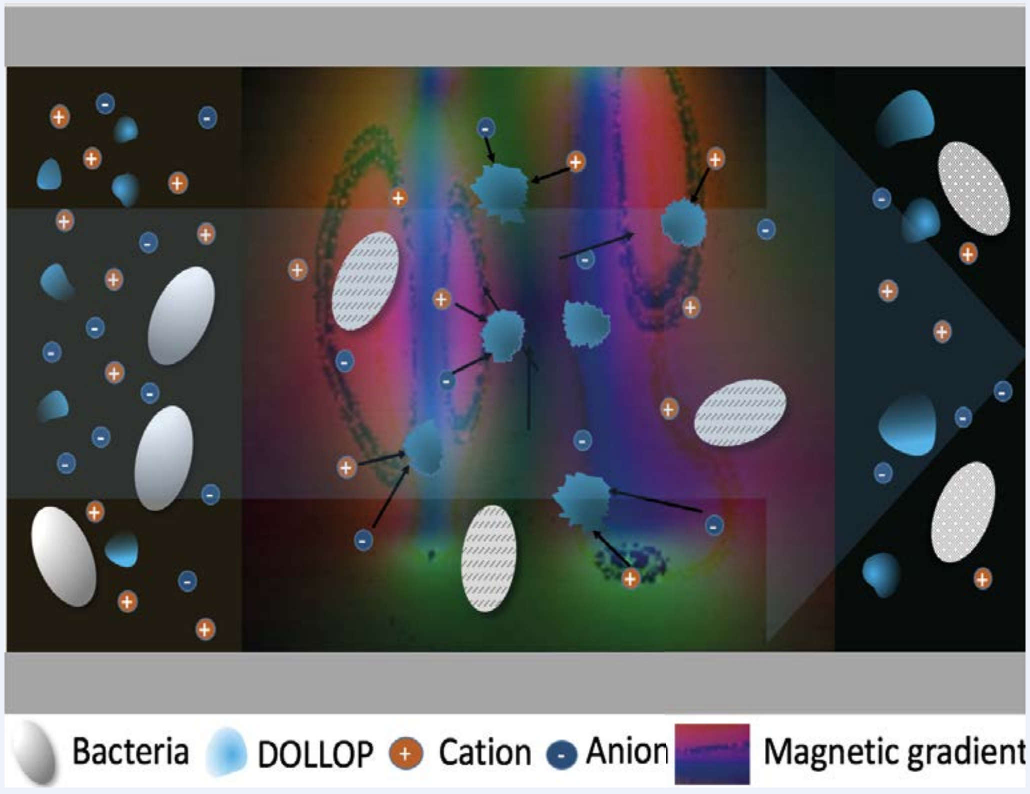

Fig.1 Illustration of the effect of a strong magnetic gradient on DOLLOP formation and microorganisms. A magnetic gradient can dephase the protons spins on the surface layer of DOLLOPs (dynamically ordered liquid like oxyanion polymers), therefore allowing additional ions to join the DOLLOP structures more easily. As a result, the chemical equilibrium is shifted to the colloidal (DOLLOP) phase, and the chemical environment of the microbes is changed by the magnetic field gradient, which in turn influences the microbial behavior.

Technological challenge

Despite many difficulties in studying the effect of a magnetic field, a good understanding of the mechanism is essential for a better application of magnetic water treatment systems. As microorganisms play an important role in water quality management and interact intensively with calcium in drinking water distribution systems, the effect of magnetic fields on the microbial community as well as their interaction with calcium precipitation needs to be better understood. Therefore, the main goal of the project is to understand the mechanism of magnetic field effects on microbial communities and use the knowledge achieved to regulate microbial communities and calcium precipitation in drinking water system.

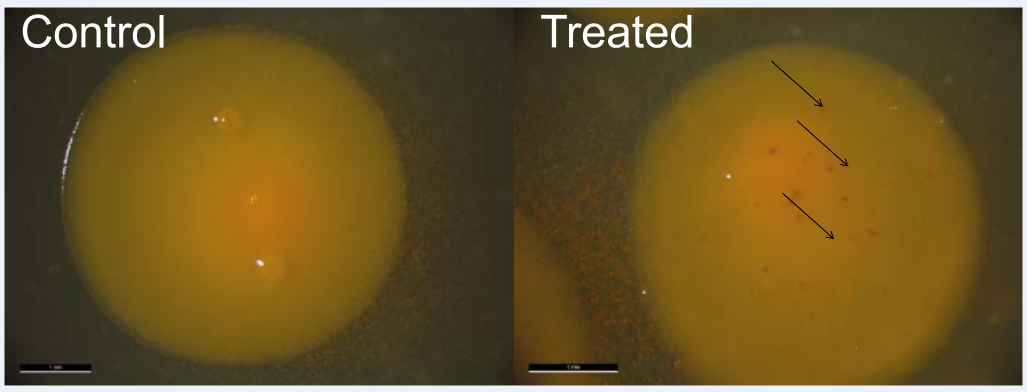

Fig.2 Microbial colonies isolated from tap water exhibit different behavior in microbial induced calcium precipitation before and after the magnetic treatment.

Research Goals

- Establish a methodology in the laboratory to scientifically examine the effect of magnetic fields on microorganisms.
- Investigate the specific physiological response of microorganisms to the magnetic treatment.
- Provide a better understanding on the proposed anti-fouling effect of magnetic water treatment from the perspective of microbiology.
- Develop a microbial management strategy based on the magnetic water treatment effect to improve water quality.

Reference

[1] Emil Chibowski, Aleksandra Szcześ, (2018). Magnetic water treatment–A review of the latest approaches, Chemosphere, 203, 54-67.

[2] Sammer, M., Kamp, C., Paulitsch-Fuchs, A. H., Wexler, A. D., Buisman, C. J. N., & Fuchs, E. C. (2016). Strong gradients in weak magnetic fields induce DOLLOP formation in tap water. *Water (Switzerland), 8*(3).

[3] Coey, J. M. D. (2012). Magnetic water treatment – how might it work? *Philosophical Magazine, 92*(31), 3857–3865.

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Xiaoxia Liu MSc, dr. E.C. Fuchs, dr. A. Paulitsch-Fuchs, PD dr. G. Zarfel, dr. I.Dinkla, prof.dr. W. Loiskandl

Universität für Bodenkultur Wien
University of Natural Resources and Life Sciences, Vienna