Interaction of flow field and biofilm formation in a dripper supplied by reclaimed wastewater

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In the reclaimed wastewater reuse using drip irrigation, one of the main issues is the bio-clogging of drippers and decrease of water distribution efficiency in field level. However, the relation between the complex flow created along the dripper (in general formed by a milli-channel with labyrinth geometry) and the biofouling development are rarely studied.

In order to improve the knowledge of these mechanisms, the objective was to combine the numerical flow simulations to three-dimensional measurements of biofilm along a milli-fluidic system (nominal flow rate 1L/h) fed by treated wastewater. At first, using the Optical Coherence Tomography (OCT) method and based to Qian et al, 2018 studies, the bio-clogging structure was measured at different levels of fouling (up to 77\% of channel volume). Secondly, the new fouled dripper geometries were integrated to 3D CFD models (using comsol multiphysics software) to analyse the effect of biofilm on flow topology and the dripper hydraulic parameters (pressure drop, shear stress, turbulence kinetic energy in particular).

The results show that the main areas of biofilm growth correspond to vortices zones where fluid velocity, turbulent kinetic energy values and shear stress are lowest. When the level of clogging increases, the numerical plot of stream lines show local perturbation and reduction of vortices areas caused by their interactions with the biofilm structure. There is also a gradual increase in pressure drop along the milli-channel comparing to initial clean dripper. Finally, by characterising the flowrate in function of inlet pressure and according to Karmeli, 1977, the increase of biofilm formation induces also a modification of the global flow regime in the dripper, i.e. the transfer from a turbulent to a laminar regime.