

Remediation of drinking water distribution systems by removing contaminated biofilms with new cleaning regimes

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Abstract

The contamination e.g. by a deliberate attack with chemical, biological, radiological or nuclear (CBRN) agents on drinking water distribution system will result in contaminated water and internal surface deposits. On the inner surfaces of a drinking water network different type of deposits develop over time and act as potential sorbent for the contamination. As it is known that biofilms form on all inner surfaces, the present work aims to evaluate the possibility to remove these biofilms altogether as completely as possible. In contrary to water, surface deposits and biofilms are not easily rinsed out and remain as reservoirs for the contamination.

Several cleaning respectively decontamination procedure of biofilms have been tested in pilot plants using alternative hydraulic treatments comparable with conventional flushing. Biofilms were grown in a pilot plant on PE-HD 100 pipes segments over 2-3 months under realistic hydraulic conditions. Bacterial density was in the range of 10^8 bacteria/cm². By applying a treatment employing the abrasive potential of ice crystals, called "Ice-pigging", it was shown that the biofilms was removed to a very high degree leaving only a few thousand bacteria percm² on the surface which is a removal rate of 99,999 %. Another method, based on air-water flushing (Comprex®) generates a velocity of large air "bubbles" in water in small areas up to 15 - 20 m^s⁻¹. This results in elevated shear forces and removes up to 99.9 % of a biofilm. Conventional flushing a water supply distribution network with water up to a velocity of 3 ms⁻¹ removes loose deposits, sediments and biofilms in the range of 70 - 90%.

Ice-pigging was developed at the University of Bristol which held the patent; large experience is not available yet. An advantage is that on a routine bases air-water flushing such as Comprex® is applied since many years and has generated considerable experience. However, the removal rate will depend on the geometric situation in the distribution system and the number of pulses used and has to be taken into account for the individual case.

In general, air-scouring and ice-pigging appear promising methods for rapid removal of soft deposits in piping systems and should be taken into account in emergency situations.

Literature

<http://www.bris.ac.uk/research/impact-stories/2012/ice-pigging.html>

Comprex®: <http://www.hammann-gmbh.de/de/247/service/downloads/information-in-english.html>

Schaule et al., 2000. Steps in biofilms sampling and characterization in biofouling cases. In: BIOFILMS. Eds. Technomic Publishing Co., Inc. ISBN No. 1-56676-869-1