



## Challenge tests with virus surrogates: an accurate membrane integrity evaluation system?

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### ABSTRACT

The use of membrane filtration in drinking water treatment has significantly increased in the last decades due to its advantages, including its capacity to produce water of high quality with a high level of pathogens rejection. However, if membrane integrity is compromised, this feature cannot be guaranteed, increasing the associated microbial risk of the treated water. This study has focused on the development and application of a protocol based on virus surrogates challenge tests applicable to the three existing ultrafiltration (UF) configurations. The operational conditions have been defined, and the tests have been conducted successfully. The selected micro-organisms, PDR-1, MS-2, GA and *Bacillus* spores, present different characteristics providing complementary information of membrane integrity and its status. In particular, PDR-1 and *Bacillus* spores, due to their larger size, are mainly removed by size exclusion and low removal rates may indicate membrane impairment. MS-2 and GA, 25 nm in size approximately, may not be rejected by size exclusion but by adsorption and electrostatic interactions, so that their removal values may not necessarily be indicative of membrane integrity failures. Since they may be influenced by further factors, such as membrane characteristics, feed water quality, non-chemically removable fouling, etc., the results obtained can be used to better understand membranes performance.

*Keywords:* Membrane integrity; Viruses surrogates; Bacteriophages; *Bacillus* spores; *Cryptosporidium*; Ultrafiltration; Pressure decay test

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