NAVI-gate®

Monitoring membrane integrity using native viruses in water

NAVI-gate®, a breakthrough in monitoring membrane integrity: verify up to Log Removal Value (LRV) 7 in one Liter water samples without dosing surrogates.

Why monitor membrane integrity?

Microbiologically safe water is crucial in many water applications, e.g. for production of drinking water, in the food and beverage industry, horticulture and industry. Increasingly, membrane filtration processes (ultrafiltration, reverse osmosis, nanofiltration and microfiltration) are applied in water treatment plants to help ensure pathogens including viruses are removed effectively.

Verifying the integrity of membrane filtration processes is key. Most stringent applications require a Log Removal Value (LRV) 7 or more to be demonstrated, that means a removal of 99.99999%. Conventional methods for integrity monitoring show (1) insufficient sensitivity or (2) require dosing of surrogates to the raw water, which is not acceptable in full-scale systems (e.g. MS2 bacteriophage) and/or (3) require system shutdowns. And this is where NAVI-gate® comes in!

NAVI-gate®, how does it work?

Multi-year research by KWR[1] identified native bacterial viruses – or 'bacteriophages' – that are present in high concentrations in rivers, treated wastewater and lakes. These *native viruses* are the key to determining removal efficiency of physical treatment steps, such as membrane filtration. No need to dose high concentrations of surrogates as these viruses are already present in the raw water. When to apply NAVI-gate®?

- Assigning LRV to membrane treatment processes: testing the effectivity of membrane treatment and robustness under varying conditions, typically during a pilot stage
- Verification monitoring of full-scale membrane systems: verify whether the membrane treatment step is achieving the required or assigned LRV in practice
- Other water treatment steps: NAVI-gate® is also applicable to other processes if these are based on physical removal mechanisms

[1] Hornstra, L. M., T. Silva, B. Blankert, L. Heijnen, E. Beerendonk, E. Cornelissen and G. Medema (2019). "Monitoring the integrity of reverse osmosis membranes using novel indigenous freshwater viruses and bacteriophages." Environmental Science: Water Research & Technology **5**.

In short, the NAVI-gate® steps include:

Pre-stage

1. Quantifying the native virus community in the raw water
2. Confirming the applicability of NAVI-gate® for the raw and treated water of interest

Operational stage

3. Take 1 Liter samples of feed and permeate water.
4. Have the samples tested by the KWR laboratory based on qPCR technology (see box below).
5. Receive an analysis certificate with the measured concentrations of native viruses in the water samples including the calculated LRV credits of a treatment step.

qPCR (quantitative Polymerase Chain Reaction) relies on DNA technology for quick and accurate detection of micro-organisms in water. It works by specifically multiplying and quantifying the genetic material of the microbes of interest after a water sample has been concentrated and all DNA has been isolated and purified. Results are reported as copies per liter of water concentrated.

Key benefits of NAVI-gate®

NAVI-gate® enables innovative and highly efficient monitoring:

- Only 1 Liter water sample required
- No dosing of tracer or surrogate compounds
- No interruption of the water treatment process
- Wide window of operation, LRV 7 achievable
- Validated on over ten surface water treatment sites at full scale
- Applicable to other water matrices (e.g. groundwater, seawater, wastewater effluent)
- Opening the route to on-site (semi)continuous monitoring

The patented NAVI-gate® method (EP 3486650) is highly innovative. The developers received the IWA Global Project Excellence Award during the IWA Membrane Technology Conference (2025) in South Korea (TKI Project wins Excellence Award for Innovative Membrane Monitoring - KWR).

Our services

Interested in NAVI-gate®? We are happy to offer our services, including sampling and analyzing water, developing the application to a specific water matrix, providing advice about overall water treatment integrity and microbial risk assessment. Please contact KWR at navi-gate@kwrwater.nl.

If you are interested to obtain a license for using NAVI-gate®, e.g. to apply in your own laboratories or focused on (semi)continuous monitoring, then contact Allied Waters at navi-gate@alliedwaters.com.