



FILMTEC Membranes

Water Chemistry and Pretreatment: Biological Fouling Prevention

Assessment of the Biological Fouling Potential

The potential for biological fouling should be assessed during the project phase so that the system can be designed accordingly. Warm surface waters generally have a higher biofouling potential than cold well waters. The regular assessment of the microbiological activity of the feed water should also be part of the operating discipline of an existing plant so that any increase of the microbiological activity can be responded to at an early stage.

Some techniques require water sampling, whereas others use online monitors. Sampling of microbiological activity can be done using presterilized sampling containers. If the laboratory equipment needed for analysis of the microbiological samples is not available at the RO plant site, an adequate laboratory should be found to perform the needed analysis not later than 8 hours after sampling. Samples should be stored in a refrigerator.

The minimum number of sampling points required is listed below:

1. Intake (surface) or well, before addition of any chemicals.
2. After a clarifier, settling pond, sludge contact unit, or similar sedimentation process.
3. After filtration units (sand, multimedia, activated carbon, or other).
4. Just before the membranes, after addition of chemicals (normally after cartridge filtration).
5. Concentrate stream.
6. Permeate stream.

The frequency of sampling and analysis depends on the risk of biofouling. For surface water plants, a daily check of the feed water (point 4) and a weekly check of all points are recommended.

Culture Techniques

The concentration of bacteria in water is directly related to the biological fouling potential of the water. The number of colony forming units (CFU) is a quantitative expression of the number of culturable microorganisms in a water sample. It is determined according to Part 9000 of the Standard Methods [/1/](#) by filtering a measured quantity of water through a membrane filter. Subsequently, the organisms thus retained on the filter surface are cultured on the appropriate nutrient medium to develop colonies, which are then observed and counted at low power magnification. Different media are used for different microorganisms and different water types.

The main advantage of this method is that it can be performed easily without expensive equipment. The test results, however, are only available after up to seven days, and the counted colonies may represent as little as 1-10 % or less of the total bacteria count (TBC). Nevertheless, culture techniques are still valuable as indicators of the level and the trend of the biological fouling potential.

They can be applied to monitor the water quality from the intake through the subsequent treatment steps up to the concentrate stream and the permeate. An increase of the CFU is an indication of an increased biofouling potential.

Total Bacteria Count

The total bacteria count (TBC) is determined with direct count techniques. These employ filtration of the water sample and counting the retained microorganisms on the filter plate directly under a microscope. To make the microorganisms visible, they are stained with acridine orange and viewed with an epi-illuminated fluorescent microscope [/28/](#).

Thus, an accurate count of total microorganisms is obtained immediately. The types of microorganisms can be assessed and differentiated from debris particles. Direct count methods are preferred, because they are much faster and more accurate than culture techniques.

The concentrations of microorganisms in raw water, in the feed stream, and in the concentrate stream are helpful numbers for assessing biological fouling potential. Other factors, however, like the concentration and the kind of nutrients or growth promoting substances may be more important for the development of a biofilm.

Assimilable Organic Carbon (AOC)

The AOC test addresses the growth potential of microorganisms in a given water sample with given nutrients. It is a bioassay with two well-defined pure cultures. From the maximum growth level of the two individual strains the AOC concentration is calculated and expressed as $\mu\text{g/L}$ of acetate C equivalents. The procedure is described in Part 9217 of the Standard Methods [/1/](#). *Vrouwenvelder et al.* observed severe biofouling in cases where the feed water had AOC values exceeding $80 \mu\text{g/L}$ [/29/](#). *Nederlof et al.* proposed a standard of $10 \mu\text{g/L}$ to prevent biological fouling [/30/](#), but in some cases biofouling may be possible with AOC values even below $10 \mu\text{g/L}$ [/29/](#).

Biofilm Formation Rate (BFR)

The BFR value is determined with an online operated biofilm monitor at a continuous flow rate of 0.2 m/s . The accumulation of active biomass measured as ATP (adenosinetriphosphate) on the surface of glass rings in this monitor is determined as a function of time [/32/](#). BFR values exceeding $100 \text{ pg/cm}^2 \text{ ATP}$ were observed with severe biofouling, and BFR values of less than $1 \text{ pg/cm}^2 \text{ ATP}$ were measured in cases of stable operation without any cleaning needs [/29/](#). The BFR value is most closely correlated with the degree of biofouling in a membrane plant [/31/](#).

FILMTEC™ Membranes

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