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The selection of nanofiltration membrane characteristics to purify landfill leachate and reduce concentrate

Alexei Pervov[1]*, Vyacheslav Dzubenko[2], Tatiana Shirkova[1]

[1]*Moscow State University of Civil Engineering, 26, Yaroslavskoye Shosse, Moscow, Russia, email: ale-pervov@yandex.ru (A. Pervov),*
[2]*JSC RM Nanotech, 224d, Dobroselskaya str., Vladimir, Russia, email: v.dzyubenko@membranium.com (Vyacheslav Dzubenko).*

ABSTRACT

The state of the art of landfill leachate treatment using reverse osmosis is presented. When preparing this review, we were surprised by the widespread use of seawater membranes, which is striking. This can be explained by the high osmotic pressure values of leachate that require high working pressures. A serious disadvantage of this approach is the use of reverse osmosis high-pressure membranes, which leads to losses of membrane permeability and the necessity for additional treatment of the concentrate. This approach is used in seawater desalination technologies to reduce concentrate and is known as "membrane brine concentration" (MEC) technology. Not only operational costs (such as energy and membrane replacement) are compared in the research. The value of operational costs is influenced by the calcium carbonate precipitation rate, as well as fouling rates of other organic and inorganic deposits that increase the hydraulic resistance of the membrane channel. Results of the investigation demonstrate that the formation of calcium carbonate is excluded when using nanofiltration membranes. The increase and growth of hydraulic resistance in the membrane channel are easily avoided by the use of a modified spacer that increases the area of the live section of the stream and improves its hydrodynamic flow characteristics when suspended solids and organic fouling occur in the channel. This measure also improves the efficiency of hydraulic flushing procedures applied to destroy and remove fouling layers. Results of scaling and organic fouling rate determinations are presented and illustrated by SEM photos of fouling layers and their

*Corresponding author

spectral analysis performed after membrane element autopsies. Contrary to the fears of experts, the main obstacle to safe membrane operation is attributed not to organic fouling and not to high COD values of feed water, but to calcium carbonate “hidden” in the organic fouling layer and formed due to supersaturation conditions provided by high pressures and high membrane rejection of “seawater” membranes. Results of economic calculations are presented that demonstrate the advantages of the newly proposed technology based on the use of low-rejection membranes to reduce concentrate flow as compared to conventional high-pressure (“seawater”) membrane application.

Keywords: Reverse osmosis; Nanofiltration; Membrane rejection; Scaling; Organic fouling of membranes; Hydraulic resistance of membrane channel; Membrane spacer; Modified membrane spacer