No. 1914

Development of the Real-Time Counting Technology for Bacteria in the Reverse Osmosis Permeate during Seawater Desalination

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Summary

The online monitoring of bacterial content during seawater desalination by reverse osmosis membrane is an important strategy for enhancing safety of treated waters. Although real-time bacteriological counting techniques enable online bacterial counts monitoring, the auto-fluorescence of background organic constituents in the waters (e.g., humic acids) interferes with such analysis. In this study, the efficacy of a new pre-treatment technique involving a dialysis membrane for continuously removing interfering substances is evaluated. In addition, the reliability of bacterial counting by real-time bacteriological counting technique is assessed. Further, bacterial counts in the feed and permeate of reverse osmosis process during seawater desalination were evaluated. Pre-treatment of pre-sand filtered seawater using the dialysis membrane demonstrates the effective removal of background interfering substances, thereby improving online bacterial analysis. The bacterial counts by the real-time bacteriological counter were closer to those by flow cytometry than those by epifluorescence microscopy. These two techniques are fundamentally different; the flow cytometry technique counts bacteria through nucleic acid staining, whereas the real-time bacteriological counter considers only bacteria-sized particles with high auto-fluorescence intensity. However, both analytical techniques measure bacterial cell counts based on (a) real-time particle counts and (b) biological activities determination from the fluorescence intensity of the particles. Thus, the intact bacterial cell counts by flow cytometry highlight the potential for predicting changes in bacteria counts by the real-time bacteriological counter. Lastly, the separation performance of reverse osmosis for bacterial removal was assessed by counting bacteria in the feed and permeate of reverse osmosis treatment during seawater desalination. The results showed that bacterial counts in the feed and permeate were approximately 1.1×10^4 and 2.0×10^2 counts/mL, respectively. It was suggested that the online-monitored bacterial counts in permeate can be the baseline for generating an alarm of abnormal number of bacteria in permeate, so that the deterioration of reverse osmosis separation performance can be detected. Overall, this study indicates that the real-time bacterial counting technique is an effective approach for monitoring the separation of bacteria by reverse osmosis treatment during seawater desalination.