Direct measurement of atp in seawater and application of ATP to monitor bacterial growth potential in SWRO pre-treatment systems

Abushaban, Almotasembellah; Mangal, M. Nasir; Salinas-Rodriguez, Sergio G.; Nnebuo, Chidiebere; Mondal, Subhanjan; Goueli, Said A.; Schippers, Jan C.; Kennedy, Maria D.

DOI
10.5004/dwt.2017.21783

Publication date
2017

Document Version
Final published version

Published in
Desalination and Water Treatment

Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2017.21783

99 (2017) 91–101
December

Direct measurement of ATP in seawater and application of ATP to monitor bacterial growth potential in SWRO pre-treatment systems

Almotasembellah Abushaban[a,b,*], M. Nasir Mangal[a], Sergio G. Salinas-Rodriguez[a], Chidiebere Nnebuo[a], Subhanjan Mondal[c], Said A. Goueli[c,d], Jan C. Schippers[a], Maria D. Kennedy[a,b]

[a]*UNESCO-IHE Institute for Water Education, Environmental Engineering and Water Technology Department, Westvest 7, 2611 AX Delft, The Netherlands; emails: s.salinas@un-ihe.org (S.G. Salinas-Rodriguez), m.kennedy@un-ihe.org (M.D. Kennedy)*
[b]*Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands*
[c]*Promega Corporation, 2800 Woods Hollow Road, Madison, WI 53711, USA*
[d]*University of Wisconsin School of Medicine, Madison, WI, USA*

Received 28 September 2017; Accepted 12 November 2017

ABSTRACT

The use of adenosine triphosphate (ATP) to monitor bacterial growth potential of seawater is currently not possible as ATP cannot be accurately measured at low concentration in seawater using commercially available luciferase-based ATP detection. The limitation is due to interference of salt with the luciferin–luciferase reaction, which inhibits light production. This research demonstrates that new reagents developed for (i) ATP extraction from microbial cells and (ii) ATP detection in seawater are able to reliably detect Microbial ATP as low as 0.3 ng L^{-1} in seawater. The luminescence signal of the new detection reagent is significantly higher (>20 times) than the luminescence signal of the freshwater reagent, when applied in seawater. ATP can now be used to monitor bacterial growth potential (BGP) through pre-treatment trains of seawater reverse osmosis (SWRO) plants. The level of detection of the new BGP test is significantly lower than the estimated threshold value required to prevent biofouling in SWRO systems. The new reagents have been used to monitor Microbial ATP in coastal North Sea water. Moreover, Microbial ATP has been applied to monitor the bacterial growth potential (using indigenous bacteria) through the pre-treatment train of an SWRO desalination plant. A significant reduction (>55%) of the bacterial growth potential was found through the dual media filtration with 4.5 mg-Fe(III) L^{-1} coagulant. Overall, the new reagents can detect low Microbial ATP concentrations in seawater and can be used to monitor bacterial growth potential in seawater desalination plants.

Keywords: Adenosine triphosphate; Seawater; Bacterial growth potential; Reverse osmosis; Desalination; Biofouling

* Corresponding author.