Desalination and Water Treatment
www.deswater.com
doi: 10.1080/19443994.2014.940647

55 (2015) 2647–2668
August

Taylor & Francis
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Biodesalination: an emerging technology for targeted removal of Na^+ and Cl^- from seawater by cyanobacteria

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Received 14 April 2014; Accepted 16 June 2014

ABSTRACT

Although desalination by membrane processes is a possible solution to the problem of freshwater supply, related cost and energy demands prohibit its use on a global scale. Hence, there is an emerging necessity for alternative, energy and cost-efficient methods for water desalination. Cyanobacteria are oxygen-producing, photosynthetic bacteria that actively grow in vast blooms both in fresh and seawater bodies. Moreover, cyanobacteria can grow with minimal nutrient requirements and under natural sunlight. Taking these observations together, a consortium of five British Universities was formed to test the principle of using cyanobacteria as ion exchangers, for the specific removal of Na^+ and Cl^- from seawater. This project consisted of the isolation and characterisation of candidate strains, with central focus on their potential to be osmotically and ionically adaptable. The selection panel resulted in the identification of two Euryhaline strains, one of freshwater (*Synechocystis* sp. Strain PCC 6803) and one of marine origin (*Synechococcus* sp. Strain PCC 7002) (Robert Gordon University, Aberdeen). Other work packages were as follows. Genetic manipulations potentially allowed for the expression of a light-driven, Cl^--selective pump in both strains, therefore, enhancing the bioaccumulation of specific ions within the cell (University of Glasgow). Characterisation of surface properties under different salinities (University of Sheffield), ensured that cell–liquid separation efficiency would be maximised post-treatment, as well as monitoring the secretion of mucopolysaccharides in the medium during cell growth. Work at Newcastle University is focused on the social acceptance of this scenario, together with an assessment of the potential risks through the generation and

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Presented at the Conference on Desalination for the Environment: Clean Water and Energy 11–15 May 2014, Limassol, Cyprus

application of a Hazard Analysis and Critical Control Points plan. Finally, researchers in Imperial College (London) designed the process, from biomass production to water treatment and generation of a model photobioreactor. This multimodal approach has produced promising first results, and further optimisation is expected to result in mass scaling of this process.

Keywords: Biodesalination; Osmolytes; Biotechnological screening; Sustainable; Remediation