

# Mitigation of Membrane Biofouling by Harnessing Bacterial Cannibalism

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## Problem and Research Objectives

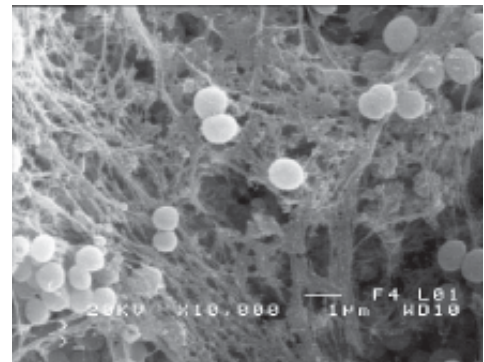
In 2002, about 113 million barrels (bbls) of produced water were generated in New Mexico during crude oil and natural gas production. The majority of the produced water is re-injected back into the same geological formation to enhance recovery of fuel reserves while the remainder is disposed of via deep injection wells. The amount of water disposed of through the injection wells is vast. Even partial desalination of water for use in industry, agriculture, and recreation would dramatically decrease pressures on freshwater aquifers and provide more water for beneficial needs. Membrane desalination, being a well-established and effective separation process, is used routinely to reclaim small quantities of produced water. Large-scale implementation of the membrane processes for desalinating produced water, however, is hampered by the recurring biofouling of the membranes and the associated high operating costs. Acid and alkaline/detergent cleaning of biofouling are generally found to be ineffective.



Professors Rogelj (left) and Huang.

## Methodology

In this research, the applicability of bacterial cannibalism on biofouling control was studied. *Bacilli* and *Bdellovibrio bacteriovorus* have been shown to degrade biofilms and thus were chosen as the candidates to induce cannibalism. Evaluation of the protease and DNase activities showed that the 36-hour conditioned media (CM) by *B. subtilis* and *Bdellovibrio bacteriovorus* exhibited a significant proteolytic and DNA-degrading activity, respectively. Consequently, the 36-hour CM could potentially be used to control biofouling. To assess the degree of degradation on pre-formed biofilms, *Pseudomonas fluorescens* biofilms were cultivated at the air/growth media interface and characterized using Scanning Electron Microscopy with a special sample preparation process. The preformed *Pseudomonas fluorescens* biofilms were then immersed either in control saline, or *B. subtilis* conditioned media either in the absence or the presence of the living *B. subtilis* cells, or *E. coli*-*Bdellovibrio* conditioned medium. The effectiveness of biofilm removal was gauged by staining the remaining biomass after treatment with crystal violet.



A scanning electron micrograph of *S. epidermidis* biofilm. The filmy extracellular material, characteristic for biofilms and secreted by the cells, protects the bacteria and makes the biofilm tough and difficult to remove.

## Principal Findings

From the results, the treatment of the pre-formed *P. fluorescens* biofilm with the *B. subtilis* or *Bdellovibrio* conditioned medium appeared to have reduced the *P. fluorescens* biofilm accumulation over time.

