PENNSTATE

Technology Available for Licensing
Office of Technology Management - The Pennsylvania State University
113 Technology Center, University Park, PA 16802
814.865.6277 phone; 814.865.3591 fax

Non-Confidential Description - PSU No. 4337
"Living Reverse Osmosis (RO) Membranes"

Field of Invention/Keywords:

Anti-biofouling, Biofilm, Separation Membranes,
Wastewater recycling, desalination

Inventors:

Thomas Wood, Manish Kumar, Thammajun Wood

Background

Reverse Osmosis (RO) membranes purify low-quality water sources such as recycled wastewater, brackish water and seawater by removing almost all substances dissolved in water including salt, microbial and organic contaminants. However, the accumulation of material on the membrane's surface gradually clogs the membrane, reducing its efficiency and increasing the energy requirements, thereby driving up expenses to purify the water. The concurrent growth of microbial colonies on these deposits results in biofouling, which accelerates the process and is difficult to prevent, control and remove. Biofouling shortens the life of the membranes, which must be replaced at added expense in labor, materials and downtime. Most current biofouling control techniques are either only initially effective due to biofilm adaptation or need repeated long-term applications of the control agent, such as disinfectants and biocides.

Invention Description

The inventors engineered a beneficial biofilm that prevents membrane fouling by limiting its own thickness. The subject invention exploits the bacterium's biological pathway to inhibit excessive biofilm growth while also engineering the organism to possess one or more enzyme(s) that degrade an important class of environmental organic pollutant. The invention relies on a genetic modification to the bacterium that internally controls its triggers to produce a key protein that leads to the dispersal of the beneficial biofilm. The inventors used at least 15 different membrane biofilm samples consisting of polyamide RO membranes, spanning three independent cultures and found that this self-regulating bacterial strain had approximately 42-fold lower biomass amounts than the control strain. When cultured with Pseudomonas aeruginosa, a major biofouling bacterium, the beneficial strain suppressed the P. aeruginosa biomass by around 40 fold and reduced the P. aeruginosa average biofilm thickness by around 100 fold, compared to the negative control. Without the presence of the beneficial biofilm, the control biofilm generated 165% more resistance to flux due to P. aeruginosa infiltration into the biofilm. The beneficial biofilm was also engineered to enzymatically degrade a small hydrophobic compound that normally passes through the membrane. This biofilm degraded the compound by more than 39 +/-4% in a single pass batch filtration.

Future Developments

The invention's approach can be extended to other membrane technologies such as membrane bioreactors and forward osmosis for contaminant degradation and biofouling prevention. The inventors also believe that their technology may be suitable for industrial settings such as cooling towers, water distribution systems and HVAC systems. Uncontrolled proliferation of bacteria in biofilms affects medical catheters and biomedical implants and contributes to human diseases such as cystic fibrosis, dental plaque and chronic rhino sinusitis suggesting another application.

Contact: **Matthew D. Smith**
Sr. Technology Licensing Officer
The Pennsylvania State University

Phone: (814) 863-1122
Fax: (814) 865-3591
E-mail: mds126@psu.edu