Membrane technology for sustainable water treatment

Tae-Hyun Bae
School of Chemical and Biomedical Engineering, Nanyang Technological University
62 Nanyang Dr., Singapore 637459

thbae@ntu.edu.sg

Anaerobic digestion-based processes for converting wastewater into clean water and energy are attracting an ever-growing industrial interest. However, at the current status, the technology (apart from the microbial digestion step) is still open for progress as an integrated process. Particularly, for meeting the stringent discharge standards, the anaerobic effluents often require extensive post-treatment steps. Also, a significant portion of the produced biomethane inevitably remains dissolved in the effluents and eventually get released to the environment, causing economic losses and global warming concerns. To recover biomethane from the anaerobic effluent and thereby maximize the energy recovery from anaerobic processes, membrane contactor employing hydrophobic porous hollow fiber membrane has been applied. By optimizing the surface hydrophobicity and the porosity of membranes, a desirable CH_4 flux which is much higher than that of a commercial polypropylene membrane could be achieved. A stable performance of membrane was also demonstrated by a long-term test. Subsequent modelling analysis revealed that net energy obtainable from the membrane contactor is very attractive and can further be increased by the optimization of operating parameters. If such energy combines with biomethane recovered from the head space of the reactor, the total energy is sufficient to operate an anaerobic wastewater treatment plant.

Meanwhile, the seawater desalination has also emerged as a key technical element for sustainable water management. Among the various approaches to desalination, reverse osmosis (RO) has become a dominant technology for seawater desalination owing to its energy efficiency. However, room remains for further improvement of the efficiency of the conventional RO process, which requires costly pre-treatments and post-treatments necessitated by inadequate ion removal. The development of more selective membranes using novel materials that can selectively transport water molecules over ions would be an ideal solution to this problem. In this context, we are utilizing channel-based materials to develop next-generation desalination membranes. In parallel, we are trying to develop and optimize the hybrid FO(forward osmosis)-RO desalination system for simultaneous treatments of wastewater and seawater. Currently, a pilot plant is under operation at a test bedding site near Singapore's desalination plant.