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The Performance of specific membranes in membrane bioreactors

What is this research about?

Membrane bioreactors (MBRs) are a wastewater treatment system that is a combination of biological wastewater treatment processes and membrane filtration, where filtration is used to separate the treated water from the microorganisms or biomass which are employed to degrade the contaminates in the wastewater. The main objective of this paper is to review the concept and application of the submerged hollow fiber module and its operation within MBRs. This paper reviews the design of current commercial submerged hollow fiber membrane modules, the filtration principles of the hollow fiber membrane, the main MBR system design specifications, the operation conditions, and the amount of residue under the sub-critical flux (flow) condition.

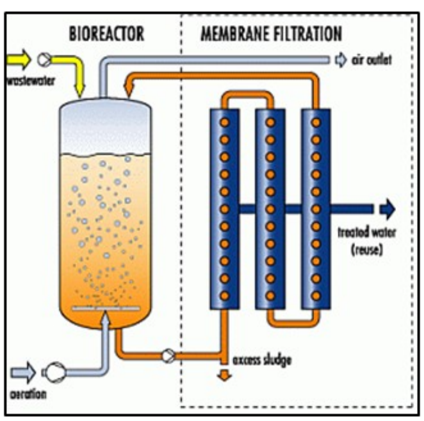

Image from http://3.bp.blogspot.com/_3d2Nl9Lavik/ TTd6PtDbk8IAAAAAAADU/SpRyuqMVzik/s1600/membrane_bioreactor_process_300.gif

What you need to know:

Submerged hollow fiber membrane modules are an effective design for membrane bioreactors. The cost effectiveness of the membrane system depends on the balance between the fiber packing density, aeration energy consumption, and other factors. For long-term operation under sub-critical flux conditions, a gradual decline in the membrane permeability will require maintenance and cleaning. This is needed for long term-stable operation of the membrane systems.

How can you use this research?

- **Manufacturers** can use this research to determine how they will design and manufacture their products.
- **Public Health** can use this research to set safety standards on wastewater treatment and waster reuse within their communities.
- **Municipalities** can use this research to upgrade their wastewater treatment facilities or optimize the process operation if a MBR system is in use.
- **Governments** can use the research to design policies and budgets that will allow this type of system to be implemented and potentially expanded in wastewater treatment systems.

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What did the researcher do?

Four aspects of filtration principles and performance of submerged hollow fiber membrane were tested:

1. Hollow fibre membranes were packed in di ferent bundle configurations. These bundles were assembled together to form an engineered system which provided a common permeate collection conduit. Important parameters include packing density and the design of the airflow over the individual membrane bundles.
2. Filtration with submerged hollow fiber-membranes has an uneven distribution of the transmembrane pressure (TMP) along the fibers. The actual TMP along the fibre could be significantly different from calculated values based on the suction pressure at the outlet. This could cause error in the estimation of the membrane permeability. The accuracy of the measurement can be improved by estimating the actual TMP along the fibre length based on the measured suction pressure and the average flux applied.
3. The typical design of MBR systems was explored. Systems could include oxygen-free and oxygen enriched biological treatment processes combined with a separate membrane tank. Sludge is recycled from the membrane tank to the biological tank and screens are used for pre-treatment of the wastewater to prevent the accumulation of trash in the membrane tank.
4. Membrane processes in MBR plants are often operated below the critical flux or in the sub-critical flux operation mode. In these modes, how can membrane fouling be reduced?

What did the researchers find?

The researcher found the following results:

1. Optimizing module packing density is of crucial importance for the capital and operation costs of MBR plants. A high module packing density could reduce the number of modules and the membrane tank size required to treat wastewater. They could also provide operational benefits due to the use of a smaller membrane tank, including reduced consumption of membrane cleaning chemicals or increased aeration.
2. The results of the mathematical equation show that the increased fiber length, permeability, ratio of O.D. to I.D. and reduced fiber inner diameter can result in a higher non-uniformity of the flux distribution. The filtration resistance of submerged hollow fiber membrane changes with time due to the build up of deposits on the membrane surface..
3. All MBR plants reviewed use alternating aeration. Air scouring was found to be essential to control membrane fouling. It was also found bubbling in mixed liquids can effectively control the reversible fouling through generating a secondary flow. The fouling control efficiency by bubbling is affected by the bubble size, shape, sprinkle type, and gas flow rate. For filtration with submerged hollow fiber membranes, intermittent air scouring, instead of continuous aeration can save 50% aeration energy.
4. The concept of the critical flux is based on the balance between the permeate flow induced particle deposition and the shear-induced back transport. However, even under sub-critical flux condition the soluble inorganic and organic materials in the mixed liquid can still build up on membrane surfaces and cause membrane fouling.

About the Researcher:

S. Chang is an Associate Professor with the School of Engineering at University of Guelph. Article: *Application of submerged hollow fiber membrane in membrane bioreactors: Filtration principles, operation, and membrane fouling, Desalination (2011), doi:10.1016/j.desal.2011.03.025*. schang@uoguelph.ca

Keywords:

MBR, Membrane, filtration, fouling, Packing density, Wastewater treatment, performance.

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