Better desalination technology key to solving world's water shortage

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Over one-third of the world's population already lives in areas struggling to keep up with the demand for fresh water. By 2025, that number will nearly double. Some countries have met the challenge by tapping into natural sources of fresh water, but as many examples - such as the much-depleted Jordan River - have demonstrated, many of these practices are far from sustainable.

A new Yale University study argues that seawater desalination should play an important role in helping combat worldwide fresh water shortages - once conservation, reuse and other methods have been exhausted - and provides insight into how desalination technology can be made more affordable and energy efficient.

"The globe's oceans are a virtually inexhaustible source of water, but the process of removing its salt is expensive and energy intensive," said Menachem Elimelech, a professor of chemical and environmental engineering at Yale and lead author of the study, which appears in the Aug. 5 issue of the journal *Science*.

Reverse osmosis - forcing seawater through a membrane that filters out the salt - is the leading method for seawater desalination in the world today. For years, scientists have focused on increasing the membrane's water flux using novel materials, such as carbon nanotubes, to reduce the amount of energy required to push water through it.

In the new study, Elimelech and William Phillip, now at the University of Notre Dame, demonstrate that reverse osmosis requires a minimum amount of energy that cannot be overcome, and that current technology is already starting to approach that limit. Instead of higher water flux membranes, Elimelech and Phillip suggest that the real gains in efficiency can be made during the pre- and post-treatment stages of desalination.

Seawater contains naturally occurring organic and particulate matter that must be filtered out before it passes through the membrane that removes the salt. Chemical agents are added to the water to clean it and help coagulate this matter for easier removal during a pre-treatment stage. But if a membrane didn't build up organic matter on its surface, most if not all pre-treatment could be avoided, according to the scientist's findings.

In addition, Elimelech and Phillip calculate that a membrane capable of filtering out boron and chloride would result in substantial energy and cost savings. Seventy percent of the world's water is used in agriculture, but water containing even low levels of boron and chloride - minerals that naturally occur in seawater - cannot be used for these purposes. Instead of removing them during a separate post-treatment stage, the scientists believe a membrane could be developed that would filter them more efficiently at the same time as the salt is removed.

Elimelech cautions that desalination should only be considered a last resort in the effort to provide fresh water to the world's populations and suggests that long-term research is needed to determine the impact of seawater desalination on the aquatic environment, but believes that desalination has a major role to play now and in the future.

"All of this will require new materials and new chemistry, but we believe this is where we should focus our efforts going forward," Elimelech said. "The problem of water shortage is only going to get worse, and we need to be ready to meet the challenge with improved, sustainable technology."

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