PRO as a sustainable energy production system is crippled by biofouling

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Researchers at the Zuckerberg Institute for Water Research at Ben-Gurion University of the Negev (BGU) and Yale University have determined that pressure-retarded osmosis technology is not feasible primarily due to biofouling (the accumulation of organic material as well as different organisms such as algae and bacteria on various surfaces that impairing structures and hinder system performance).

Pressure-retarded osmosis (PRO) is a process that for several decades has been considered to have potential as a sustainable energy source. It utilizes various salinity gradients, such as sea and river water, or desalination brine and wastewater. In PRO, water from a low-salinity feed solution permeates through a membrane into a pressurized, high-salinity draw solution. Power is obtained by depressurizing the draw through a hydro-turbine.

According to the new study published in the journal *Environmental Science & Technology*, researchers at the Zuckerberg Institute and Yale University found that, "power generation by PRO produces little and next to nothing due to biofouling caused by bacteria that clog the membrane structure and the feed channel." Prior to this study, researchers from Yale reported that this technology is thermodynamically challenging and is hardly viable.

"While the concept of using an 'osmotic gradient' to harness power has existed since the 1970s, our research shows that commercial PRO is currently 'dead in the water'," says Zuckerberg's Dr. Edo Bar-Zeev.

"Biofouling is detrimental to the process and can't be mitigated since there are no membranes today that are specifically designed for PRO."

He claims that to make PRO viable, the process requires either sterile streams on both sides or a new membrane design. "These membranes must be dedicated for PRO technology instead of using the current forward osmosis (FO) membranes," Dr. Bar-Zeev explains.

In the study, researchers explored the PRO's efficiency and practicality under biofouling conditions using synthetic wastewater secondary effluents and seawater reverse osmosis (SWRO) desalination brine. Experiments were conducted in a small-scale PRO setup using thin-film composite FO membrane and fabric feed spacers.

"The study showed that organic matter and bacteria in the feed wastewater stream resulted in extreme biofouling development across the feed spacer as well as the membrane support layer, thereby crippling PRO performance," explains Bar-Zeev. "These results will likely extend to other natural waters, such as river waters, where dissolved organic matter and bacteria are also prevalent."

More information: *Environmental Science & Technology*, dx.doi.org/10.1021/acs.est

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