

Resource recovery in an integrated urban water management framework

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Abstract: New membrane processes including forward osmosis (FO) and membrane distillation (MD) provide an excellent platform to transform wastewater treatment facilities to biorefineries. Major advantages of FO and MD include operation at very low hydraulic pressures, high rejection of a broad range of contaminants, and lower propensity for membrane fouling than in pressure-driven membrane processes. Our research demonstrates that FO and MD can be used to directly extract clean water from raw sewage for reuse, while simultaneously concentrating wastewater to the level suitable for anaerobic treatment. Anaerobic treatment of wastewater, sludge, and organic waste can produce biogas, which can then be used by a combined heat and power engine to produce electricity and thermal energy. Membrane based techniques have been developed to recovery phosphorus as either struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) or hydroxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$) from the sludge centrate. Pathway for practical implementation of the research outcomes toward a 'livable city model' will also be briefly discussed.