Investigation of Forward Osmosis Process for Wastewater Treatment and Water Reuse

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Introduction

- Rising water demand due to population growth, industrialization, and urbanization.
- Declining freshwater resources and water quality from pollution.
- Need for sustainable, affordable wastewater treatment, and water reuse techniques.
- Forward osmosis – a potential method with:
  - Low energy usage
  - Excellent pollutant rejection
  - High-quality water production for various uses
- Investigate performance and viability under different operating conditions.
- Current challenges in technology deployment for wastewater treatment and water reuse.

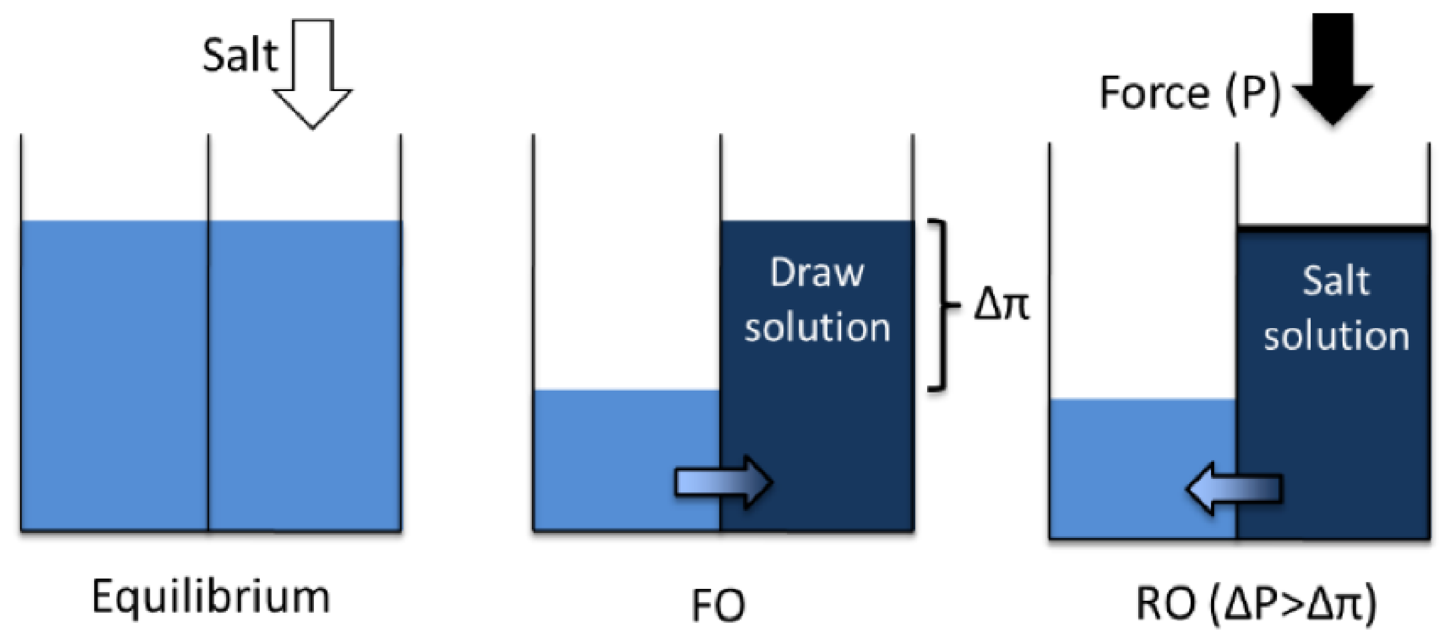

Figure 1: Solvent flow in FO, PRO and RO (Source: Medhrdad et.al, 2020).

Objectives

- Goal: Effectively remove challenging organic trace contaminants (phenol, aniline, nitrobenzene) for wastewater reuse.
- Examine forward osmosis (FO) as a promising wastewater treatment and water reuse technology.
- Study objectives:
  - Compare FO efficiency and efficacy to reverse osmosis (RO).
  - Investigate impacts of various variables on FO process.

The study will specifically look at the effects of:

1. Water flux
2. Cross-flow velocity
3. Temperature
4. pH of the draw solution

Methodology

Study examines forward osmosis for wastewater treatment and water reuse

Conduct thorough analysis of academic literature:
- **Academic repositories**
- **Internet resources**
- **Conference proceedings**

Findings

Draw Solution Selection

a) High osmotic pressure drive the water flow.
b) Be rapidly and effectively separated from the diluted draw solution to allow for the recovery and repurposing of the draw solution.
c) Be safe for the environment and non-toxic.
d) Be able to withstand membrane scaling and fouling.

Findings (cont'd)

Effect on water flux

•Optimal performance requires balance between water flow, osmotic pressure, and FO process effectiveness (McCutcheon et al., 2006).
•Mitigate issues with increased water flow:
- Right operating conditions.
- Membrane characteristics.
- Fouling reduction techniques:
  - Pretreatment.
  - Membrane surface modification (Zhao et al., 2012)

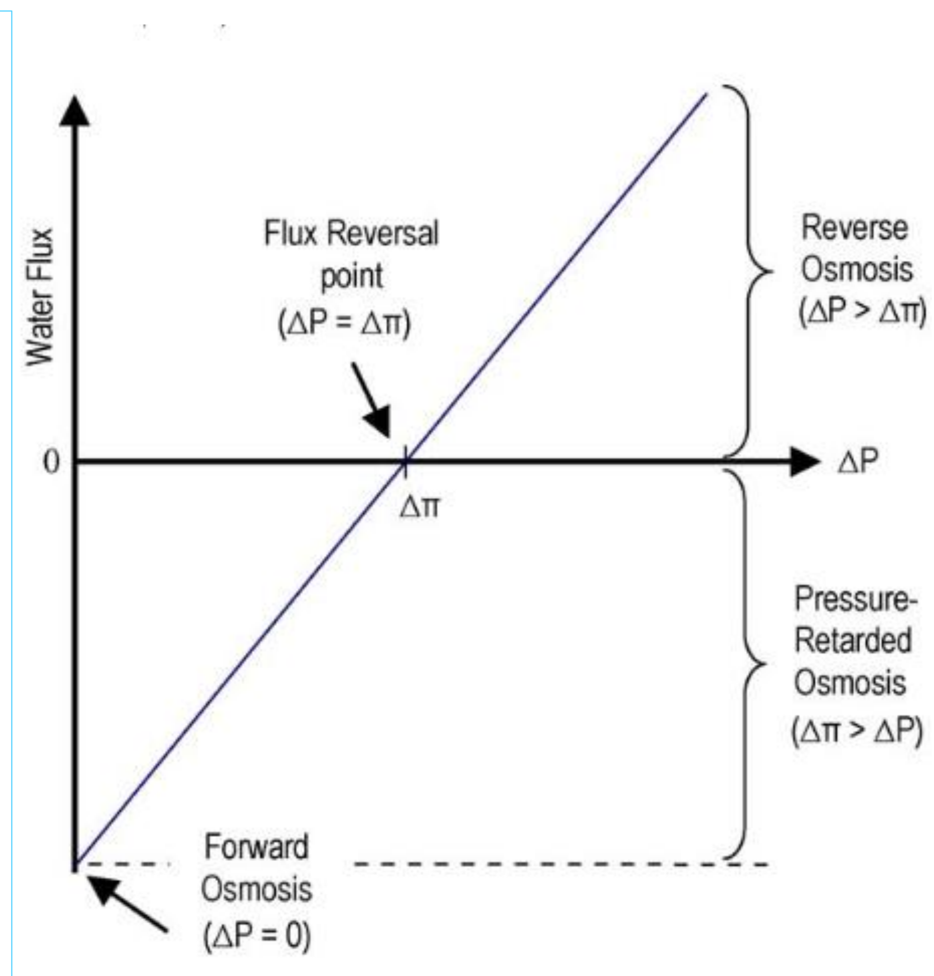

Figure 2: The relationship between water flux and pressure in FO, PRO and RO (Sources: Cath et.al, 2006).

Effect on Cross-flow velocity

•Cross-flow velocity impacts concentration polarization, fouling, and water flux in FO processes (Cath et al., 2006).
•Higher velocities:
- Increase flow
- Decrease polarization and fouling (Xie et al., 2013; Lay et al., 2010)
- Use more energy

•Ideal velocity balances performance and energy costs (Cath et al., 2006; McCutcheon et al.).

Effect on Temperature

•Temperature affects osmotic pressure, viscosity, solute solubility, and recovery effectiveness.
•Optimal draw solution should:
- Reduce concentration polarization (McCutcheon et al., 2006; Xie et al., 2012)
- Minimize fouling (Shaffer et al., 2015)
- Enable efficient draw solute recovery under specific temperature conditions (Chekli et al., 2016)

Effect on pH of the draw solution

•Draw solution pH influences: Solute rejection.
•Water flow.
•Pollutant rejection.
•Chemical stability, membrane charge, solute-membrane interactions (Mi et al., 2010; Lutchmiah et al., 2012; Wu et al., 2013).

Conclusion and Future work

•FO potential for sustainable water management due to:
- Enhanced pollutant rejection
- Decreased energy consumption
- Reduced fouling

•Important variables: water flux, temperature, pH.
•Future research focus to address global water scarcity and sustainable water resource management:
- Integration with existing treatment technologies
- Innovative draw solutes
- Advanced membranes
- Fouling resistance