Removal of Salt from Wastewater Streams

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1 Motivation and Goals

Currently: Nation Ford Chemical processes a wastewater stream with 3,300 mg/L of TDS
Future: Implement process that will produce additional stream with 23,083.3 mg/L of TDS

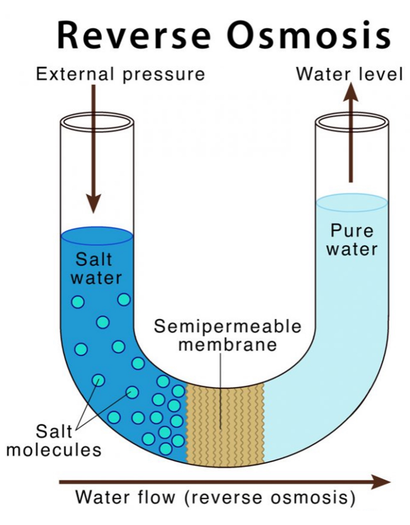
New Regulation ⍰ POTW has proposed a new TDS limit of 1,500 mg/L

Goals

- Lower TDS of combined process stream below 1500 mg/L using reverse osmosis
- Create an economical separation process
- Minimize safety hazards by implementing control and safety equipment

2 Technical Background

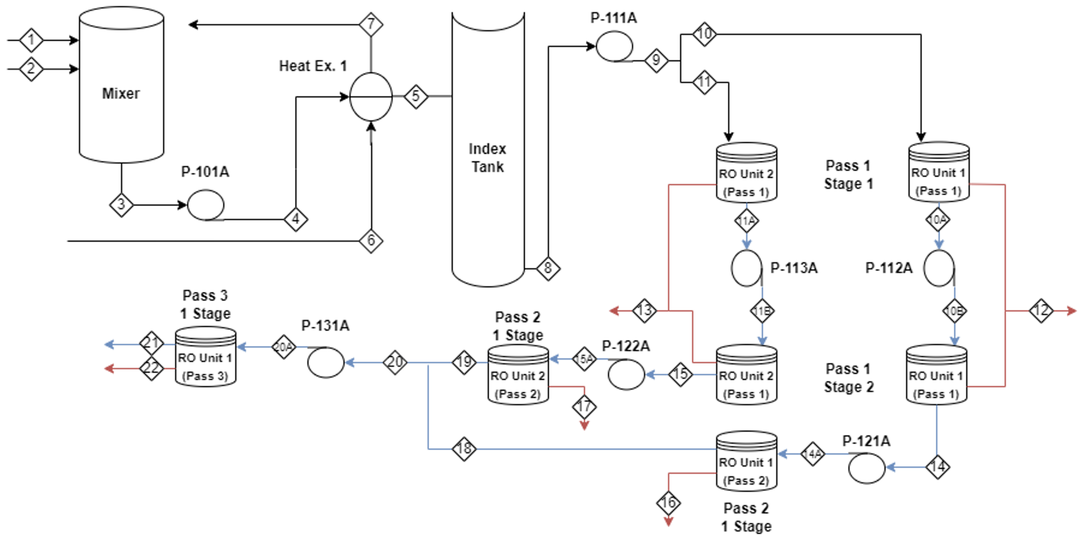
Reverse Osmosis: pressurized feed ran across membrane configuration.
- Permeate has low concentration of contaminants
- Concentrate has high concentration of contaminants
- Operable range of pressures to satisfy design needs
- Range and bounds found through sensitivity analysis



Reverse Osmosis Diagram
Reverse Osmosis, https://www.sciencefacts.net/reverse-osmosis.html

3 Design

Process Flow Diagram



Equipment Selection

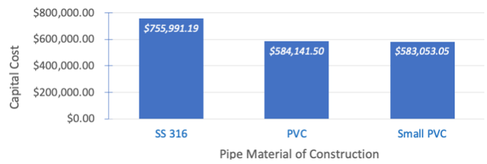
Equipment Name	Type	MOC
Mixer	Mixing Tank (built in agitator)	SS 316
Pumps	Centrifugal	SS 316
Heat Exchanger	Shell and Tube	Shell: CS // Tube: SS 316
Valves	Pressure Relief // Globe	SS 316
Index Tank	Welded Equalization Tank	SS 316
RO System	FilmTec™ Eco Pro-400 Element	Membrane: Polymer // Housing: SS 316
Piping	Stainless Steel	SS 316

Stream Table

Stream Number	10	10A	10B	14A	18	20A	21
Temperature (°C)	21.11	21.11	21.11	21.11	21.11	21.11	21.11
Pressure (psi)	295.00	287.50	295.00	165.00	19.00	19.00	14.70
Flow Rate (gal/min)	8.63	2.07	8.63	6.93	3.31	6.62	0.33
Component Flow Rate (kmol/h)							
Salt 1	0.19	0.04	0.18	0.17	0.01	0.03	0.0008
Salt 2	0.21	0.07	0.31	0.29	0.02	0.05	0.0013
Water	53.78	25.80	107.57	86.22	41.63	83.26	4.15
TDS Mole Percentage	**0.73%**	**0.45%**	**0.45%**	**0.21%**	**0.09%**	**0.09%**	**0.05%**

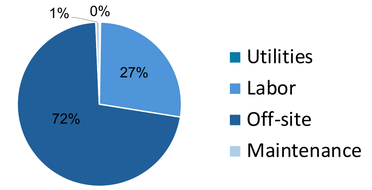
4 Economic Analysis

Capital Cost



Final Capital Cost: ~$756,000

Operating Cost



Total Operating Cost: ~$2,850,000

Return on Investment

1st Year ROI: ~ -26.3% **3-Year ROI: ~ -32.5%**

5 Hazards and Operability

HAZOP Guidewords- *More, Less, No*
HAZOP Recommendations
- Use a composition analyzer to determine the effectiveness of the RO separation
- Apply secondary containment such as a dike in the event of loss of containment from an overflow in the index or mixing tanks
- Have regular functionality checks of process equipment
- Add insulation to process piping

6 Conclusions

The Process is Not Suited for Commercialization
- From a technology standpoint, the project is feasible. RO is widely used in industry.
- To produce half of the volumetric input, there would need to be 27 passes
- The maintenance and energy consumption of so many passes is so expensive that the final ROI will -26.35% after 1 year of operation

Acknowledgments and References

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