Abbott Nutrition Reverse Osmosis Design Project

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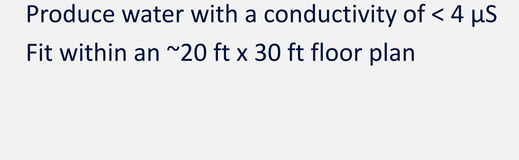
Abstract

At Abbott Nutrition's plant in Sturgis Michigan, hard well water goes through traditional treatment steps before being fed to boilers and eventually incorporated into products. To bring their boiler feed water treatment system to the state of the art system that produces water conductivity under 4 micro-Siemen, a reverse osmosis (RO) system was designed. This design will produce over supply over 180,000 pounds per hour.

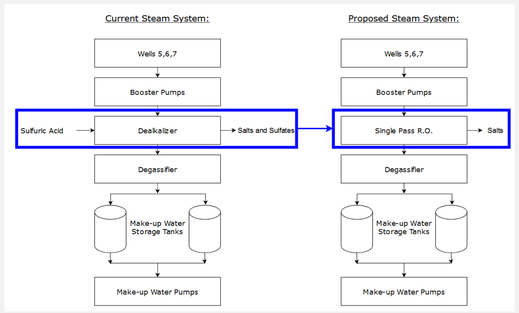
Background

De-alkalization



- Original way of cleaning well water
- Removal of calcium carbonates
- Sulfuric acid is used to regenerate the resin

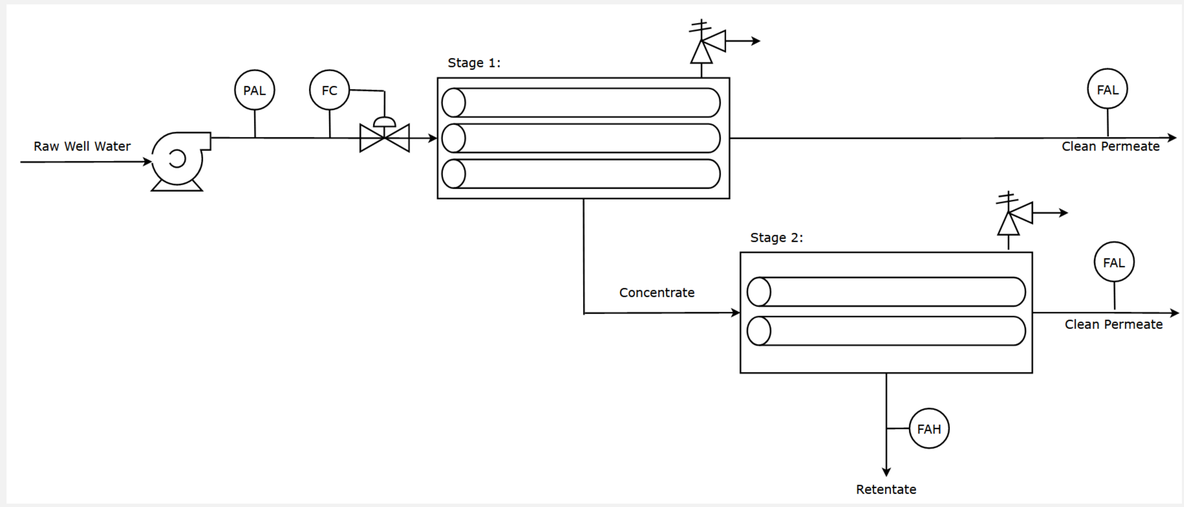
Project Proposal



Project Specifications

- Produce ~62,000 lb/hr makeup water for the boiler system
- Produce water with a conductivity of < 4 µS
- Fit within an ~20 ft x 30 ft floor plan

RO System Design



Design Specifications

Number of Elements

$$N_E = \frac{Q_P}{f * S_E}$$

Q_P = Permeate Flowrate
F = Design Flux
SE = Membrane Area

N_E = 30 elements

Staging Ratio

$$R = \left(\frac{1}{1-Y}\right)^{\frac{1}{N_S}}$$

Y = System Recovery
N_S = Number of Stages

$R = 1.09$

Number of Pressure Vessels

$$N_V = \frac{N_E}{N_{EPV}}$$

N_E = Number of Elements
N_{EPV} = Number of Elements per Pressure Vessel

N_V =5 vessels

Number of Vessels in Stage One

$$N_{V1} = \frac{N_V}{1 + R^{-1}}$$

N_V = Number of Pressure Vessels
R = Ideal Staging Ratio

$N_{V1} = 3\ stages$

System Pressure Drop

$$\Delta P_{fc} = \frac{0.1 * \frac{Q}{1440}}{Y * N_{V2}} * \left(\frac{1}{N_{VR}} + 1 - Y\right)$$

Y = System Recovery
N_{V2} = Number of Vessels in Stage 2
N_{VR} = Stage Ratio

$\Delta P_{fc} = 98\ psi$

Number of Vessels in Stage One

$$N_{V2} = \frac{N_{V1}}{R}$$

N_{V1} = Number of Pressure Vessels in Stage One
R = Ideal Staging Ratio

$N_{V1} = 2\ stages$

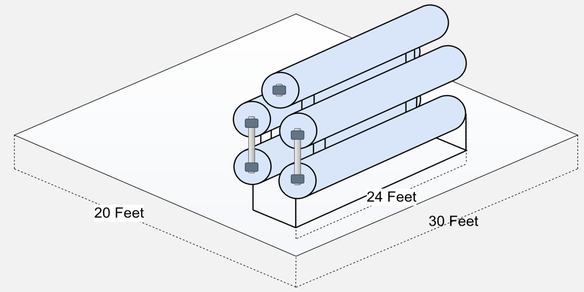
Membrane Specifications

- Membrane: Dow FilmTec BW30-440
- Type: Polyamide Thin-Film Composite
- Active Area: 440 ft^2
- Permeate Flowrate: 10,500 gpd
- Min Salt Rejection: 99%
- Max Pressure Drop: 15 psi

Economics

- Membrane Cost: $1000/unit
- Vessel Cost: $1200/unit
- Pump: $34,000/unit
- Correction Factor: 5
- **Total Estimated Cost: $350,000**

Floor Plan



References

[1] Dow Chemical, "FilmTec Membrane System Design," Form No. 45-D01695, Rev. 10, Feb. 2022

[2] Dow Chemical, "FilmTec Design Equations," Form No. 609-02057

[3] Dow Chemical, "DOW FILMTEC BW30-440," Form No. 609-00482-0910