Corrosion informed costing

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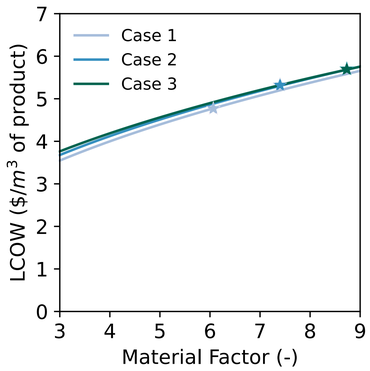
Background

- Corrosion is a significant challenge when treating waters at high concentrations, particularly in thermal processes
- Preventing corrosion requires selection of materials that are corrosion resistant at specific operating conditions
- Implementing cost functions that account for material selection to prevent corrosion will enable WaterTAP models to better balance trade-offs between operating conditions and material costs

Motivation

- Material factor F_m (costing multiplier to account for cost of different materials) impacts the LCOW of MVC significantly, so need to account for effects of corrosion in determining the material factor

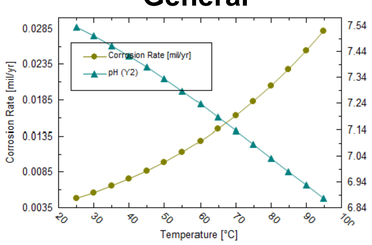


Methods

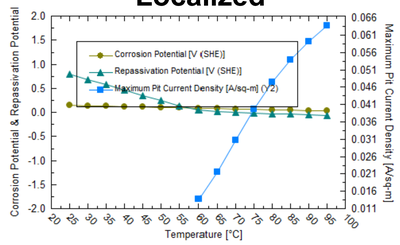
OLI Corrosion Analyzer

- Predicts general corrosion rate and localized corrosion

General



Localized



Temperature survey for seawater with duplex stainless steel 2205

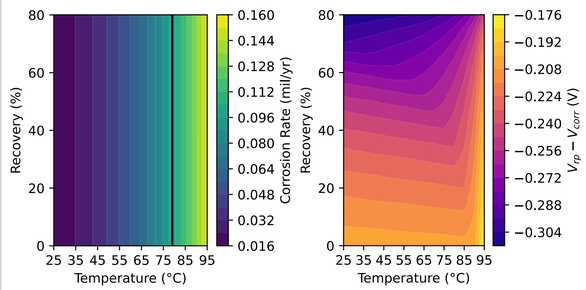
- Conducted parameter sweeps for seawater

Parameter	Range
Temperature	25-95 C
pH	3-8
Recovery	0-80%
Dissolved oxygen	0-10 ppm
Flow	static, pipe flow, agitated
Material	carbon steel 1018→ stainless steel 304/316 → duplex stainless steel 2205/2507 → nickel alloys 625/825

Material Selection

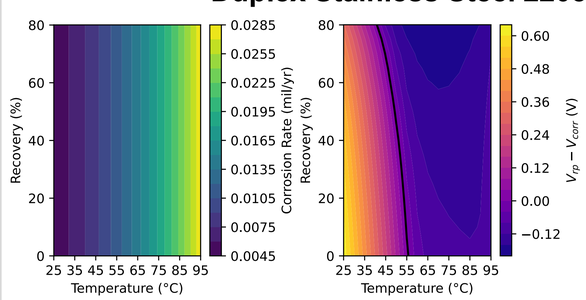
- Select materials with a general corrosion rate less than desired threshold and where no localized corrosion occurs

Stainless Steel 316



Below the black line at 79°C, the general corrosion rate is sufficiently low, but localized corrosion occurs at all recoveries and temperatures

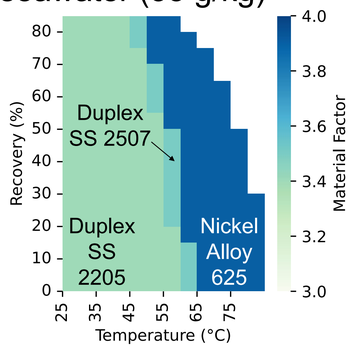
Duplex Stainless Steel 2205



The general corrosion rate is sufficiently low at all recoveries and temperatures, but localized corrosion occurs above the black line

Results

- Material factor corresponding to lowest cost, corrosion resistant material across temperature and recovery for seawater (35 g/kg)



- May be overestimating material costs at lower brine salinities (by 15% below) and underestimating at higher brine salinities and temperatures

Case (seawater)	Recovery (%)	Temperature (C)	Material Factor (-)	LCOW ($/m³)
Original F_m estimate	70	75	3.9	3.85
Corrosion informed F_m			3.4	3.25

Future work

- Use surrogate models to consolidate corrosion parameter sweep into a new material factor function for the evaporator and heat exchangers
- Quantify how much considering corrosion in the material selection impacts pretreatment and the LCOW of MVC and other brine concentration processes that rely on heat exchangers

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