* Objectives
* Inlet Stream Conditions and Purity Target
* Treatment Trains
  + High level overview
    - Pretreatment, primary and secondary treatment
  + Process Flow
    - Pretreatment
      * NF
      * IX
    - Primary Treatment
      * Membrane Distillation
      * Low-salt rejection reverse osmosis (LSRRO)
    - Secondary Treatment
      * Osmotically assisted RO
      * Counterflow RO
  + Summary of NF and MD Unit Operations
    - Introduce WaterTAP
    - Nanofiltration
      * NF Zero Order (ZO)
        + Assumed performance model
      * NF Donnan Steric Pore Model (DSPM-DE)
        + Incorporates first principles mass transport models
    - Membrane Distillation
      * More complex, not just a single piece of process equipment
      * All processes are based on first principles heat, mass and momentum transfer
    - **Note**: The feed solution was made charge neutral by adjusting Cl- concentration
  + NF Zero Order
    - Assumed performance – the performance of the model is based on the user’s specification, not necessarily on physics/thermodynamics
    - Pros
      * Easy to set up
        + Few DOF
      * Quick to simulate
      * Highly flexible
        + Some processes may be too tedious to describe using first principles models
    - Cons
      * Lack of physical basis means results can be unrealistic
      * Related process parameters aren’t affected by change in performance variable
        + Ex. a turbine will lower enthalpy of influent steam, which manifests as a decrease in temperature between influent and effluent
    - In this case, 2 DOFs
      * Inlet stream composition
      * Membrane solute rejection
  + DSPM-DE
    - Theoretical basis
      * Nernst-Planck equation
      * Gives mass flux of a charged species in a fluid due to
        + Diffusion
        + Advection
        + Electrostatic effects
      * Eqn
      * Ion mobility is affected by membrane pore size (Knudsen diffusion)
      * Terms for convective and diffusive hindrance are added to account for this
    - Simulation
      * Nernst-Planck can be discretized
        + Eqn
      * And linearized (I won’t show)
      * Show Fig 2 in Geraldes
    - The WaterTAP model handles this simulation for us
  + Membrane Distillation
    - Unlike most membrane processes which rely on hydrostatic pressure differences, MD relies on vapor pressure differences
    - How MD works:
      * Hydrophobic membrane (i.e. PTFE) separates hot and cold
        + Liquid phase water cannot wet the pores (contact angle > 90 degrees)
      * Only vapor may pass through the membrane
      * The vapor pressure of most salts is negligible at normal operating conditions
        + The vapor phase that forms within the membrane is effectively pure water
      * A temperature gradient across the membrane (arising from temperature difference of the fluid at either boundary) acts as a driving force
      * Clausius-Clapeyron
        + Given enthalpy of vaporization and temperature difference, we can calculate difference in partial pressure
    - The waterTAP model
* Results