Solar Membrane Distillation for Off-Grid, Decentralized Water Purification

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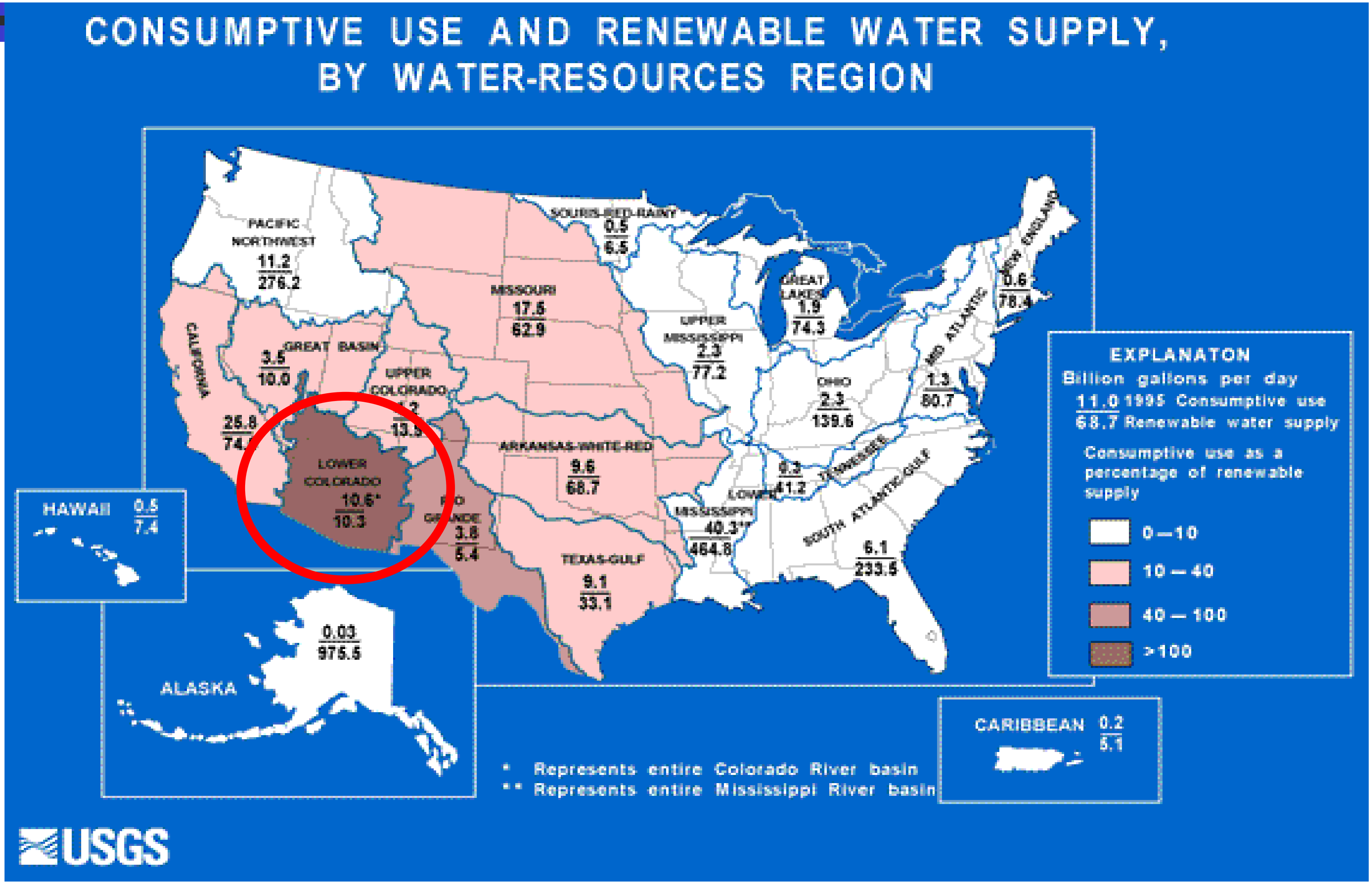
U.S. Water Stress Ratio



Water Stress: Leading Edge

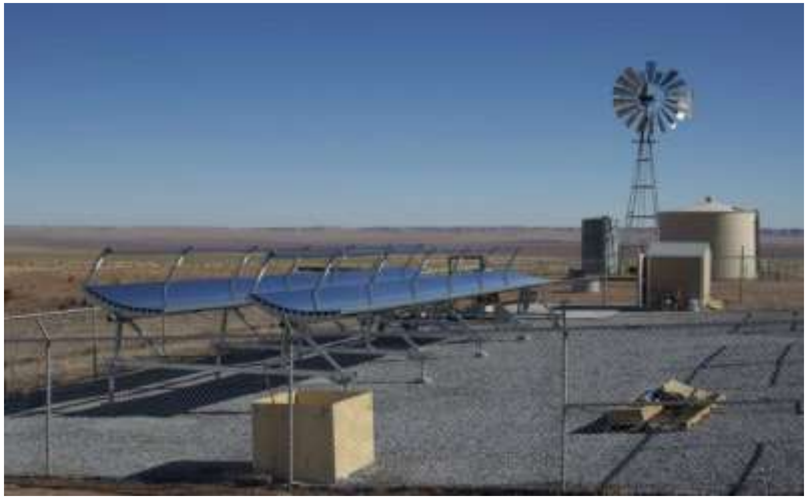
- 21000 homes and 300,000 residents
- 40% no access to running water
- ~243 LPCD (~711 other places in USA)
- Water hauling ~ 60km round trip
- Water cost:

Tucson	City of Phoenix	Navajo Nation
$0.0011/L	$0.0013/L	$0.038/L

-Ronson Chee

Why MD for Navajo?

- Large, brackish aquifer
- Off-the-Shelf
- O & M Simplicity



Courtesy of A. Barnhart

Courtesy of D. Serwon

- Autonomous, off-grid operation
- Brine Minimization
- Solar compatibility

V/SG MD Research Objectives

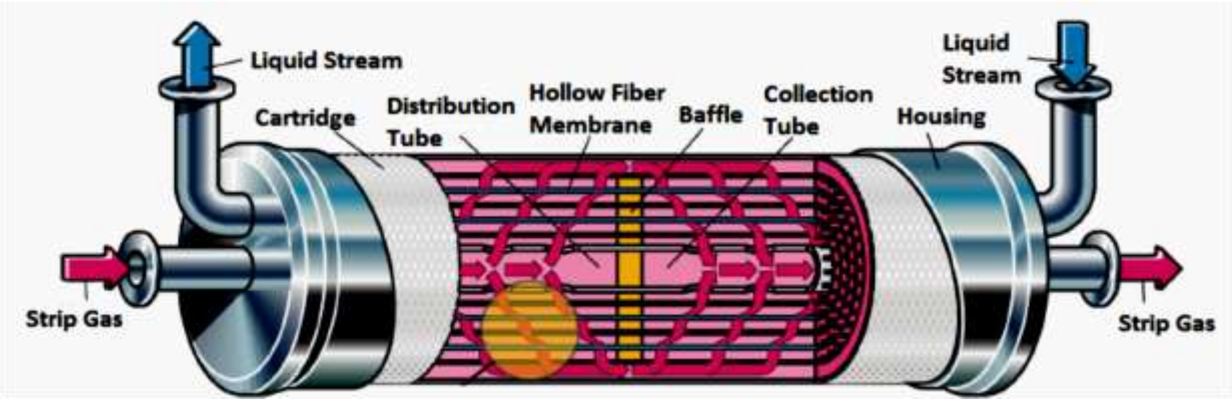
1. Adapt and characterize commercial modules and off-the-shelf components for Membrane Distillation (MD) desalination

2. Develop predictive, mechanistic model (numerical simulation) and validate against experimental observations

3. Implement and monitor demonstration-scale system in field and train local ownership and operation team

Hollow Fiber (HF) Contactors

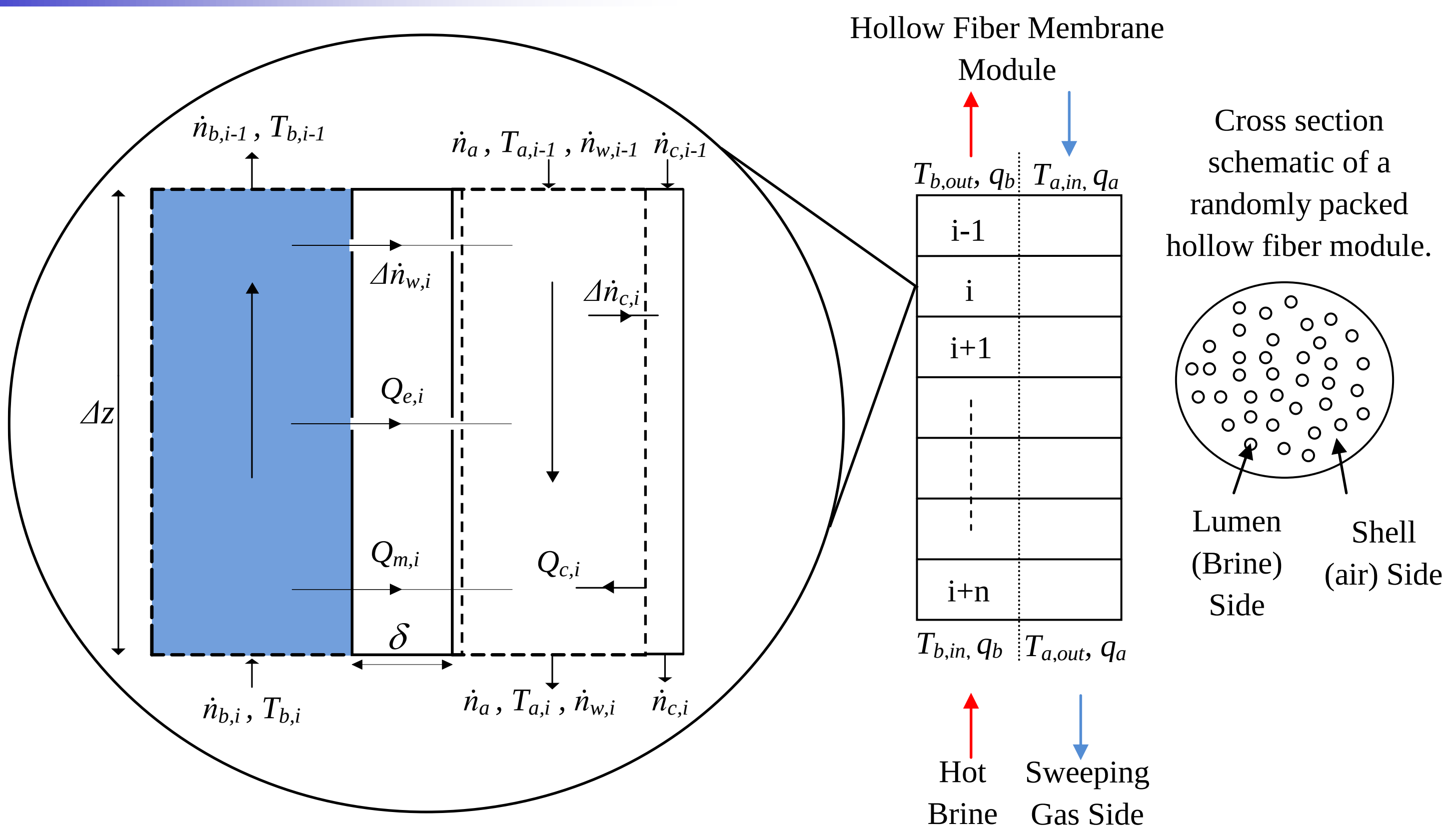
Liqui-Cel Membrane Module	
Membrane material [--]	PP/ PVDF
Area [m^2]	1.4
Pore size [μm]	0.03-0.1
Fiber length [m]	0.2
Fiber inner diameter [mm]	225
Fiber outer diameter [mm]	315
Porosity [%]	30



MD Study Progression

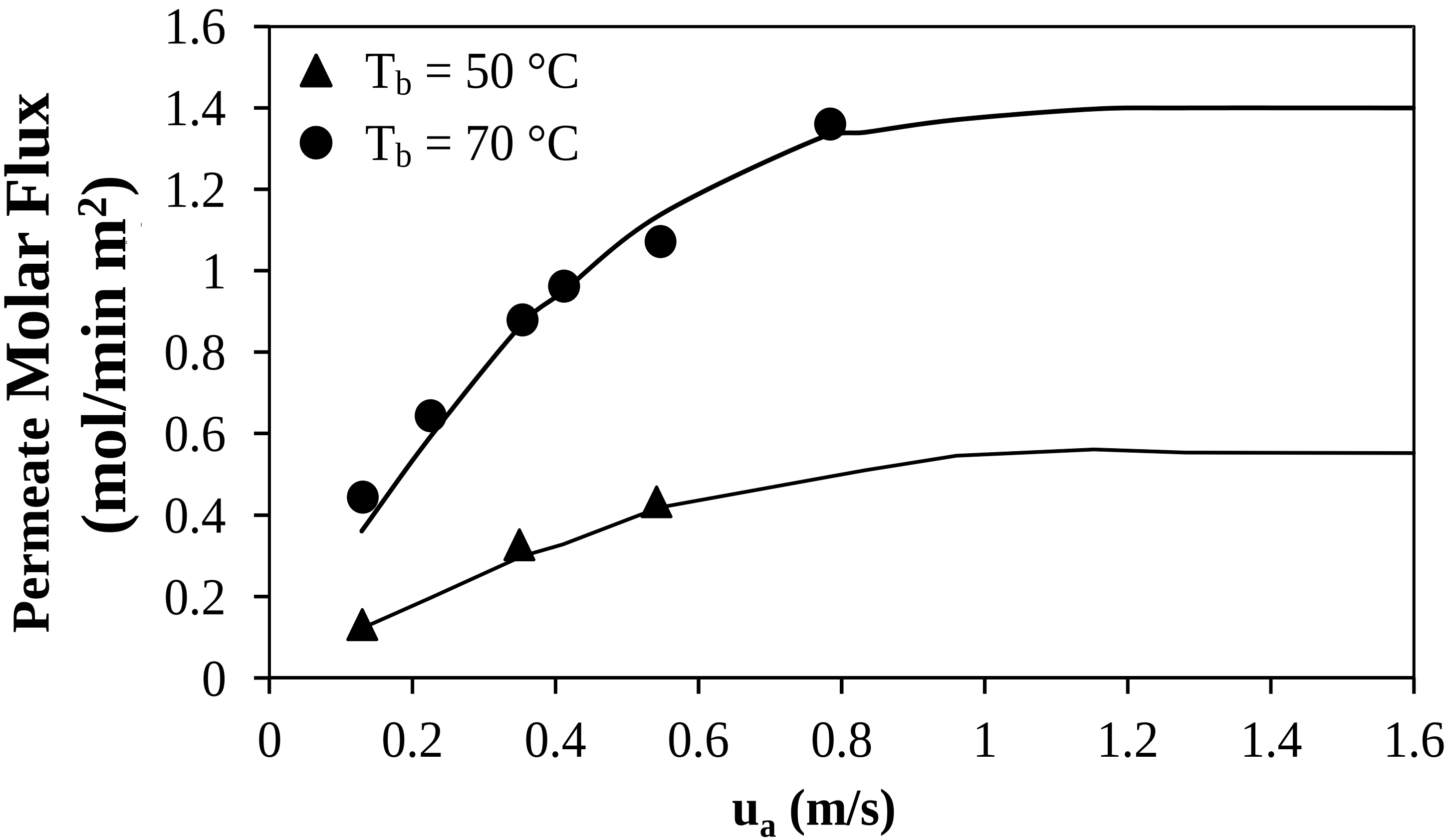

Field scale

Model Development



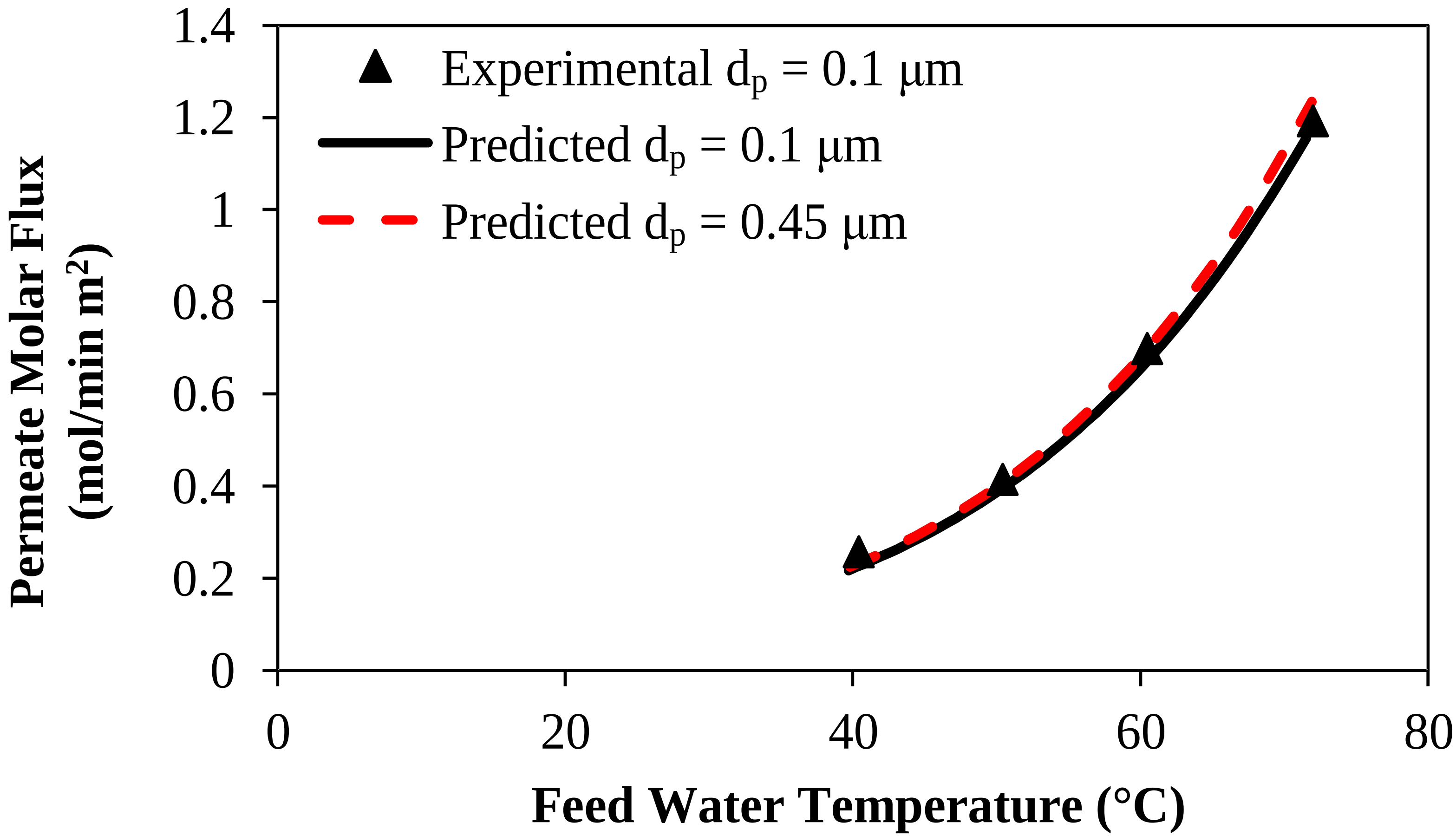
- Finite Difference Method
- Coupled mass and energy balances
- Fractal analysis for inter-fiber distance
- Condensation term
- Fitted parameter: tortuosity

Sweep Gas Velocity Effect



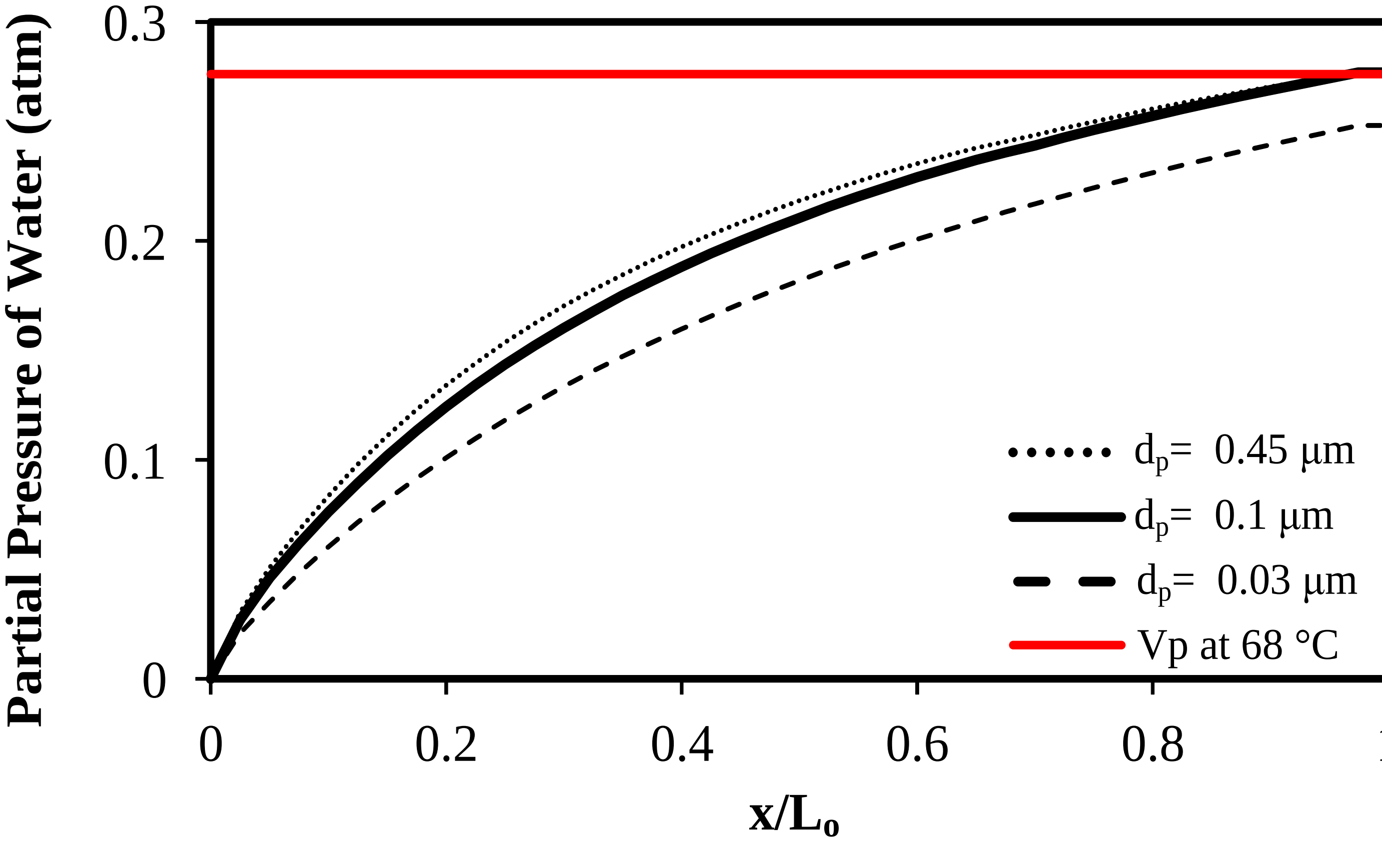
- u_b constant
- Solid lines represent predicted values

Pore Size Effect



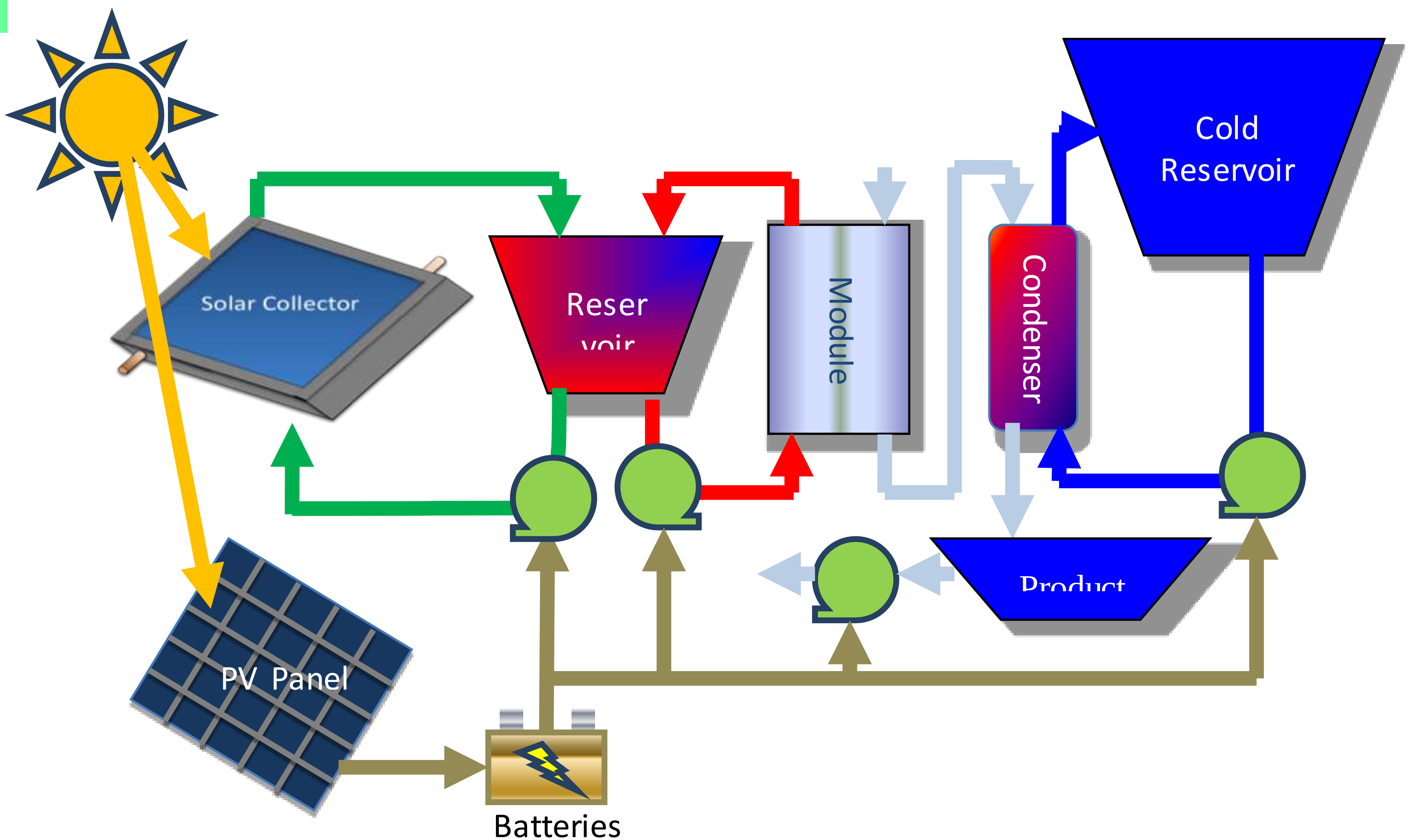
- u_a and u_b constant

Partial Pressure of Water



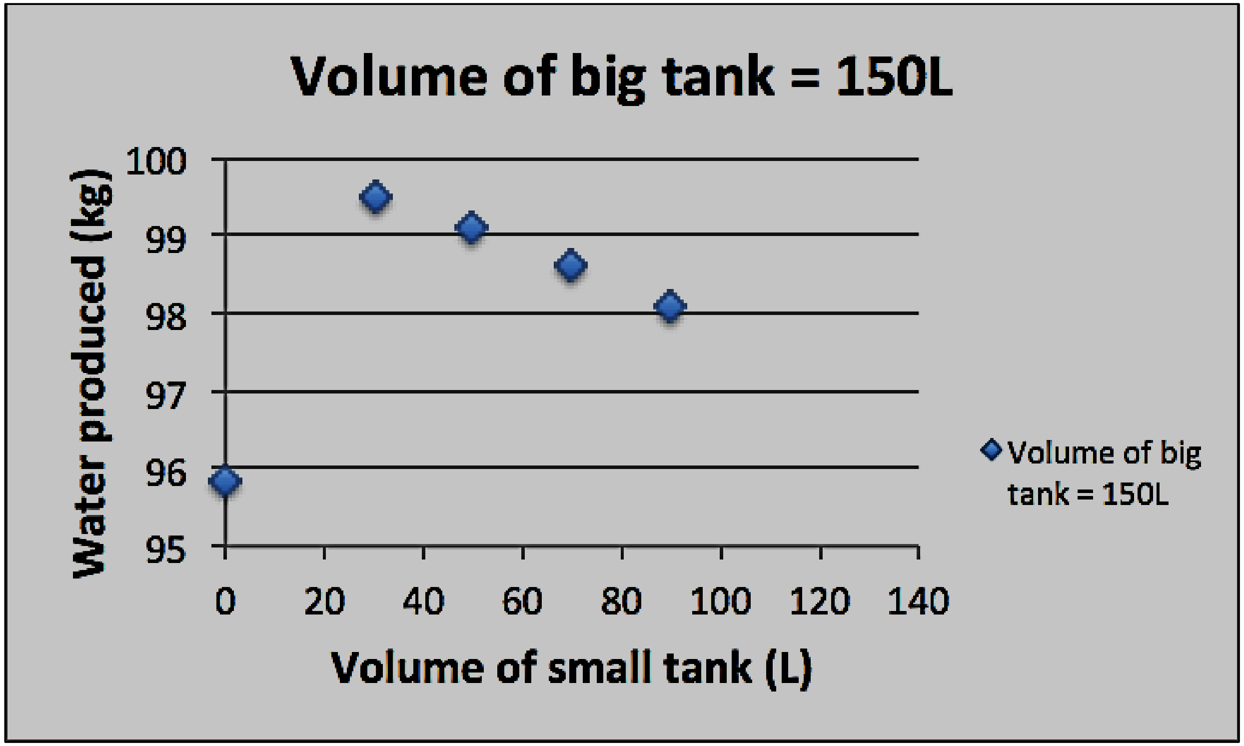
- u_a, u_b and T_b constant

Implementation Layout

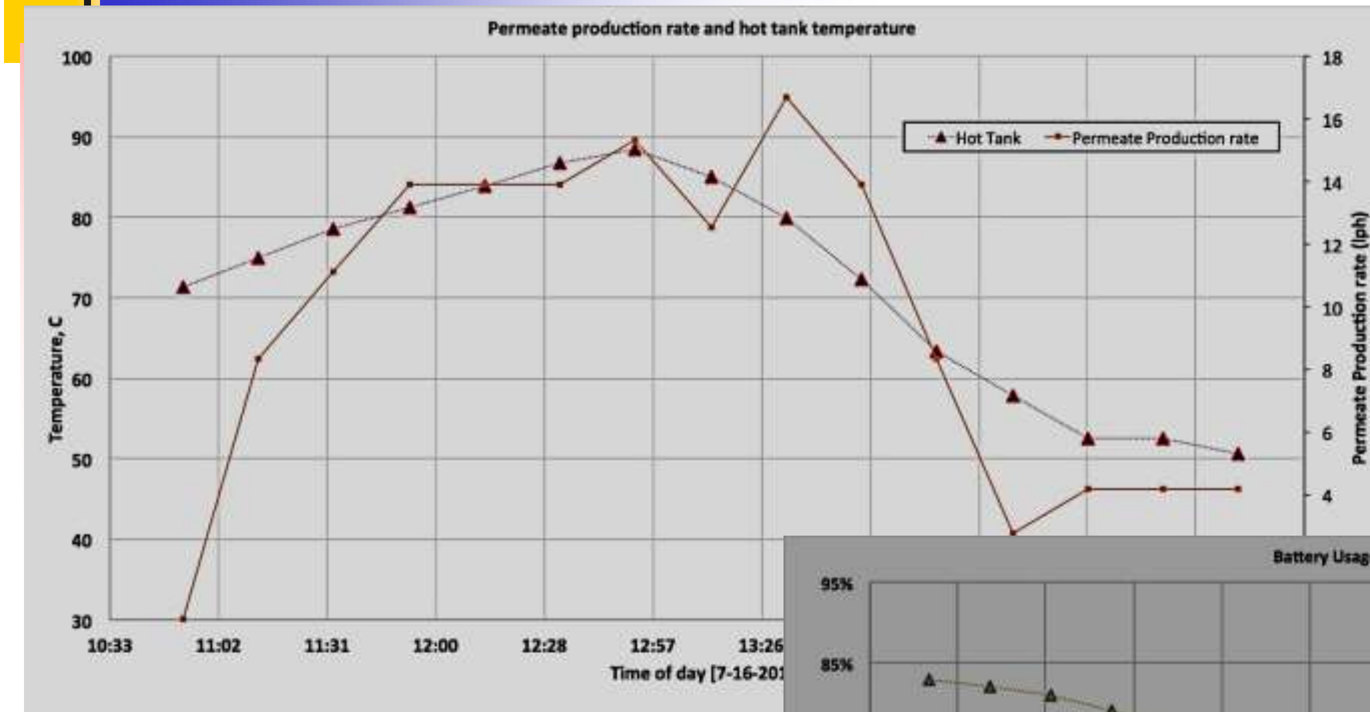


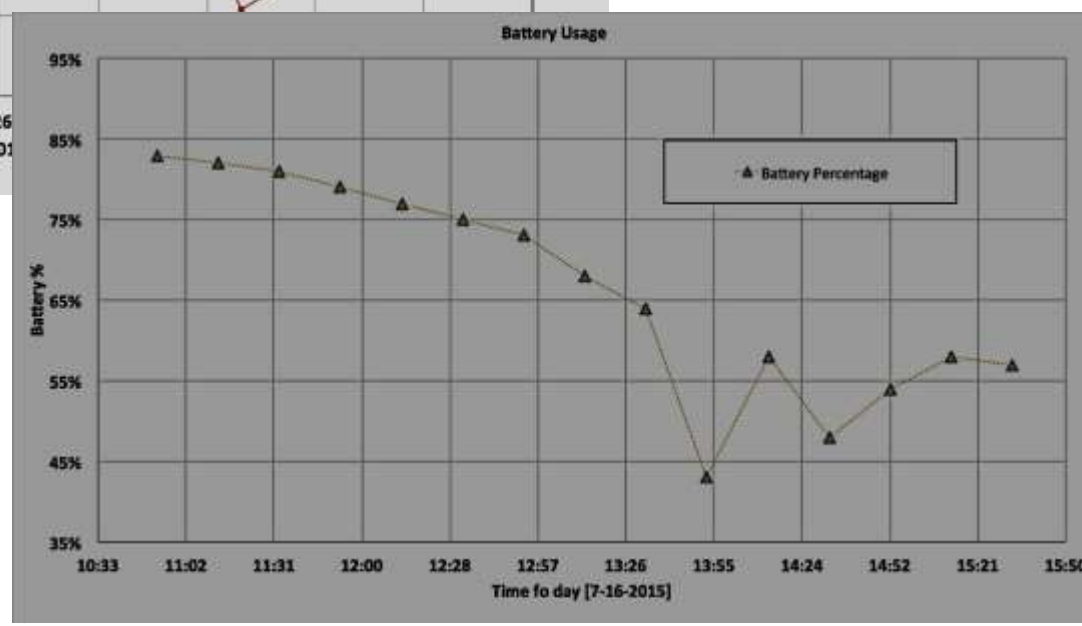
Integrating Solar and MD

Two "tank" system: one small h/x followed by large heat storage tank.



Insight 1: Component Scaling





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Questions

Concerns

Comments

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