Advanced Quality Ultrapure Abstraction (via) Solar (AQUASOL)

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Executive Summary

- AQUASOL is a project focused on revitalizing clean drinkable water on our planet. Our engineers will design and produce a system that will transform brine into clean drinkable water using thermodynamic and fluid dynamic principles. Generating most of the power from the sun we can provide our product in almost any part of the world near an ocean. For the foreseeable future, we hope to be able to provide clean and drinkable water for communities in need of clean water.

Goals & Objectives

- Our goal is to create a solar water purification system, which requires us to do two things: one is to design a water purification system, and the other is to design a solar energy supply device. The water purification system consists of an RO system and pump, therefore, we need to design the RO system and pump, as well as their corresponding circuits powered by solar energy.

Engineering Analysis

- The primary goal is to evaluate the flow characteristics within the piping system, such as velocity, pressure drops, and Reynolds number, to ensure efficient and reliable operation of the desalination process.
- Part of the Fluid Dynamics MATLAB code calculations [1]:
  - % 1. Calculate Flow Velocity (V) A = pi * (D/2)^2; % Cross-sectional area of pipe (m^2) V = Q / A; % Flow velocity (m/s) %
  - 2. Reynolds Number (Re) Re = (rho * V * D) / mu;
  - % 4. Pressure Drop due to Pipe Friction (Delta P_f) Delta_Pf = f * (L/D) * (rho * V^2 / 2); % Pressure drop due to friction (Pa)
- Results: Flow Velocity (V): 0.22 m/s, Reynolds Number (Re): 2141.55, Total Pressure Drop (Delta P_total): 758513.85 Pa, Pump Power Requirement (P_pump): 15.95 W

References & Acknowledgements:
AquaSol gratefully acknowledges the crucial guidance of of our sponsor Abdelrahman Elmaradny

[1] H. T. El-Dessouky and Hisham Mohamed Ettouney, Fundamentals of salt water desalination. Amsterdam ; New York: Elsevier, 2002.

RO Membrane

- Reverse Osmosis (RO) is a water filtration process that uses a semipermeable membrane to remove contaminants from water
- The spiral-wound RO membrane achieves a high salt rejection rate, ensuring that the water output is sufficiently purified.
- Using a conductivity meter it is necessary to acquire water under 200 ppm which meets health and safety standards by ensuring that dissolved salts and other impurities are effectively removed

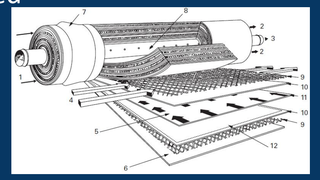

Figure 1: Spiral-wound membrane

3 Chamber Diaphragm Pump and Pipe/Valve

- The Pump is a efficient component to deliver consistent water pressure to the RO membrane. Its 3 chamber design ensures smooth water flow with no pulsation, maintaining optimal filtration performance. The pump works with pipe and valve system to regulate water flow and pressure.

Power Generation

- Operated via photovoltaic cells, we can generate electricity from direct sunlight and convert it to electricity, in which is stored in a battery to ensure continuous operation. The feasibility of this approach has been validated through energy balance calculations, confirming that the generated power is sufficient for the desalination process.

Combined System

- The Combined System integrates an efficient water purification solution. The solar panels generate and store electricity to power the diaphragm pump, which delivers pressure to the RO membrane, ensuring optimal filtration performance. The system could effectively filter brine and produce purified water below 200 ppm, meeting health and safety standards.

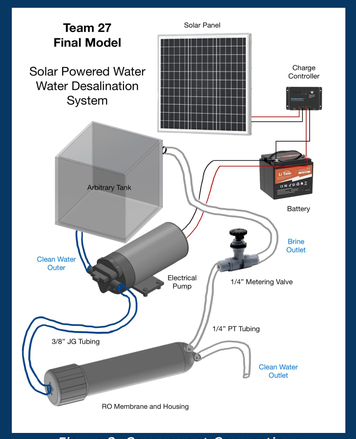

Figure 2: Component Connections

Results

Figure 3:Physical Model

Final design

- The solar panel generates electricity to charge the battery for energy storage.
- The battery powers the electric pump, ensuring water flows through the system under pressure.
- The electric pump pushes water through the RO membrane for efficient reverse osmosis filtration.
- The RO membrane removes impurities and contaminants, providing clean drinking water.

Tests

- System works to reject salt through RO membrane, when continuously filtered (filtered output dispensed into input) it reduces salinity by 50 % within 15 minutes
- When not continuously filtered, RO membrane rejects 93 % of initial salt in permeate stream

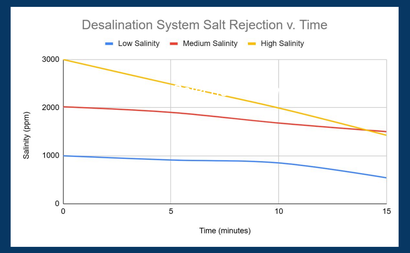

Figure 4: Salt Rejection vs Time

Conclusions & Future Improvements

- Needs a cohesive user interface and better water management system
- Parallel RO Membranes for better filtration for future project successors

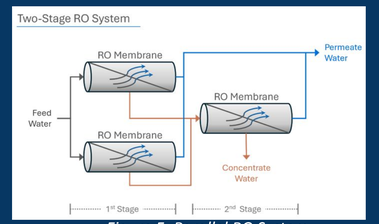

Figure 5: Parallel RO System