UNT
COLLEGE OF ENGINEERING
Department of
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Consolar Aqua-Pump Team

Solar Desalination Circulation System

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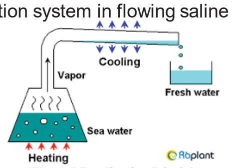
Consolar Aqua Pump
Fresh water everyday

Introduction

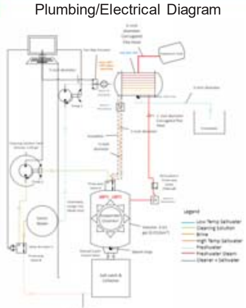
The effects of Global Warming has seen an increase in scarcity of many basic human resources, one of which that is most significant is freshwater. A sufficient solution to this is desalination, the process of separating salt from seawater by a closed system of evaporation and condensation. However, a drawback of desalination is the energy consumption required to produce a worthy amount of freshwater. Therefore, the objective of the Consolar Aqua Pump is to support the desalination system in flowing saline water through a multistage distillation process, generating power for its electronics and controlling the temperature through an autonomous feedback code. This poster will discuss the initial circulation design, simulation data and code operation outputs that were analyzed throughout the duration of this project.



<Thermal Desalination Principle>

Abstract

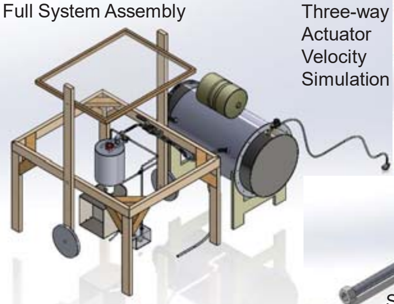
Plumbing/Electrical Diagram



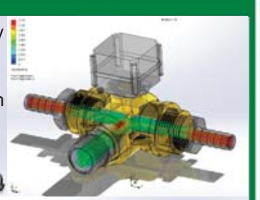
The Consolar Aqua-Pump's objectives are to promote the distillation process by powering itself, operating/monitoring its performance, and dispersing freshwater contents. By utilizing solar panels and battery circuits to power electronics we achieve a net-zero energy system. We relay on and off signals to valves and pumps between the power source and a Raspberry Pi via a feedback control loop. The control loop infers sensors' data and reacts to critical readings by isolating the system instantaneously. Finally, the temperature resistant segments connect all major components ensuring a controlled flow.

Design Models

Full System Assembly



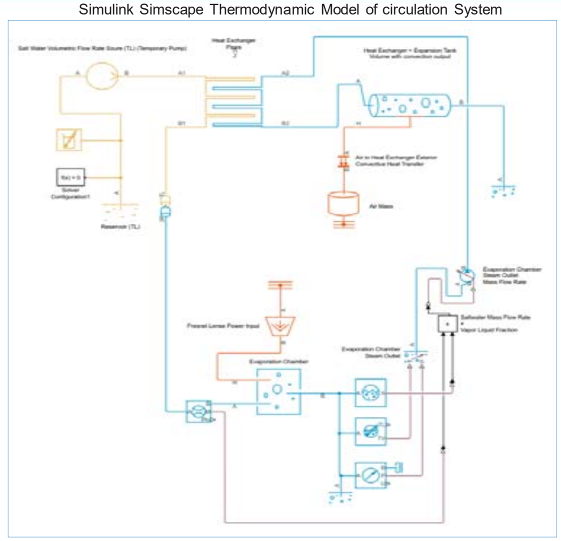
Three-way Actuator Velocity Simulation



Steam Direction Line Section

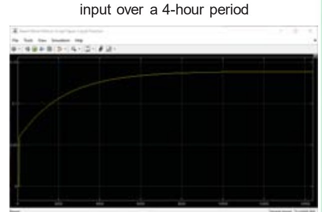
Simulink Simulation

Simulink Simscape Thermodynamic Model of circulation System

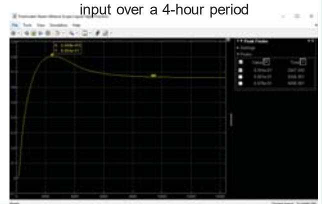


In Simscape, we designed a thermodynamic model around the boundary conditions of the heat exchanger, evaporation chamber, and salinity of seawater. This was achieved using a series of thermal fluid toolboxes tailored to the same volumetric flow rate (2 gal/hr), specific surface area geometries, maximum heat transfer (1000W), and initial temperature of saline fluid (22℃). The result confirmed our hypothesis when steam production increases, the amount of energy that the saline liquid must absorb increases proportionately. An increase in heat transferred to preheat the saline water allows for easy separation of freshwater vapor from the saltwater mixture in the evaporation chamber. However, the throttled volume of the heat exchanger hinders its heat absorption ability as increasing temperature reducing its heat transfer coefficient. This thereby restricts its ability to condense the steam into freshwater thus leading to a thermodynamic steady-state seen to the right. The steam production and condensation to mass ratio levels out at 13.89% and 66.32% respectively. When calculated, our simulated system produces 1 gallon of condensed, distilled water every 6 hours using no inputs besides saltwater and solar irradiation.

Steam to input saline mass ratio for 1000W input over a 4-hour period



Freshwater to steam mass ratio for 1000W input over a 4-hour period



Acknowledgements

SOLAR SOLUTION

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Results and Conclusion

The HiLetgo flow sensor was calibrated by counting the number of total pluses emitted to the Arduino over a run time period. Each pulse is represented by a "1" while a "0" is a count between pulses. There are 6.235E07 pulses received per one gallon of water displaced as our standard proportion ratio. The results above counted 18820041 pulses over a 10 second period equating to 0.0301 gal/sec. This measurement is accurate because the constant flow rate of our pump displaces 0.035 gal/sec. Occasionally, the voltage supplied by the raspberry pi was too weak to transit through the length of wiring ensuing lack of received data.

The Otomatico temperature sensor probes displays readings in Fahrenheit compatible with the Raspberry Pi's interface above. Sensor 1 measures preheated saline water existing the heat exchanger and serves as an efficiency variable. Sensor 2 tracks the superheated vapor temperature flowing through the steam line that communicates a range of safety readings with the Arduino. Upon releasing steam into the condenser, sensor 2 reached a peak temperature of 86°F, well within our predicted range, while sensor 1 remained at a consistent 22°F.