

Green integrated water distillation system

Team - 032



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Introduction

Problem Statement

The current methods of seawater distillation face inefficiencies and high costs, particularly in regions like Saudi Arabia with water scarcity issues. Our project aims to address this challenge by integrating geothermal heat energy, membrane distillation, solar power, and absorption chilling to create a sustainable solution aligned with Vision 2030 goals. However, there is a need to overcome technical and logistical hurdles, including optimizing system placement near geothermal hotspots and ensuring efficient energy utilization, to achieve our objective effectively.

Constraints

- Geothermal surface output of 97°C
- Geothermal spot location away from shore by 10km
- Founding limit of the 6000 SR provided by the university
- The limitation of time we have for developing our idea
- Geothermal Flow rate 6.30 kg/s
- A minimum water production of 7740 m³ daily
- Acceptable limit of total dissoluble salts 100 ~ 500 ppm

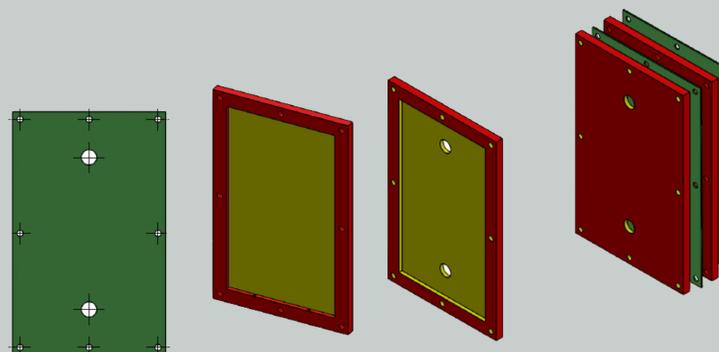
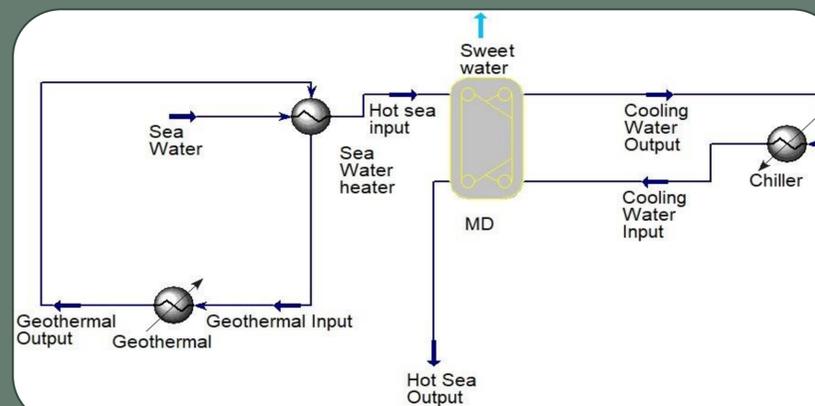
Target Specifications

- Hot Fluid flow rate = 238032 Kg/day
- Water Production flow rate = 13669 Kg/day
- Hollow fiber diameter 0.360 mm
- Tube length = 295 mm
- Tube inside diameter = 0.36 mm
- Tube number = 196758

Project Impact

By integrating renewable energy sources such as geothermal heat and solar power with innovative distillation technologies like membrane distillation and absorption chilling, this project aims to not only reduce environmental impact through decreased reliance on fossil fuels and lower greenhouse gas emissions but also enhance water sustainability by providing a cost-effective and energy-efficient solution for seawater distillation, ultimately fostering economic benefits and technological innovation in regions grappling with water scarcity.

Prototype Design



Validation

Tube Side				Shell Side			
Inlet		Outlet		Inlet		Outlet	
Name	1	Name	2	Name	geothermal	Name	geothermal-out
From Op.	P-100	To Op.	PIPE-100	From Op.		To Op.	
Op. Type	Pump	Op. Type	Pipe Segment	Op. Type		Op. Type	
Temp	25.00 C	Temp	75.04 C	Temp	97.00 C	Temp	75.16 C

PARAMETERS			
Heat Exchanger Model:		Rigorous Shell&Tube	
Tube Side Data		Shell Side Data	
Heat Transfer Coeff	---	Heat Transfer Coeff	---
Tube Pressure Drop	5.73 kPa	Shell Pressure Drop	8.52 kPa
Fouling	0.00000 C-h-m ² /kJ	Fouling	0.00000 C-h-m ² /kJ
Tube Length	10.00 m	Shell Passes	1
Tube O.D.	20.00 mm	Shell Series	1
Tube Thickness	2.0000 mm	Shell Parallel	1
Tube Pitch	50.0000 mm	Baffle Type	Single
Orientation	Horizontal	Baffle Cut(%Area)	20.00
Passes Per Shell	2	Baffle Orientation	Horizontal
Tubes Per Shell	160	Spacing	800.0000 mm
Layout Angle	Triangular (30 degrees)	Diameter	739.0488 mm
TEMA Type	A E L	Area	100.53 m ²

$$x_1 = \frac{1.316}{0.0278} * (-0.014) = -1.307$$

$$x_2 = 1.316$$

$$Y = 10^{-6}(9.412 - 6.344 * (-1.307) + 2.759 * 1.316 + 2.766(-1.307)^2 - 6.753 * 1.316^2 - 1.408 * 1.316 * (-1.307) + 1.355 * 10^{-5})$$

$$Y = 2.99 * 10^{-5} \frac{s}{j}$$

$$M = 2.99 * 10^{-5} * 2.755 * 1921 = 0.158 \frac{kg}{s} = 13669 \frac{kg}{day}$$

Conclusions

This Project details the development of an innovative, integrated water distillation system using renewable energy sources, demonstrating significant advancements in green technology and sustainable engineering. The system's design, leveraging geothermal heat and solar power, not only aligns with Vision 2030's environmental goals but also addresses the critical need for efficient seawater distillation in coastal regions. The collaborative effort, rigorous testing, and adherence to safety and environmental standards highlight the project's potential as a scalable solution for water scarcity issues. Future enhancements will focus on optimizing system efficiency and expanding its application to further contribute to sustainable development.