Concentrated Solar Power Plant

Team 75 Members:

Omar Alsherbini 201958510 ISE

Jehad Malaka 202063600 ME

Abdullah Alturaif 201929370 CHE

Mosaab Alqarni 202026140 EE

Yousef Aljahwary 201929190 EE

Ammar Alsubhi 201942430 CHE

Team Coach: Bo Liu

Introduction

- **Problem Statement**

Many conventional steam power plants rely solely on fuel combustion to generate thermal energy, resulting in high emissions and lower efficiency. This approach contributes to environmental concerns and limits the plant's ability to meet clean energy demands.

- **Project Impact**

By integrating concentrated solar thermal energy using parabolic trough collectors (PTC) with the steam power plant and utilizing molten salt as a heat transfer fluid (HTF), this project aims to address these challenges. The integration will increase the efficiency of the power plant cycle and decrease emissions rates, paving the way for meeting local clean energy demands while reducing environmental impact.

- **Constraints**

- **Site Location:** The plant must be in a location where sufficient solar radiation is available in clear weather. Specifically, locations with high Direct Normal Irradiance (DNI) such as Tabuk.
- **Land Availability**: The plant requires a significant amount of land to accommodate the mirrors and the power cycle.
- **Regular Maintenance:** since the weather in Saudi Arabia is dusty, regular maintenance will be required to clean the mirrors.

- **Target Specifications**

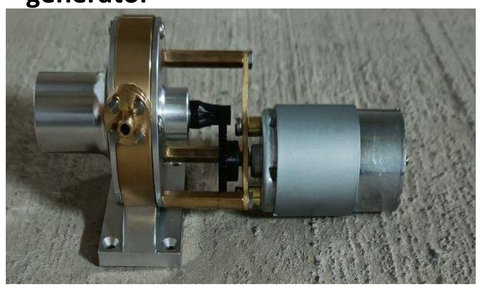
Steam	**Temperature**	Turbine Inlet: 500 °C Turbine Outlet: 45.81 °C
	Flow Rate	40 – 60 kg/s
	Pressure	Turbine Inlet: 100 bar Turbine Outlet: 0.1 bar
Molten Salt Flow Rate		300 – 400 kg/s
Turbine Torque		147,275 N/m
Output Power		50 MW

Main Physical Parts:

- **Heat exchanger.**

- **Curved Mirror:**

- **Steam turbine connected with DC generator**



- **Pumps**

Simulation Result:

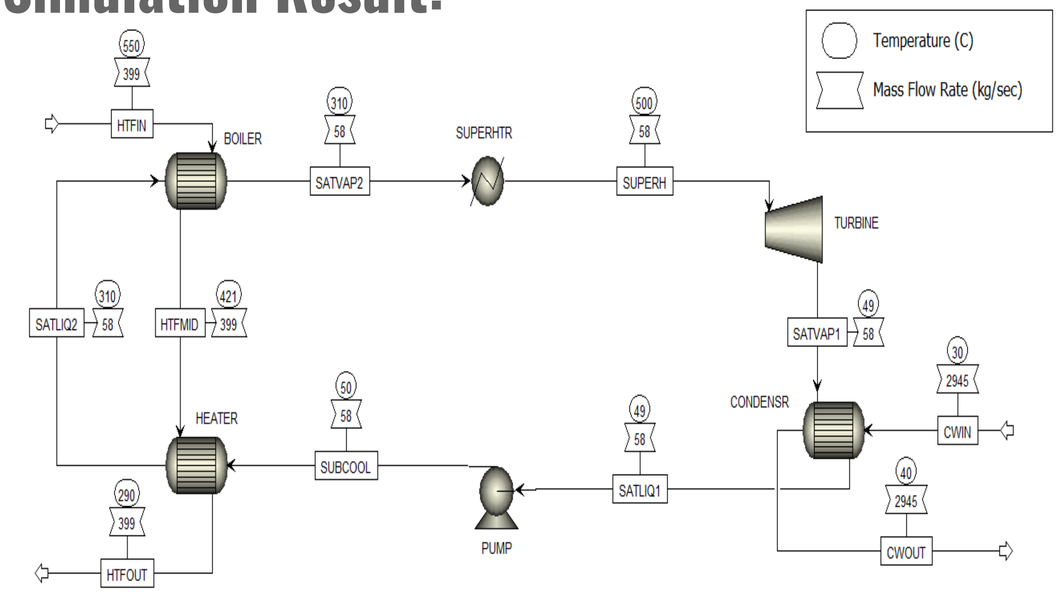


Figure: Aspen Plus power cycle model

Prototype Results:

Flow Rate Test:
The conducted tests on the pump to measure its flow rate at 5 watts of power was performed shows the following:

Trial 1	**83ml/s**
Trial 2	**86ml/s**
Trial 3	**98ml/s**
Trial 4	**92ml/s**
Trial 5	**88ml/s**

For the second method, the 5-trial tested we varied the elevation of the output pipe.

Trial 1	**70ml/s**
Trial 2	**72ml/s**
Trial 3	**74ml/s**
Trial 4	**78ml/s**
Trial 5	**72ml/s**

Validation

The target specifications were met by using Aspen Plus results and hand-calculations. Also, comparison between these methods were done to verify the results.

Conclusion

A hybrid parabolic trough power plant has been successfully created, meeting the required specifications. By combining parabolic mirrors and using molten salt for heat transfer, the plant is anticipated to exceed traditional steam power plants performance in terms of efficiency while reducing emissions, meeting Saudi Arabia's 2030 vision.