Design of Solar Air Heater by Adding Mixing Promoters to the Absorber Plate

By: Nasser Almoterdy, Mohammed Yahya and Mohammed Alotaibi

Supervisors: Dr. Umar Alqsair and Dr. Mutabe Aljaghtham

2nd Semester 2021/2022

جامعة الأمير سطام بن عبد العزيز

Prince Sattam Bin Abdulaziz University

كلية الهندسة

College of Engineering

ABSTRACT

Solar air heater SAH considers a heat exchanger device which is one of the sources to absorb the heat from the sun and increases the ambient temperature by sun radiation. In this project, we performed experimental design of SAH by adding mixing promoters to the absorber plate, how and where to install it. We designed SAH by adding mixing promoters to the absorber plate single pass. The measurements of the solar radiation, outlet temperature, heat losses, air velocity, temperature of absorber and the ambient temperature are recorded. We took 15 days reading for two collectors, a collector of this project (with mixing promoters) and compared it to previous project of flat surface and we chose the best 4 days of the measurement which are (March 1st, 8th, 29th, and 30th) of this year 2022.

OBJECTIVES

- ❖ Improve heat transfer between flowing air and the absorber
- ❖ A comparison between the efficiency of the modified SAHs air heaters with and without mixing promoters

DESCRIPTION

The SAH system which consists of absorber, glass at the top, inlet channel and outlet channel. The geometry design of the absorber plate which is a metal plate with a black color to absorbs radiation of the sun with special shape to increase the efficiency of the system . The purpose of glass at the top is to collect the highest amount of radiation, and the insulator is used to prevent the heat losses. The blower device provides the air flow from surrounding (ambient air) above the absorber to generate hot air by conviction heat transfer. The inlet and outlet channels have a trapezoidal shape.

MAIN APPLICATIONS

- ❖ Heating rooms and cold areas.
- ❖ Drying food .

MATERIALS SELECTION

Part	Material
Body	Steel
Insulation	Mineral wool Foam
Cover	Single glass
Absorber Plate	Aluminum

MATHEMATICAL MODEL

❖ Reynolds number:

$$Re = \frac{\rho\, u\, D_h}{\mu}$$

❖ Nusselt number for roughened :

$$Nu_r = \frac{h\, D_h}{K_{air}}$$

❖ Nusselt number for smooth duct :

$$Nu_s = 0.023\, Re^{0.8} Pr^{0.4}$$

❖ Useful energy:

$$\dot{Q}_u = \dot{m}\, C_p \left(T_{a,out} - T_{a,in}\right)$$

❖ SAH efficiency:

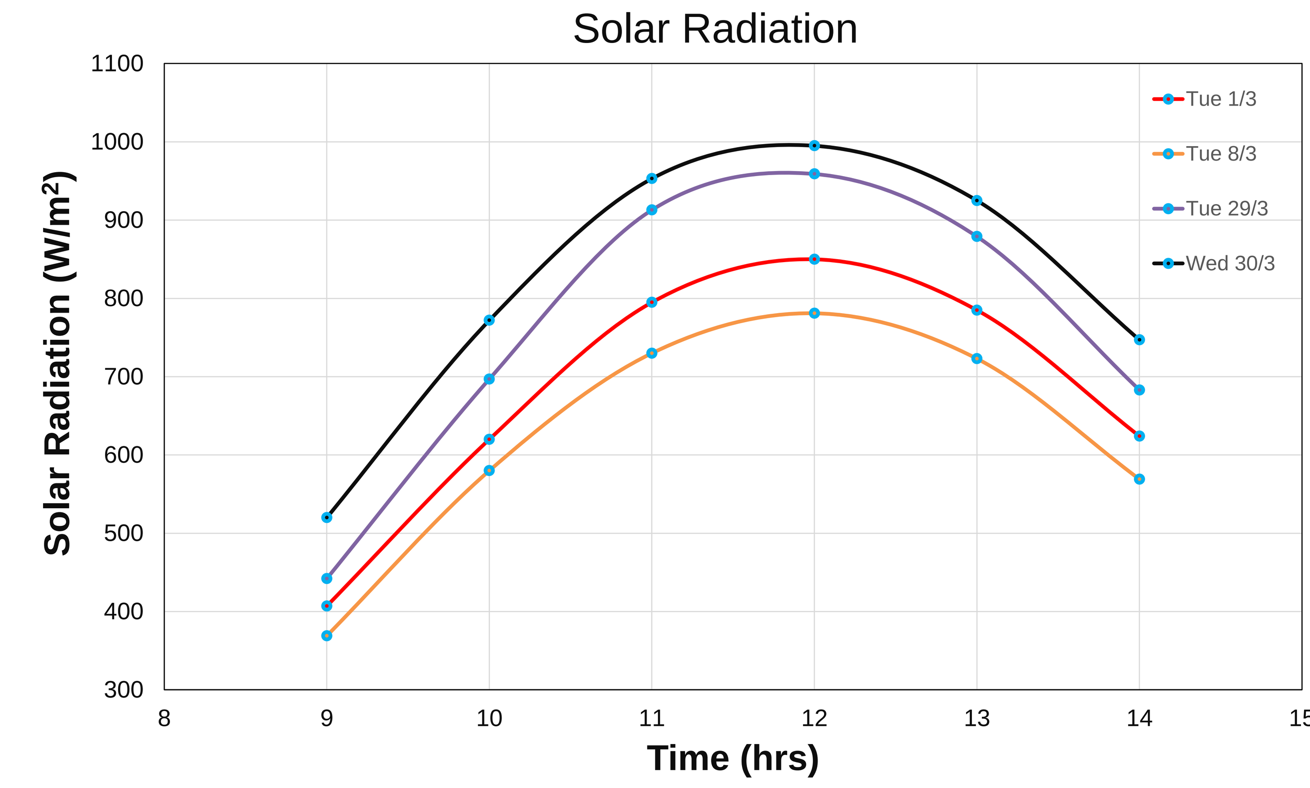
$$\eta = \frac{\dot{Q}_u}{I_R\, A_h}$$

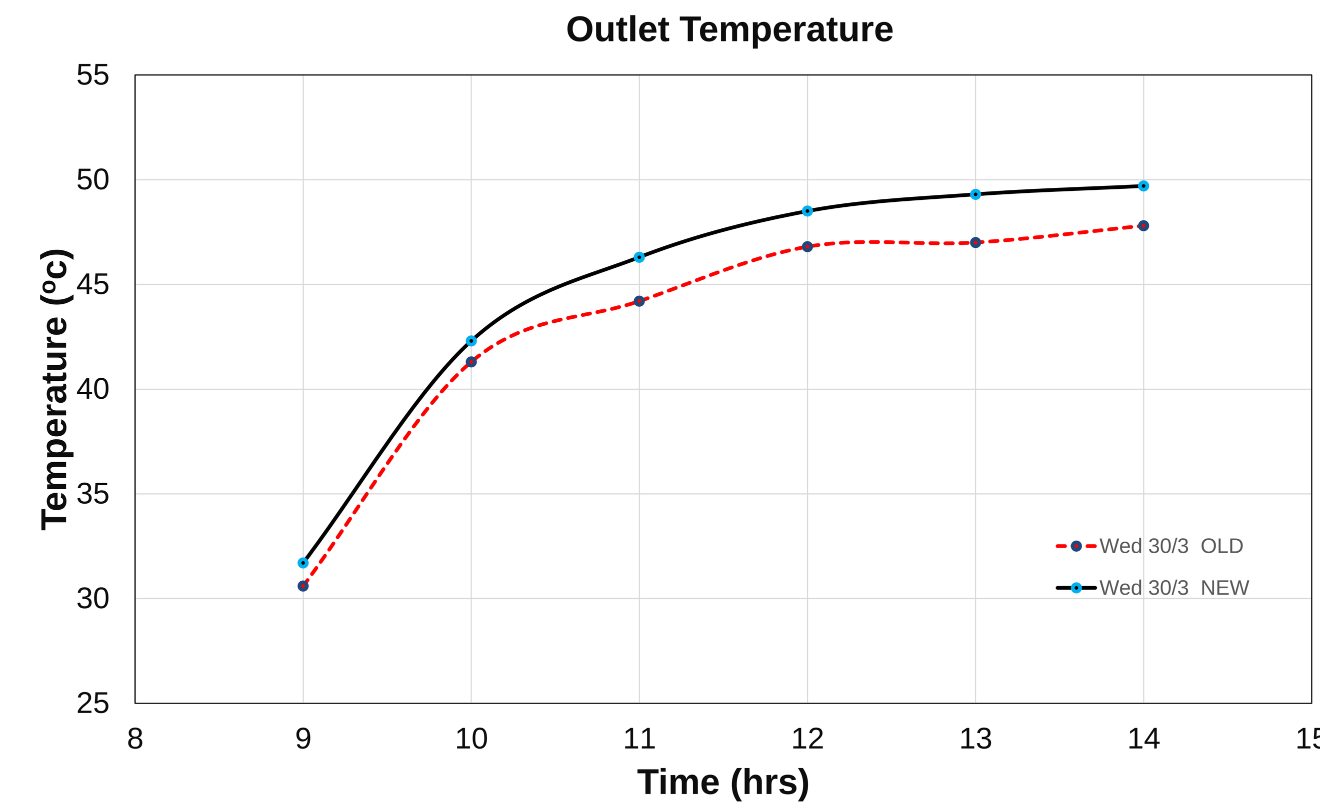
EXPERIMENTAL FIGURES

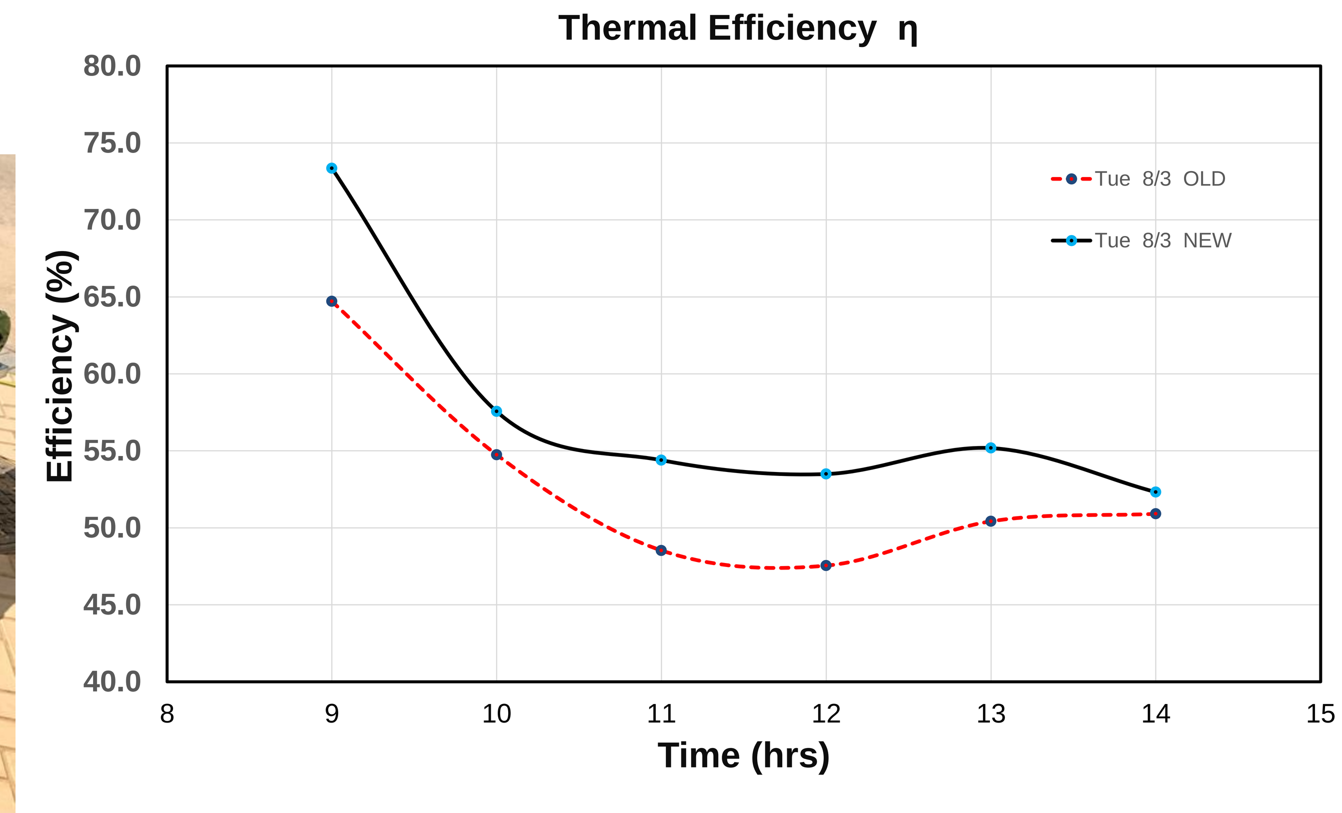
PROJECT COST

The total cost of the project is **2269 SAR**

RESULTS







CONCLUSION

- ❖ In this project, solar radiation and outlet temperatures of several days was measured experimental of SAH with and without mixing promoters.
- ❖ The maximum outlet temperature results for (NEW-SAH) equal to 43.7 °C, 45.6 °C, 46.7 °C and 49.7 °C.
- ❖ The maximum outlet temperature results for (OLD-SAH) equal to 42 °C, 44.5 °C, 46.6 °C and 47.8 °C.
- ❖ The maximum efficiency for (NEW-SAH) equal to 72.3% ,73.4 % ,58.7% and 62.9%.
- ❖ The maximum efficiency for (OLD-SAH) equal to 66.8% ,64.7% ,57.8% and 52% .

Saudi Arabia, Prince Sattam bin Abdulaziz University, College of Engineering, Mechanical Engineering Department