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Enhancing Thermal Performance of a Parabolic Trough Collector with Inserting Longitudinal Fins in the Down Half of the Receiver Tube

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Abstract

Heat transfer in a finned absorber of a parabolic trough collector is studied numerically; the main objective of this work is to study the effect of attached fins on the enhancement of the thermal performance of a parabolic trough collector. The values of the fins length are varied from 0 to 20 mm, and their thickness is varied from 0 to 8mm and the number of fins is 5. The parameters used in the current study are : the thermal and dynamic field, friction coefficient, Nusselt number , the thermal efficiency and thermal enhancement index .The obtained results indicate that the inclusion of fins to the lower half of the absorber enhance heat transfer in the absorber, the increase of the fins length increase the friction factor , Nusselt number and thermal efficiency, also the increase of fins thickness increase the previous parameters , beyond the value 6 mm of thickness its effect remains the same, but thickness is less effective than length. The values 15 mm of length and 6 mm of thickness are selected as optimum values. Finally the inclusion of the fins enhances the thermal performance of the parabolic collector by 8.45

Keywords: solar energy, Nusselt number, thermal efficiency, parabolic trough collector, forced convection.

1. Introduction

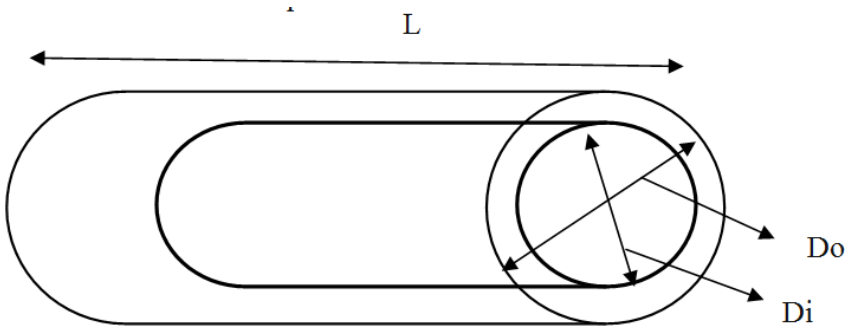
Solar energy is one of the most important sources of renewable energy, the cleanest and most environmentally friendly; it comes from the light and heat of the sun. These techniques include: the use of solar thermal energy in one of the direct heating methods or the mechanical conversion of the energy of the movement or electrical energy.

One of the most important ways of converting solar energy is the parabolic concentrators, which convert solar radiation into thermal energy used to manage a steam turbine to produce electricity.

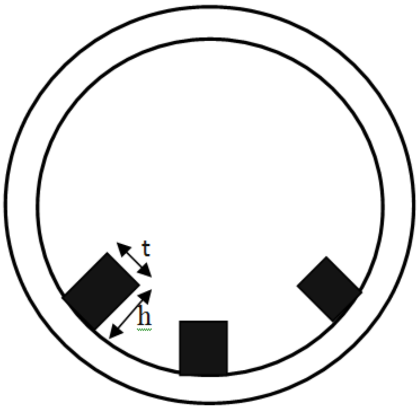
In order to improve the performance of the parabolic trough concentrators the researchers have made several techniques, most of them are expensive, a technique is not expensive is proposed by many researchers is to attach longitudinal fins to the inner surface of the absorbent tube of a parabolic trough solar concentrator.

2. Our approach

A solar parabolic concentrator is considered with an absorbent tube of length L = 2m, and of internal diameter Di = 0.066m, and external diameter Do= 0.07m. The fins are attached to the inner surface of the lower part of the absorbent tube and have the following dimensions: a length (h) varies from 0 to 20 mm, a thickness (t) varies from 0 to 8 mm and a number N equals 5.



(a)



(b)

Fig. 1. The geometry of the physical model studied: a): a longitudinal view of the geometry, b): a cross section of the absorbent tube.

3. Objective

The objective of this work is to study the effect of the inclusion of fins in the down half of the inner surface of the absorber tube of a parabolic trough collector on heat transfer by forced convection between the working fluid and the absorber tube, the movements and the structure of the working fluid the structure of the fluid in the absorber tube, in order to enhance its thermal performance, in this study the effect of length and thickness is studied numerically

4. Resolution method

The previous equations (Navier-stockes equations) are solved by the **Fluent** software, which is based on the finite volume method presented by **Patankar [32]**, this method is based on the discretization of the transport equation on a discreet control volume. Pressure-velocity coupling is handled by the use of the Simple algorithm.

4. Results and Discussion

4.1 Effect of fins length h:

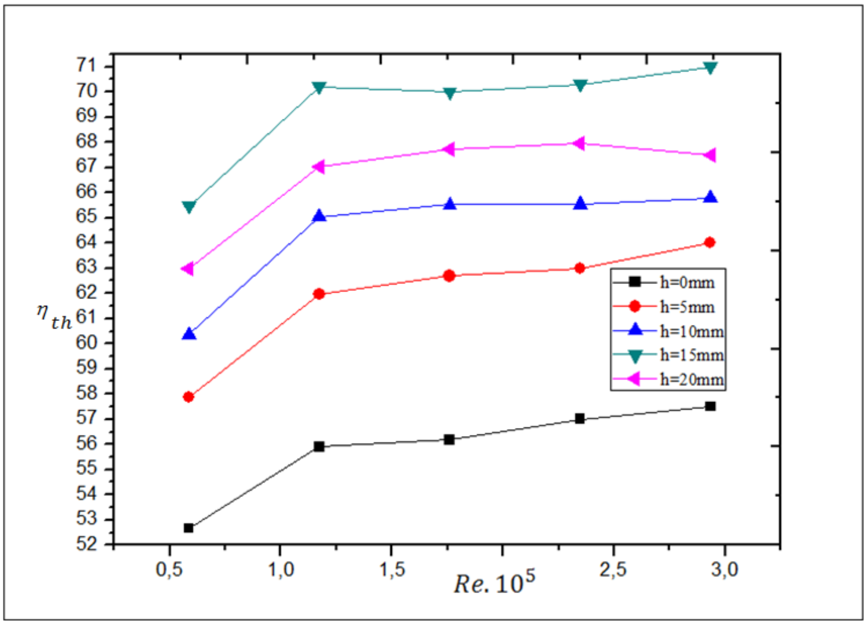


Figure2, thermal efficiency for different fins length

Figure2, shows the variations of the thermal efficiency with fins high h, which varies from 0 to 20 mm for different values of the Reynolds number and a fixed thickness and number (t = 4 mm and N = 5). It is noted that the addition of fins causes an increase in the value of the thermal efficiency about 11.76%, also the increase in the fins length increases the thermal efficiency, the maximum increase is obtained for the value of h= 15 mm. Also the increase in the number of Reynolds causes an increase in the thermal efficiency of the parabolic trough concentrator.

4.2 Effect of fins thickness t:

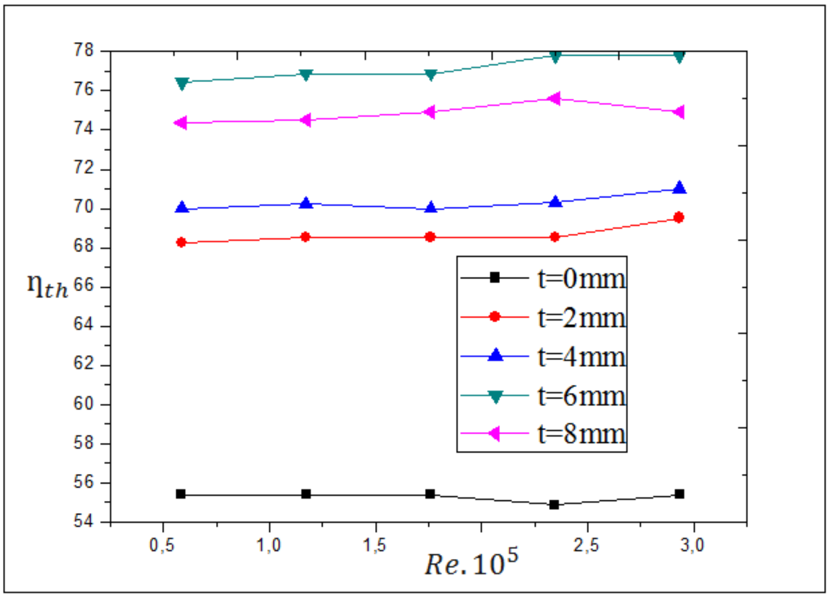


Figure3, thermal efficiency for different fins thickness

The variations in the thermal efficiency of the parabolic trough collector are shown in **Figure3**, for a number equal to 5 and a length of 15 mm, for different values of the thickness t (from 0 to 8 mm). According to the figure the inclusion of the fins causes an increase of the thermal efficiency. A maximum increase for the value of (t = 6mm), so beyond the value 6mm the effect of the thickness become not important. The value of thickness 6mm is an optimal value.

5. Conclusion

- ✓ The increase of the fins length even 15mm increases the friction factor, the Nusselt number and the thermal efficiency.
- ✓ Thermal efficiency and thermal enhancement index increase with the increase of fins length and thickness.
- ✓ The increase of the fins thickness even 6mm increases the friction factor, Nusselt number and thermal efficiency.
- ✓ The impact of the fins length is more intense than thickness.
- ✓ The values 15mm for fins length and 6mm for fins thickness are optimum values.

6. References

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