

Design and Analysis of Solar Air Heater

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ABSTRACT-Solar energy is the new way of energy thinking which focused on developing altering energy resources which would be renewable and environmentally friendly. Solar energy resources are being harnessed for various applications such as power generation, air-conditioning, space heating, domestic hot water etc. The main goal of this project was to develop the low cost solar air heater with higher efficiency for producing hot air which is used for dehydration of food in home applications.

Solar air heater is a type of system driving outdoor air through a sealed, sun-heated collector mounted on an exterior wall or roof, returning the warmed air back to the living space. SAH device is useful because of its simple design, easy to fabricate and maintain and its low cost. Here the problem occurs in solar air heater that efficiency of solar air heater is depends upon design of air heater tube(collectors) along with inclination. Accurate design of collector is not approach, it may cause to due to fail.

The main aim of this object was to develop the solar air heater for home application with accurate design and high thermal efficiency. Previously researchers worked out on thermal analysis of solar air heater with different orientations. In this research different geometries of solar air heater with different orientations at high temperature climate with high air flow velocity are studied briefly. Design of different geometries of solar air heaters were developed by using Unigraphics CAD software. And thermal analysis of solar air heater with different orientations at high air flow velocity is done using Ansys CFD software.

Keywords – solar air heater, energy resources, thermal efficiency.

I. INTRODUCTION

We are honored with Solar Energy in wealth at no expense. The sun powered radiation episode on the outside of the earth can be helpfully used to assist human culture. One of the prominent gadgets that saddle the sun powered vitality is sunlight based boiling water framework (SHWS).

A sunlight based Air radiator comprises of an authority to gather sun oriented vitality and a protected stockpiling tank to store high temp water. The sun based vitality occurrence on the safeguard board covered with chosen covering moves the cap to the riser pipes underneath the safeguard board. The water going through the risers get warmed up and are conveyed the capacity tank. The re-dissemination of a similar water through safeguard board in the authority raises the temperature to 80 C (Maximum) in a decent bright day. The all out framework with sun based authority, stockpiling tank and pipelines is called sun oriented heated water framework.

1.1 THERMOSYPHON PRINCIPLE

Thermosiphon (or thermosyphon) is a technique for latent warmth trade, in view of common convection, which

circles a liquid without the need of a mechanical siphon. Thermosiphoning is utilized for course of fluids and unstable gases in warming and cooling applications, for example, heat siphons, AIR HEATERS, boilers and heaters. Thermosiphoning likewise happens crosswise over air temperature inclinations, for example, those used in a wood fire stack or sunlight based fireplace.

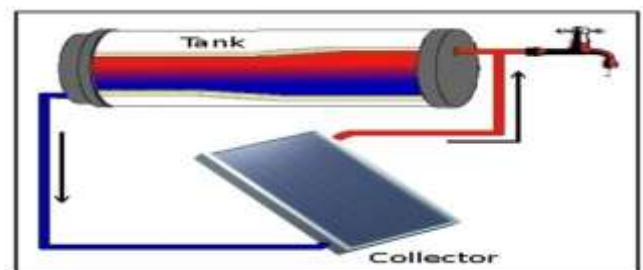


Fig:01 shows the Thermo siphon (or thermosyphon)

1.2 FLAT PLATE COLLECTOR

A sun powered gatherer is a unique sort of warmth exchanger that changes sun based brilliant vitality into heat a sun powered authority contrasts in a few regards from progressively regular warmth exchangers: The last ordinarily achieve a liquid to-liquid trade with high

warmth move rates and. with radiation as an immaterial factor. In the sun oriented gatherer, vitality Trans is from a removed wellspring of brilliant vitality to a liquid.

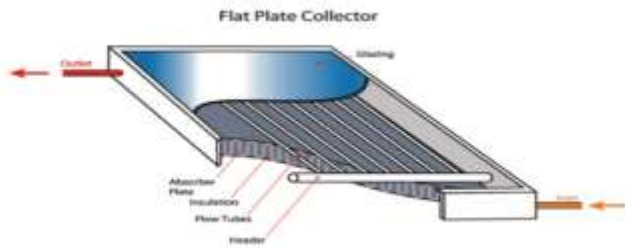


Fig: 02 shows the flat plate collector

PARABOLIC PLATE COLLECTOR

Parabolic Trough Reflector

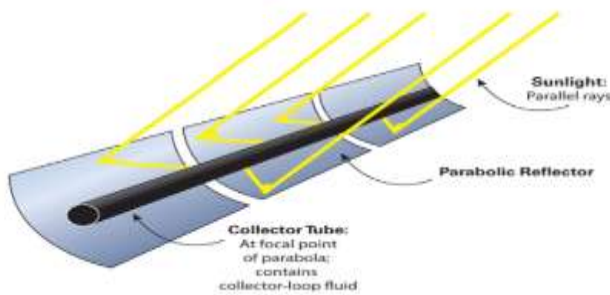


Fig: 03 shows the parabolic trough reflector

1.3 SOLAR DISH COLLECTOR

This sort frameworks can likewise be a piece of another sun oriented innovation called a "sun based dish-motor" framework. The dish some portion of a sun oriented dish motor framework is fundamentally the same as the one portrayed above, however may incorporate numerous individual yet littler illustrative mirrors rather than one huge single dish all calculated and centered to the equivalent point of convergence.

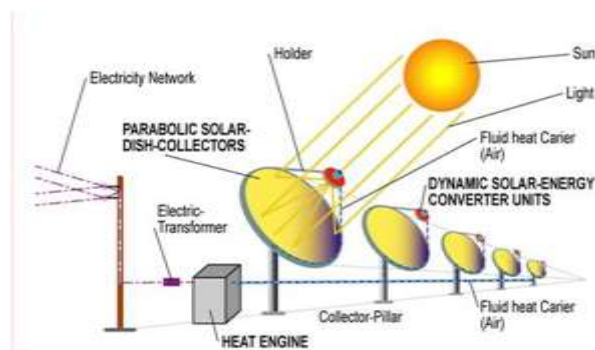


Fig: 04 Shows the solar dish collector

1.4 INTRODUCTION TO 3D MODELING

PC upheld plan (CAD) is the use of PC systems to help in the creation, change, examination, or improvement of a structure. PC supported structure writing computer programs is used to grow the productivity of the designer, improve the idea of setup, improve trades through documentation, and to make a database for gathering. PC

supported plan yield is regularly as electronic reports for print, machining, or other gathering errands. The term CADD (for Computer Aided Design and Drafting) is in like manner used.

1.5 OVERVIEW OF CAD

In the mid-1970s, as PC bolstered plan structures began to give more limit than just an ability to reproduce manual drafting with electronic drafting, the cash sparing preferred position for associations to change to CAD got clear.

UNIGRAPHICS INTRODUCTION

The UNIGRAPHICS NX Modeling application gives a solid showing system to engage snappy hypothetical structure. Designers can join their essentials and plan constraints by describing numerical associations between different bits of the structure.

INTRODUCTION TO DRAFTING

The Drafting application is proposed to empower you to make and keep up a combination of drawings delivered utilizing models made from inside the Modeling application. Drawings made in the Drafting application are totally associated to the model. Any movements made to the model are thus reflected in the drawing.

1.6 INTRODUCTION TO CAE

In general, there are three phases in any computer-aided engineering task:

- **Pre-preparing** – characterizing the limited component model and natural elements to be applied to it
- **Analysis solver** – arrangement of limited component model
- **Post-handling** of results utilizing perception apparatuses.

ANALYSIS (COMPUTATION SOLUTION)

The following phase of the FEA procedure is investigation. The FEM conducts a progression of computational strategies including applied powers, and the properties of the components which produce a model arrangement.

POST-PROCESSING (VISUALIZATION)

These outcomes would then be able to be examined utilizing perception apparatuses inside the FEA condition to see and to completely recognize ramifications of the investigation.

STRUCTURAL ANALYSIS

Auxiliary examination contains the arrangement of physical laws and science required to think about and predicts the conduct of structures. The subjects of auxiliary examination are designing antiques whose uprightness is judged generally dependent on their capacity to withstand

loads; they normally incorporate structures, scaffolds, flying machine, and ships.

INTRODUCTION TO FEM

The Basic idea in FEA is that the body or structure might be partitioned into littler components of limited measurements called "Limited Elements". The first body or the structure is then considered as a gathering of these components associated at a limited number of joints called "Hubs" or "Nodal Points".

The Basic Steps Involved in FEA

Numerically, the structure to be broke down is subdivided into a work of limited measured components of straightforward shape. Inside every component, the variety of relocation is thought to be dictated by basic polynomial shape capacities and nodal removals.

1.7 INTRODUCTION TO ANSYS

The ANSYS program is independent universally useful limited component program created and kept up by Swason Analysis Systems Inc. The program contain numerous schedules, all bury related, and just for primary motivation behind accomplishing an answer for an a designing issue by limited component strategy.

MESHING:

Prior to cross section the model and even before building the model, it is essential to consider whether a free work or a mapped work is suitable for the examination. A free work has no confinements regarding component shapes and has no predefined example applied to it.

II. LITERATURE REVIEW

Nosa Andrew Ogie,1Ikponmwosa Oghogho,2 and Julius Jesumirewhe: Had worked out on "Structure and Construction of a Solar AIR HEATER Based on the Thermosyphon Principle". A sun oriented water warming framework for household use has been planned and developed utilizing locally accessible materials.

Jorge Alexander Alarcón1 ,Jairo Eduardo Hortúa2 , Andrea López G: Researched an article on "Structure and development of a sunlight based gatherer illustrative dish for rustic zones in Colombia". This paper displays the advancement of a sun oriented illustrative dish gatherer model for provincial territories with high sun powered asset accessibility in Colombia, which have no entrance to power administration or spending assets to buy a stove (electric or gas).

Lakshmi kumari et al. [1] Now a days the utilization of regular assets are exceptionally in progress on the grounds that counterfeit assets, for example, power, gas, fuel and so forth are in declination arrange and are pricey. Sunlight based radiation from sun is discharged and falls on earth surface this radiation is gathered by utilizing sun powered

authorities. The present work is expected to anticipate the exhibition of level plate gatherer tried for 3 unique days, utilizing a use of water warming. The material utilized in the work is safeguard plate, cylinder or pipe made of GI, packaging and glass.

III. MODELING

PROBLEM DEFINITION

Sunlight based air warmer is a sun oriented warm innovation in which the radiation from the sun is caught by a retaining medium and used to warm air. Sun oriented air warming is a sustainable power source warming innovation used to warmth or condition air for structures or procedure heat applications.

Sun based tourist collectors are mounted on south-bound vertical dividers or rooftops. Sun oriented radiation arriving at the gatherer warms the safeguard plate. Air going through the authority grabs heat from the safeguard plate. Here the issue discover that air radiator exposed to high streamlined burdens with sunlight based temperature. So need to create exact structure.

METHODOLOGY

- Design of flat plate collector with accurate dimensions by using Unigraphics software.
- Structural coupled field analysis of flat plate collector with Ansys software.
- Analysis of flat plate solar collector is done by using Aluminum and copper materials.
- Design of parabolic solar plate collector with accurate dimensions by using Unigraphics software.
- Structural coupled field analysis of parabolic solar plate collector with Ansys software.
- Analysis of parabolic solar plate solar collector is done by using Aluminum and copper materials.
- From all analysis results, best solar plate is proposed

DESIGN OF FLAT PLATE AIR HEATER

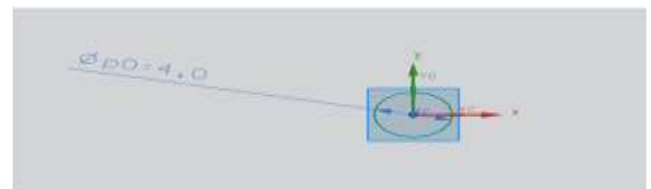


Fig: 05 shows 2d sketch of flat plate tube

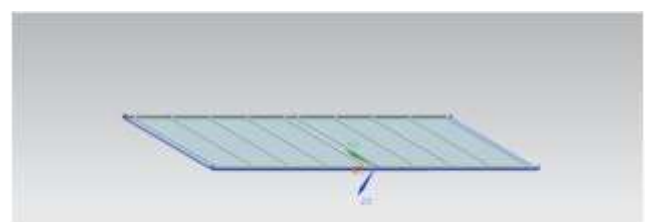


Fig: 06 Shows the final model of the solar flat plate collector

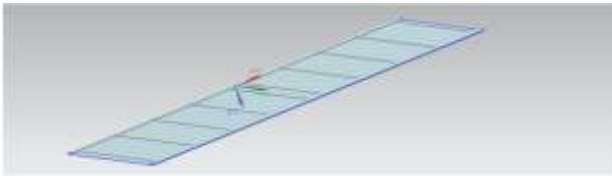


Fig: 07 Shows the isometric of the solar flat plate colleter

3D MODELING OF SOLAR PARABOLIC COLLECTOR

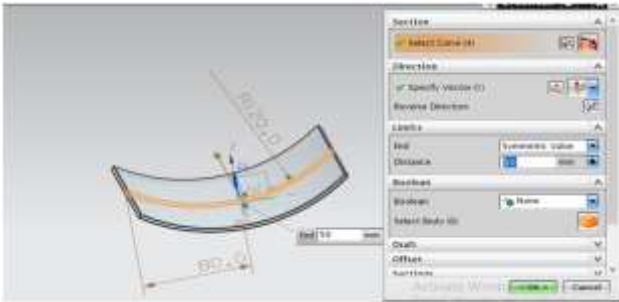


Fig: 08 Shows the 3D model of parabolic plate

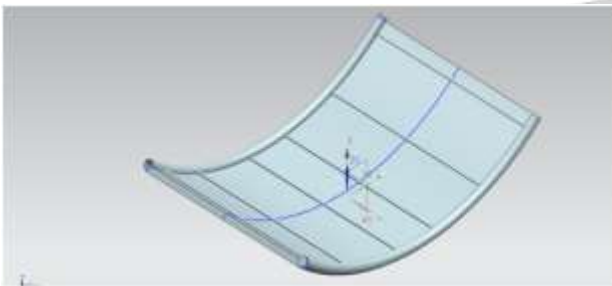


Fig: 09 Shows the isometric view of the parabolic solar flat

IV. 4.1 ANALYSIS OF FLAT AIR COLLECTOR USING ALUMINUM A360

Aluminum A360:

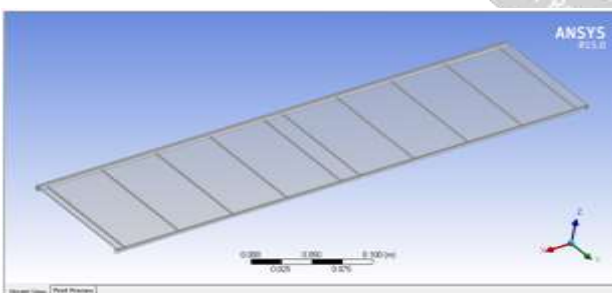


Fig: 10 Shows imported geometry of the flat plate

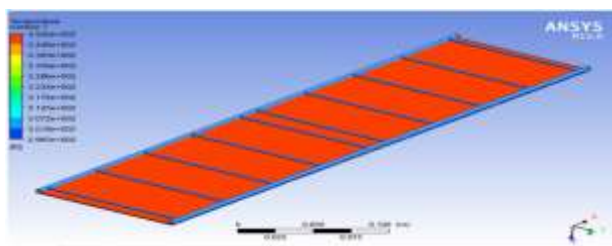


Fig: 11 Shows maximum temperature of the solar flat plate
ANALYSIS OF FLAT AIR COLLECTOR USING COPPER

COPPER MATERIAL

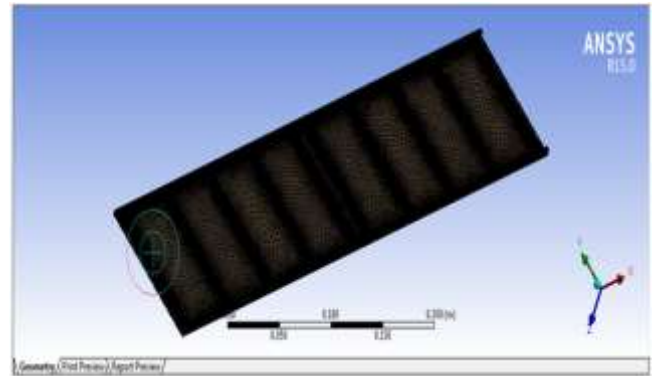


Fig: 12 Shows meshing model of the flat plate

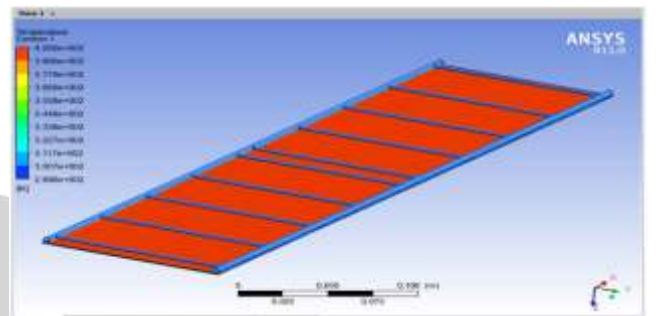


Fig: 13 Shows maximum temperature for copper
ANALYSIS OF PARABOLIC AIR COLLECTOR USING ALUMINIMA360

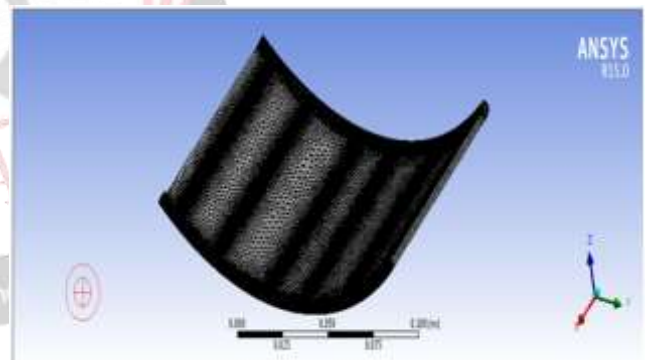


Fig: 14 Shows the meshing model of parabolic flate

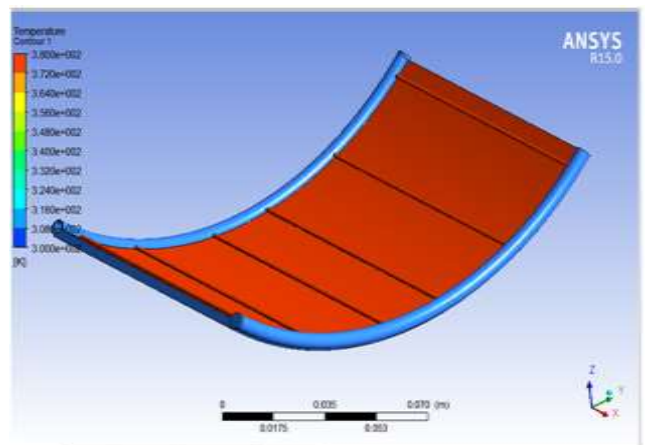


Fig: 15 shows the maximum temperature on parabolic flat using aluminum

ANALYSIS OF PARABOLIC AIR COLLECTOR USING COPPER COPPER MATERIAL

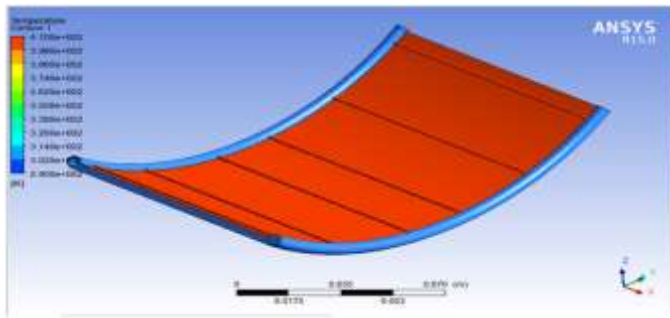
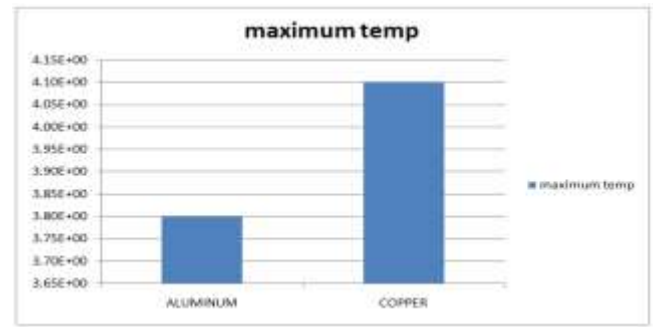


Fig: 16 Shows the maximum temperature on parabolic flat using copper



Graph: 02 parabolic flat collectors Graph between aluminum vs copper

CHAPTER-V

RESULTS

- Analysis has been done with 2 different types of materials aluminum and copper for the flat plate collector.
- Solar temperature 350 K is applied inside of tubes of collectors.
- Below results are the maximum temperatures of the 2 different materials

Analysis of flat air collector

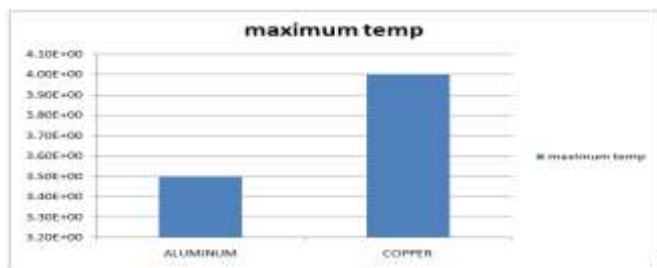
Material	Maximum temperature
ALUMINUM A360	3.500 ^{e+002}
COPPER MATERIAL	4.000 ^{e+002}

- ✚ Analysis has been done with 2 different types of materials aluminum and copper for the parabolic plate collector.
- ✚ Solar temperature 350 K is applied inside of tubes of collectors.
- ✚ Below results are the maximum temperatures of the 2 different materials.

Solar parabolic flat collector

Material	maximum temperature
ALUMINUM A360	3.800 ^{e+002}
COPPER MATERIAL	4.100 ^{e+002}

Graphs for flat plate & parabolic plate



Graph:01 Flat air collector Graph between aluminum vs copper

CONCLUSION

In this project higher efficiency of parabolic solar plate collector studied and compared with flat plate collector. Design of flat plate and parabolic plate collectors are done using Unigraphic software. Theoretical mass flow rate and efficiency calculated for different materials. Also this project explained that thermal analysis of collectors using Ansys software. From analysis results concluded that thermal efficiency of parabolic solar plate with copper material is high compared with others.

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