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Analysis of Parabolic Solar Collector by Using Different Nano Fluid

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Abstract: **In recent times, solar energy has attracted the attention of scientists to a large extent. On the surface, there are two reasons for this: first, scientists interested in this with the intention of innovating new functions and, secondly, to develop new ways to capitalize on it. The parabolic solar collector is a widely used concentrated type solar collector that contains a parabolic reflector and a plate or absorption tube in which the working fluid circulates. The basic function of the parabolic reflector is to concentrate the solar radiation and reflect it in the absorbent tube. The overall efficiency of the energy or collector generation system depends on the intensity of solar radiation, the shape and design of the collector, the design and the material used to absorb and characteristics of the working fluid, as compared to thermoelectric properties. Device miniaturization and energy efficiency are the main areas of interest around which new materials are developed. The design of the solar system can make some basic changes if the new materials are successfully applied. However, nano-fluids are a relatively new innovation with better heat absorption and heat transfer capacity. In this research, CuO and alumina, nano fluids are used instead of water as a working fluid. The research was conducted on three periods of 10h, 13h and 16h. When the water is replaced with 0.01% nano-liquid CuO / H2O, the outlet temperature increases by 45.5% compared to water at 10 h, 25% at 13 h and 50% at 16 h, against 0, 05% nano. CuO / H2O fluid is used that increase the temperature increases to 63.6% at 10 hours, 71.4% at 13 hours and 70% in 16 hours. The results, we can say that the increase present in 0.05% CuO / Nano water fluid is greater, this is due to the better the thermal properties of copper to conduct heat. In this research, the efficiency of the parabolic solar collector with nano fluids is tested to determine the position of Bhopal (M.P.).**

Keywords: solar energy, parabolic reflector, nano-fluids, solar radiation etc.

I. INTRODUCTION

With over utilization of fossil fuels, every day we are edging closer to onlooker the destruction of natural resources which can grounds inequity in nature. Non-conventional energy ascertained minority in this situation of energy disaster. Sources like, solar, wind, hydro powers are profuse in nature and can be coupled to any extent. Among those many thoughts sun is most abundant and significant source of renewable energy. The use of solar energy is safer to the environment and living beings. A Solar energy collector is the heat-exchanging system that consumes solar radiation energy to produce thermal energy. The essential utility of a solar collector is to charm the solar radiation that transforms it into heat and handovers this heat to the functioning fluid circulating right through the whole system.

Solar Energy Collectors

There are two types of solar energy collectors available. These are as follows:-

Non-Concentrating type Collector: The non-concentrating type collector area has the same area as absorber area. They are constrained for low temperature applications (<1200C)

Concentrating type Collector: **-** A concentrating type collector is a collector in which the region of the intercepting solar radiations is larger than that of absorber region. Concentrations can be accomplished by the optical device such as mirror or lens, through the reflection or refraction of solar radiation. The different type of concentrating collectors are as follows: -

Parabolic trough solar collector: **-** A parabolic trough solar collector procedures a reflector in the shape of a parabola which is typically a mirror or an anodized aluminium sheet provisional on the prerequisite presentations to reflect and concentrate the solar radiations in the direction of a receiver tube positioned at the focus line of the parabola. The absorber tube may be made of copper or mild steel and also smeared with the heat resilient black paint for the better presentation. The receiver engrosses the entering radiations and changes them into thermal energy, which is being conveyed and collected by a fluid medium flowing within the receiver tube. The heat transport fluid flows throughout the absorber tube, gets heated and hence transmits heat. This type of collectors can attain the temperature till 400°C.

Parabolic Dish Collector: This type of collectors can attain the temperature till 1500°C. They utilize parabolic dish shaped mirrors to concentrate solar energy onto a receiver located at the common focal point of the mirrors. Heat transfer fluid contained in the receiver is then heated up to the desirable working temperature in order to generate electricity in a small engine attached to the receiver or is sent to the storage system. They track the sun on two axes.

Linear Fresnel Reflectors: LFR consists of long flat mirrors mounted on one or two-axis tracking devices. A receiver is mounted on the focus to collect the heat. It is an array of linear mirror strips which concentrate light on to a fixed receiver mounted on a linear tower

Heliostat field collectors: The Heliostat Field Collector, also called the Central Receiver Collector, consists of a large array of flat mirrors/heliostats to reflect incident solar radiations onto the central receiving unit (solar tower). The orientation of every individual heliostat is controlled by an automatic control system powered by alt-azimuth tracking technology.

Nanofluid and its applications

Nanofluids are the mixture of nanoparticles and base fluid, which is a new challenge in the field of thermal engineering provided by the nanotechnology. Nanofluids have the distinctive characteristics altered from conservative solid-liquid mixtures in which they are in millimeter or micrometers sized particles of metals and non-metals are scattered onto it. Due to their excellent characteristic nanofluids had discovered extensive applications in enhancing heat transfer. The knowledge behind the improvement of nanofluids is using the thermo fluids in heat exchangers for the enrichment of heat transfer coefficient. And also to minimizes the dimension of heat transfer equipment's. Nanofluids assist for saving of heat energy and material required for the heat exchanger. The essential parameters which have been influencing the heat transfer with its characteristics of nanofluids are the properties which consist of viscosity, density, thermal conductivity and specific heat. The thermo substantial properties of nanofluids is mainly depend on the working temperature of nanofluids.

II METHODOLOGY

STEPS OF WORKING METHOD

Below table gives the technical specifications of Parabolic Trough Solar Collector

Parameter	Value
Collector length, *L*	1.20m
Collector breadth,*W*	0.915m
End plate thickness	2mm
Aperture area, *Aaper.*	1.0188m3
Rim angle	90 degrees
Focal length	0.30m
Receiver inside diameter (*Di*)	0.027m
Receiver outside diameter (*D0*)	0.028m
Receiver length	1000 mm
Glass envelope inside diameter (*Dci*)	0064 mm
Glass envelope outside diameter (*Dco*)	0.066mm
Insulation on pipes	Aluminum foil, Superlon
Concentration ratio, *Cr*	9.66

Figure 1: Parabolic Trough Solar Collector Geometry

Material	Density[kg m^{-3}]	Specific Heat[J kg^{-1} K^{-1}]	Thermal conductivity[W m^{-2} K^{-1}]
Copper	8978	381	387.6
Glass	2200	910	1.75

Figure 2: Properties of the Material

STEPS OF WORKING

Step 1: Collecting information and data related to Parabolic Trough Solar Collector.

Step 2: A fully parametric model of the Parabolic Trough Solar Collector is created in CATIA V5R20

Step 3: Model obtained in Step 2 is analyzed using ANSYS 15. (FLUENT), to obtain the temperature.

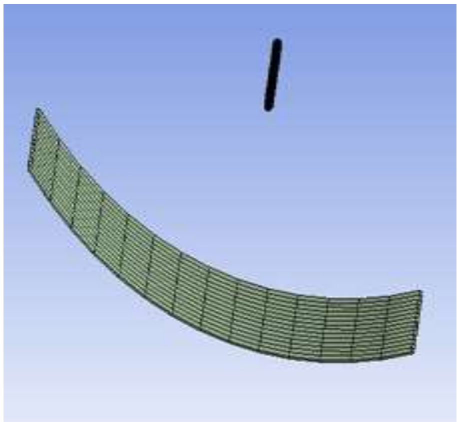

Figure 3: Meshing: Total No. of Nodes: 40153& Total No. elements: 28097

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Meshing is a critical operation in CFD analysis. In this operation the CAD geometry is divided into large numbers of small pieces. The small pieces are called mesh. The analysis accuracy and duration depends on the mesh size and orientations. With the increase in mesh size, the finite element analysis speed increase but the accuracy decreases (Figure 4.3).After completing the CAD geometry of cylinder block is imported in ANSYS workbench for further thermal analysis and the next step is meshing. The mesh created in this work is shown in figure No4.3. The total Node is generated 40153& Total No. of Elements is 28097

DEFINING MATERIAL PROPERTIES

For any kind of analysis material property are the main things which must be defined before moving further analysis. There are thousands of materials available in the ANSYS environment and if required library is not available in ANSYS directory the new material directory can be created as per requirement. For the present work glass is used as a material of Parabolic Trough and Copper as the material of Absorber tube. The material properties of the present case are presented

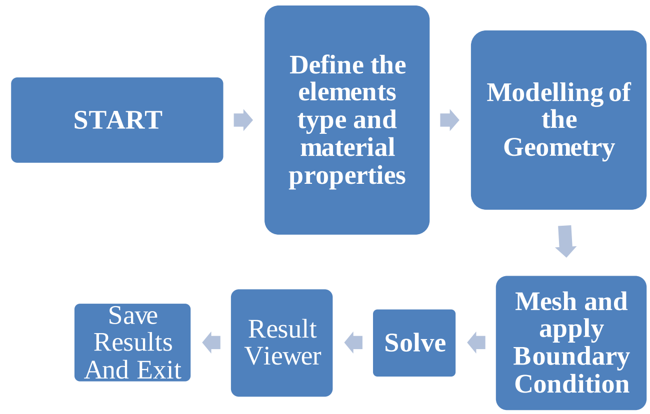

Figure 4: Setup of Working

BOUNDARY CONDITION

Solar collector	Parabolic solar collector
Solar condition	Bhopal on 21th july
Inlet boundry condition	40 LPH (0.176m/s)
Outlet boundry condition	Pressure outlet
Solver	ANSYS FLUENT

II. RESULTS AND DISCUSSION

Material	Temperature [k] at 10 AM	Temperature [k] at 1 PM	Temperature [k] at 4 PM
Water	322	328	320
0.01% CuO/H_2O	332	335	330
0.05% CuO/H_2O	336	342	334
0.1% CuO/H_2O	334	338	333
0.01% Al_2O_3/H_2O	326	329	325
0.05% Al_2O_3/H_2O	331	337	329
0.1% Al_2O_3/H_2O	327	335	324

Figure 5: Results of the CFD analysis

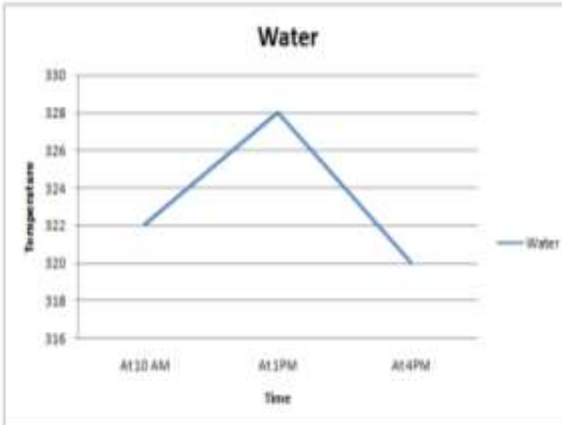

Figure 6: Results Obtained For the Water as working Fluid from the CFD analysis

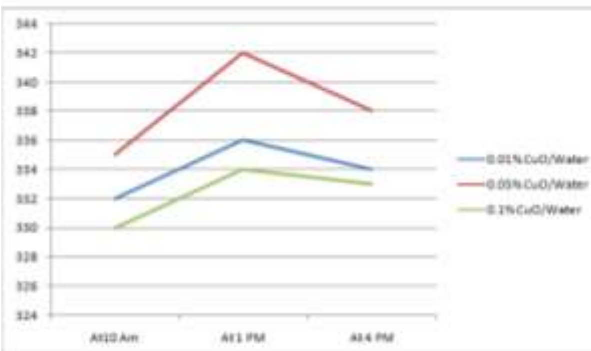

Figure 7: Results Obtained for Copper Based Nanofluids as working Fluid from the CFD analysis

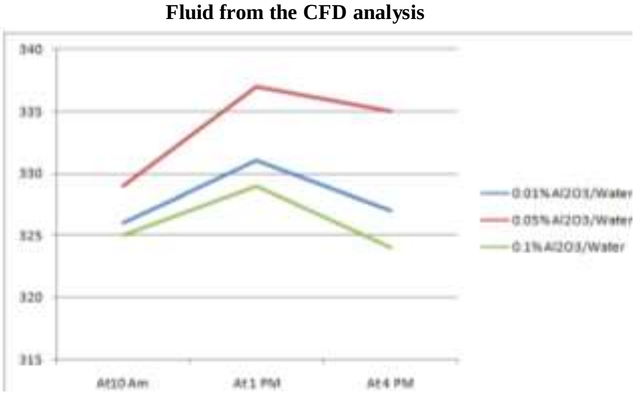

Figure 8: Results Obtained for Alumina Based Nano fluids as working Fluid from the CFD analysis

Based on the results mentioned in the previous chapter following conclusion can be drawn from the research work.

IV. CONCLUSION

From the study mentioned in this thesis following conclusion can be drawn:

1. When using water as the working fluid the increase in temperature is 220c, 280C and 200C at 10Am, 1PM and 4PM respectively
2. When water is replaced by 0.01% of CuO/H2O nanofluid there is an increase of45.5% in outlet temperature than water at 10 Am, 25% at 1PM and 50% at 4PM,
3. When 0.05% of CuO/H2O nanofluid is used this rise in temperature increases to 63.6% at 10 AM , 71.4% at 1PM and 70% at 4PM
4. As the volume concentration of CuO is further increased to 0.1% the increment in temperature is 54.5% at 10AM, 35.7% at 1PM and 65% at 4PM
5. When water is replaced by 0.01% of Al2O3/H2O nanofluid there is an increase of only 18% in outlet temperature than water at 10AM, the increase in temperature at 1 PM is reduced to 3% which increases at 4PM upto 25%
6. Further when 0.05% of Al2O3/H2O nanofluid is used this rise in temperature increases to 40.9% at 10 AM, further it is obtained 32.14% at 1PM and 45% at 4PM
7. the volume concentration of Al2O3 is further increased to 0.1% the increment in temperature is obtained to 22.72% at 10 AM, 25% at 1 PM and 20 % at 4PM
8. The results in the case of CuO based nanofluid were much better than those on the case of water and Alumina based nanofluid

From the study it can be concluded that using nanofluid as the heat transfer medium in the solar receivers can give a better thermal efficiency than the water.

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