HEAT TRANSFER ENHANCEMENT OF A SOLAR FLAT PLATE COLLECTOR BY USING NANOFLUID

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Abstract - *The analysis of combined modes of heat transfer has been the subject of many investigators. Different numerical techniques, iterative in nature and differing from each other in the way the radiation part is handled, have been employed to solve the combined radiation convection problems.The principle point of this task is to examine synchronous warmth move by radiation in a stream between parallel plates. The impact of radiation on the warmth move and the full warm advancement of the stream will be resolved. CFD investigation is done in Ansys.*

***Keywords:**- solar flat plate collector, Nano fluids, thickness of collector plate, Radiation analysis.*

1. INTRODUCTION

Radiation therapy treats cancer by using high-energy waves to kill tumor cells. The goal is to destroy or damage the cancer without hurting too many healthy cells. This treatment can cause side effects, but they're different for everyone. The ones you have depend on the type of radiation you get, how much you get, the part of your body that gets treatment, and how healthy you are overall. There's no way to predict how radiation will affect you. You may have few or only mild side effects from your treatment; someone else may have a lot of problems or very severe ones.Radiation is the process by which energy is emitted as either particles or waves. Broadly, it can take the form of sound, heat, or light. However, most people generally use it to refer to radiation from electromagnetic waves, ranging from radio waves, though the visible light spectrum, and up through to gamma waves.

Solar radiation, often called the solar resource, is a general term for the electromagnetic radiation emitted by the sun. Solar radiation can be captured and turned into useful forms of energy, such as heat and electricity, using a variety of technologies. However, the technical feasibility and economical operation of these technologies at a specific location depends on the available solar resource.

Basic Principles

Every location on Earth receives sunlight at least part of the year. The amount of solar radiation that reaches any one spot on the Earth's surface varies according to:

Geographic location

- Time of day
- Season
- Local landscape
- Local weather.

Because the Earth is round, the sun strikes the surface at different angles, ranging from 0° (just above the horizon) to 90° (directly overhead). When the sun's rays are vertical, the Earth's surface gets all the energy possible. The more slanted the sun's rays are, the longer they travel through the atmosphere, becoming more scattered and diffuse. Because the Earth is round, the frigid polar regions never get a high sun, and because of the tilted axis of rotation, these areas receive no sun at all during part of the year.

The Earth revolves around the sun in an elliptical orbit and is closer to the sun during part of the year. When the sun is nearer the Earth, the Earth's surface receives a little more solar energy. The Earth is nearer the sun when it is summer in the southern hemisphere and winter in the northern hemisphere. However, the presence of vast oceans moderates the hotter summers and colder winters one would expect to see in the southern hemisphere as a result of this difference.

The 23.5° tilt in the Earth's axis of rotation is a more significant factor in determining the amount of sunlight striking the Earth at a particular location. Tilting results in longer days in the northern hemisphere from the spring (vernal) equinox to the fall (autumnal) equinox and longer days in the southern hemisphere during the other 6 months. Days and nights are both exactly 12 hours long on the equinoxes, which occur each year on or around March 23 and September 22.

Countries such as the United States, which lie in the middle latitudes, receive more solar energy in the summer not only because days are longer, but also because the sun is nearly overhead. The sun's rays are far more slanted during the shorter days of the winter months. Cities such as Denver, Colorado, (near 40° latitude) receive nearly three times more solar energy in June than they do in December.

1.1 Active Systems

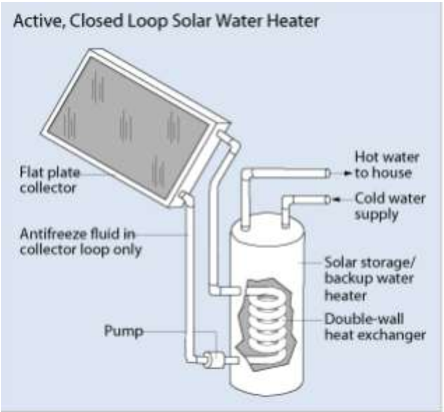

Fig 1 : active system

- Direct circulation systems

pumps circulate household water through the collectors and into the home. They work well in climates where it rarely freezes

- Indirect circulation systems

Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water that then flows into the home. They are popular in climates prone to freezing temperatures. Indirect systems are also used where hard/calcified water is found.

1.2 Passive system

Passive solar water heating systems are typically less expensive than active systems, but they're usually not as efficient. However, passive systems can be more reliable and may last longer.

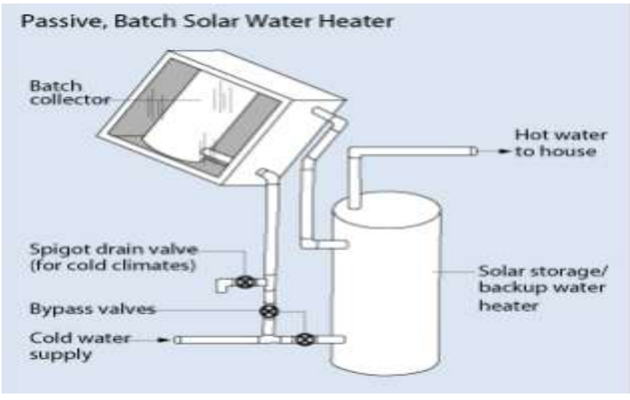

Fig 2: passive system

There are two basic types of passive systems:

- Integral collector-storage passive systems

These work best in areas where temperatures rarely fall below freezing. They also work well in households with significant daytime and evening hot-water needs.

- Thermosyphon systems

Water flows through the system when warm water rises as cooler water sinks. The collector must be installed below the storage tank so that warm water will rise into the tank. These systems are reliable, but contractors must pay careful attention to the roof design because of the heavy storage tank. They are usually more expensive than integral collector storage passive systems.

2. LITERATURE SURVEY

H.Lee et.al. [1][2] Performed experiment, the effect of thermal radiation interaction with convection, is determined using the radiation scaling laws, combined with a multi-layer solution technique. The computed temperature profiles do verify the establishment of thermal full development, for both the constant wall temperature and the constant wall heat flux cases. When the heat transfer results are carefully interpreted, they show that radiation can significantly influence the thermal development of a flow. The bulk heating of the fluid occurs earlier in the entry region, when the fluid is absorbing. Increasing the optical depth of the layer also contributes to the heating of the fluid. A lower wall temperature is also required to heat the fluid with the same wall heat flux. Attempts to correlate these results of radiation dominant problems into a Nusselt number description, which is based on convection alone, can be very misleading.

A. Hassaba et.al., [3] This paper presents a theoretical model to investigate the effect of axial wall conduction on the heat transfer characteristics for laminar flow through a thick-walled channel, taking into account the radiation effect in gases as a participating medium in the radiation exchange.

S.V. Patankar et.al., [4], The paper deals with the effect of radiation on the heat transfer and the full thermal development of the flow is studied. The effect of scattering, conduction-radiation parameter and the optical thickness are examined. The radiation is shown to substantially alter the heat transfer downstream before the thermally fully developed conditions. The full thermal development is shown to exist for the constant wall temperature case, while it is pushed further downstream and could not be seen for the constant wall heat flux case. While the radiation greatly affects the heat transfer when the fluid is heated, for the cooling case radiation effect decreases along the stream wise direction and vanishes at the fully developed conditions.

T. C. Chawla et.al., [5] Losses in channel flows are usually determined using a frictional head loss parameter. Fluid friction is however not the only source of loss in channel flows with heat transfer. For such flow problems, thermal energy degradation, in addition to mechanical energy degradation, add to the total loss in thermodynamic head. To assess the total loss in a channel with combined convection and radiation heat transfer, the conventional frictional head loss parameter is extended in this study. The analysis is applied to a 3D turbulent channel flow and identifies the critical locations in the flow domain where the losses are concentrated. The influence of Boltzmann number is discussed, and the best channel geometry for flows with combined heat transfer modes is also determined.

S. Tiwari et.al., [6] A partition separates the channel of interest into two regions (upstream and downstream region) in which two different coolant fluids bound the channel in those regions. A numerical model has been developed in this study using a finite-difference technique to solve the conjugate heat transfer problem by creating a self-made computer code. The modified P-1 approximation is employed to solve the radiation part of the problem.

3. MODELLING

Fig 3:- final arrangement of tubes

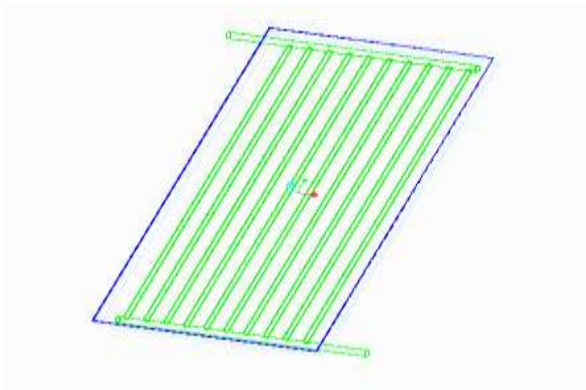

Fig4:- final assembly

4. RADIATION ANALYSIS

5mm thickness of plates:- APRIL 25th, 1:55 PM

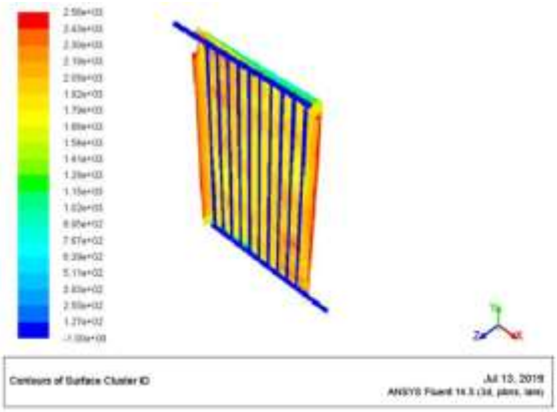

Fig 5:- radiation residuals

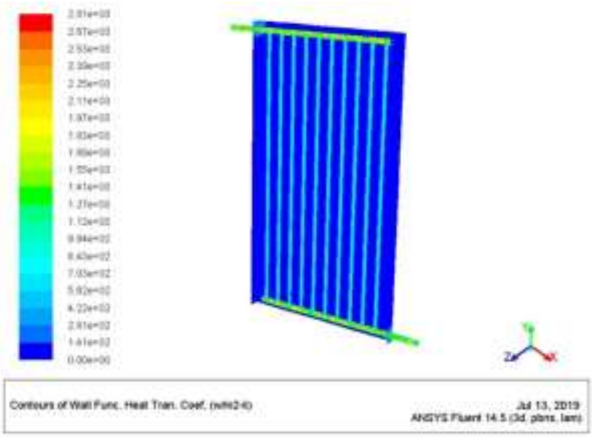

Fig 6:- wall function heat transfer coefficient

4. Results and discussions

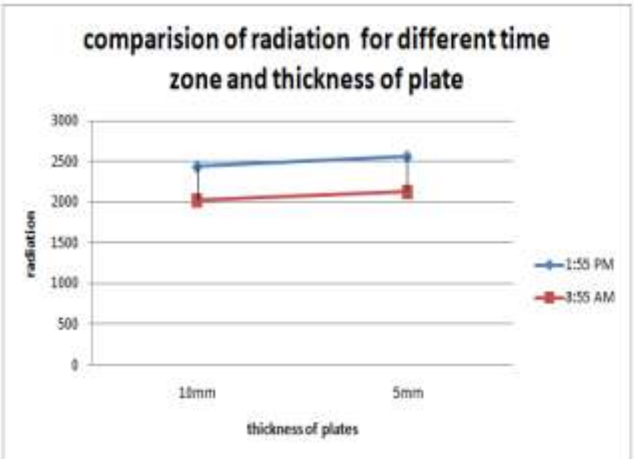

Chart 1 : radiation residuals

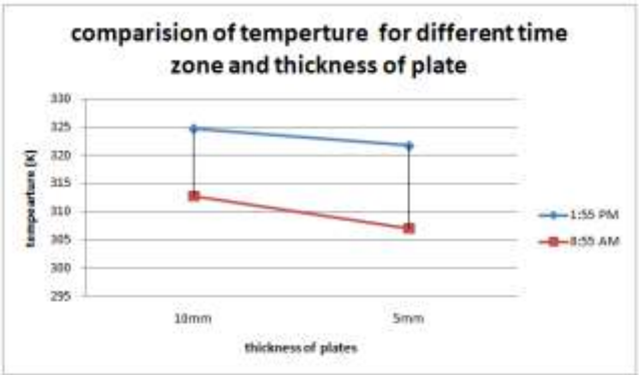

Chart 2 : temperature at different time zone

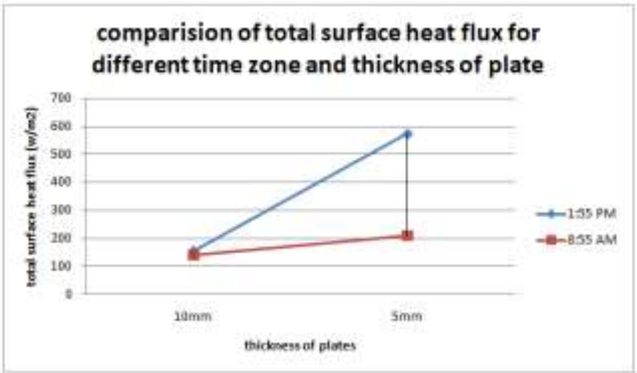

Chart 3 : total surface heat flux

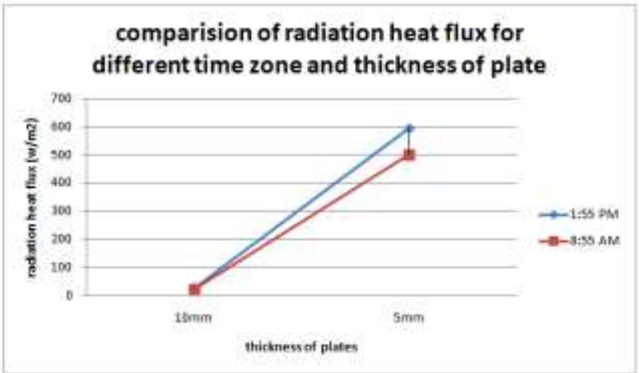

Chart 4: radiation heat flux

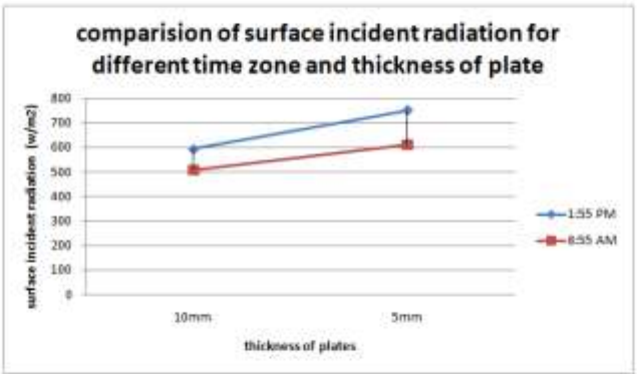

Chart 5: surface incident radiation

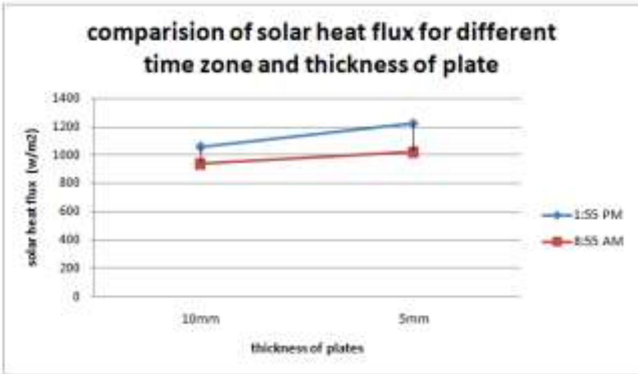

Chart 6: surface heat flux

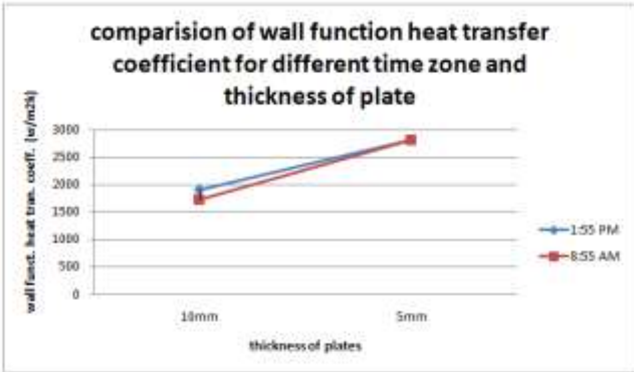

Chart 7:wall function heat transfer coefficient

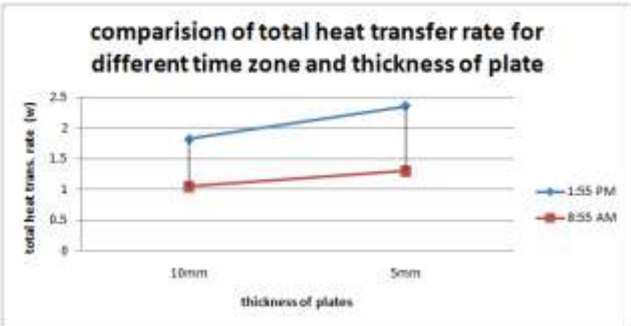

Chart 8: total heat transfer rate

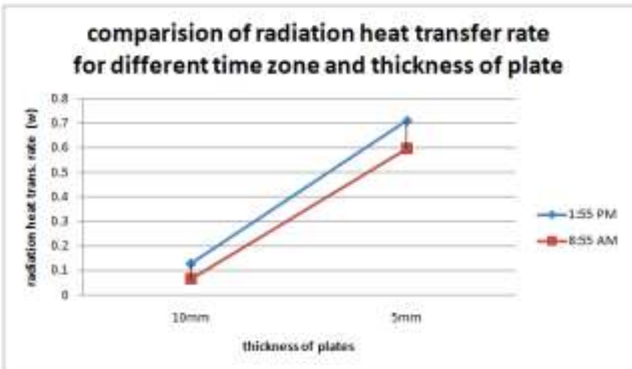

Chart 9: radiation heat transfer rate

5. CONCLUSIONS

In this work, to investigate simultaneous heat transfer by convection and radiation in a channel flow between two infinite black parallel plates is done. The effect of radiation on the heat transfer and the full thermal development of the flow is determined. The parameters such as the scattering, the optical thickness and the conduction radiation parameter will be varied and compared for the heat transfer.

From the above results, we conclude that for varying the thickness of plate,

- The radiation residuals is high for 5mm thickness at 1:55 PM
- The temperature for the working fluid is high for the 5mm thickness plate while compare to 10mm
- similarly, Radiation heat flux, surface incident radiation, solar heat flux, heat transfer coefficient, heat transfer rate are high for the 5mm thickness plate because of maximum absorption of ration is possible

So finally, efficiency is also high for TiO2 nanofluid while using 5mm thickness of solar flat plate collector.

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