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EXPERIMENTAL STUDY AND PERFORMANCE ANALYSIS OF SOLAR AIR HEATERS WITH DIFFERENT PARAMETERS

Sunil Kumar Patel[*1], Dr. M.K. Chopra[*2]

[*1,2]Department Of Mechanical Engineering, RKDF Engineering College, SRK University, Bhopal (M.P.) India.

ABSTRACT

Energy is the foundation of sustainability and quality of life. In different structures, we need energy to meet our needs. The rate of energy consumption is a pattern or gradual lifestyle. Extensive energy sources can be organized into two categories: regular and irregular. Conventional energy sources include petroleum products (coal, crude oil and flammable gas), which are highly accurate and limited in use and practical. Previous studies have found that irregular roughness of various shapes without airflow changes their laminar behavior to a turbulent shape. The turbulent effect of the flow inside the solar air heater duct disturbs the boundary layer formed near the hot surface.

Keywords: Experimental Study; Solar Energy; Performance Analysis.

I. INTRODUCTION

There is no electricity grid in most parts of the country, so one of the first uses of solar energy was to pump water to replace India's 1 million diesel water pumps, each 3.5 watt-kilowatt-hours. The sun is the best source of energy. With solar energy coming from Earth, a small portion of the light is enough to survive. This light is converted into different types of energy which is useful for many types of experiments. In addition to nuclear energy from various energy sources, it is also generated from the sun. Because of the benefits of the sun, many researchers around the world are looking for financial resources to control their energy.

India is blessed with abundant sunshine, rain and biomass. The last two decades of hard work has paid off as people in all walks of life realize the benefits of renewable energy, particularly with the need for alternatives to electricity if needed in cities or suburbs. The government created the Extraordinary Energy Resources Service (DNES) in 1982. Ships and grenades were built using wind energy before 7000 BC. The use of electric motors from water treatment plants or irrigation systems has speeded things up. With the advent of the revolution, as oil began to rise, the amount of energy used increased. This happened in stages from the discovery of coal mines to the discovery of real oil and gas. Only half a century ago, nuclear power was first introduced as an energy source. Over the past century, it has become increasingly clear that uncontrolled use of energy is causing more harm to the environment.

Table 1: Current renewable energy scenarios in India

Sl. No.	Sources	Approximate Potential (MW)	Potential Harnessed (MW)*
1	Wind Power	45219	17967.15
2	Small Hydro(upto 25 MW)	15000	3434.07
3	Biomass Power (Agro residues)	16881	1209.60
4	Cogeneration bagasse	5000	2109.73
5	Waste to Energy	2700	93.68
6	Solar Power	$6X10^8$	1044.16
	Total	84776	25858.39

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Measuring Units Of Energy

A unit of energy measurement is called a BTU or British thermal unit. BTU refers to the amount of heat energy required to increase the temperature of one pound of sea water by one degree Fahrenheit.

Energy can be measured in joules. The amount of energy required to weight 1 pound is about an inch. It requires 1,000 joules equivalent to one British thermal unit. Joule is named after the British scientist James Prescott Joule, who was 90 years old. Until he discovered that heat is a form of energy.

Scientists orbit the earth to measure energy in joules rather than BTUs. It seems that people around the world use metric systems, meters and kilograms, as well as metric systems. You get kilojoules: kilojoules mean 1000, so 1000 joules = 1 kilogram = BTU.

Basic Applications Of Solar Energy

There are many domestic and industrial forms of solar thermal systems. Some of the main uses of solar energy are crop drying, irrigation, chemical rehabilitation, heating and cooling, water/air heating and much more. The biggest problem with solar energy is its construction. Different types of solar collectors are used to collect the sun's rays, which can be used to provide a drinking experience for drinkers and which are used in many domestic and industrial applications. It is the number one component of any solar system.

Solar Collectors

Renewable energy has seen unprecedented improvements due to reduced demand for oil terminals that provide valuable energy sources. Solar energy is an important source of energy due to its size. The easiest and most efficient way to use solar energy is to convert it into solar energy. A nuclear solar system must convert solar energy into solar energy on average. Solar collectors use the energy they generate to convert energy from solar radiation into hot air and transfer the energy emitted from the collector.

II. LITERATURE REVIEW

The wings were shown just to give a sense of proportion. Many thin shapes increase the surface area, including the exposed conjunctival area, increasing heat transfer from the hot surface to the moving fluid. The closed surface increases the heat transfer rate with the negative effect of limiting fluid flow. Wavy V by Sebai et al. Several studies have been carried out to design efficient corrugated surfaces to increase heat transfer with minimal damage.

Roughness components can be separated into two-dimensional or three-dimensional ribs, transverse or oblique ribs, broken ribs with or without holes, or without shape. Rough components can be bent wire, cut, perforated or composite rib. Ribs are generally square, but unique shapes such as circular, semi-circular and beveled are also taken into account when examining the application of heat pressure.

The effect of roughness on the contact factor and velocity assignment was first studied by Ncordse, who led the sequence of analyzes in solid sand grains. Early tests, starting with the Neckards test, tried to produce speed and heat dissipation at some level. The use of artificial heaters using small diameter wire attached to the suction plate was first developed by Prasad and Malik to improve the efficiency of solar heat conduction. Prasad and Sini were studied experimentally under a magnetic field in the form of small thermal conduction edges of total fluid flow in the path of a solar heater. Verma and Prasad verified the inclusion of steel cables on three sides of the rectangular tunnel at room temperature and fluid flow. Gupta also studied the effects of flexible wire wool under the suction plate at different stages of operation.

Gupta and his colleagues examined the roughness of the oblique transverse rib. Ahrwal etc. Adjust the continuous slope of the bevel rib, providing the maximum roughness difference and increasing the heat transfer coefficient of the solar air heater. They study several approximate coefficients for correction. Later, Kumar etc. He also studied the summary of diagonal sides with different operating parameters.

Formulations

The layer acts as a conductive coating for heat transfer. As a result, the rough effects irritate the boundary layer and increase the rate of heat transfer. The roughness also increases the pressure drop inside the channel, to reduce its effect, it is necessary to create a turbulent flow near the surface. The effect of tilt has not yet been studied explicitly and in combination with the phase factor. Therefore, the main purpose of the present work is to increase the rate of heat transfer capacity of the solar air heater using a specific slope with the roughness of the ribs stuck in the absorbent plate. The current study was conducted with different engineering criteria used in the roughness and affecting the generation number and thermal performance. Copper wires of different diameters (such as coarse heights) and different shapes are commonly used to drive heat transfer.

III. METHODOLOGY

Before starting the experiments, make sure the tools are connected and positioned correctly. Keep connections free of air leaks, check all connections and start blower. Check the U-tube gauge level as zero and adjust the airflow through the control valve to set the preset airflow rate. The experiment was carried out to collect data on heat transfer coefficient and friction flux under steady state conditions. It takes about 40-45 minutes for the system to reach steady state. The temperature relative to the plate in the different airflow range was taken only to obtain the steady state condition assumed to be reached when the plate temperature and the exhaust air temperature did not deviate by 15 min. of time.

Procedure followed to conduct experiment

1. Make all gaskets leak-proof to eliminate errors and connect the instruments correctly with the experimental mounted for correct operation, after checking all connections the blower is then turned on.

2. Before adjusting the control valve, make sure the micrometer and the U-tube manometer are level. The preset mass flow rate is then adjusted for the test section.

3. The experiment is conducted to collect data concerning heat transfer coefficient and friction flux under steady state condition. With each change in airflow rate, the system must reach a steady state and it takes a minimum of 1 hour before data is recorded.

4. The temperature relative to the plate in different airflow ranges was reached after reaching the steady state condition. Inlet, outlet air temperature and board temperature are recorded using thermocouple wires via the data logger.

5. The pressure drop in the duct and the pressure drop in the orifice plate are obtained using a micromanometer and a U-tube manometer.

6. For each roughness, six different airflow rates in relation to the Reynolds number were conducted.

Experimental setup

To control the improvement of the solar air heater using the artificial roughness of the inclined split rib with slits, data on the heat transfer coefficient, friction factor and thermal efficiency are obtained using an experimental setup. The characteristic slope with graded rib roughness is fabricated with various geometric parameters such as the degree of relative roughness (P/e), the number of cracks at half the slope (Ng) and the relative crack size (g/e). To explore the combined effect of the Nusselt number and the friction factor, the thermo-hydraulic performance variables of the current roughness, which is the discrete slope with gap rib roughness, were also studied.

A pilot duct with a width of 200 mm and a height of 30 mm is obtained. The flow section includes an inlet section for fluid flow at atmospheric temperature, a test section for a separate study of the slope with uneven roughness and an outlet section for calculating the outlet temperature. The channel is made of wooden boards with internal dimensions of 2000 mm x 200 mm x 30 mm. The inlet section provides a fully developed flow to the test section and measures the temperature of the inlet air. In the exit area, the mixing section is provided to properly mix the air leaving the test area to obtain a uniform exit temperature, i.e., the average block temperature.

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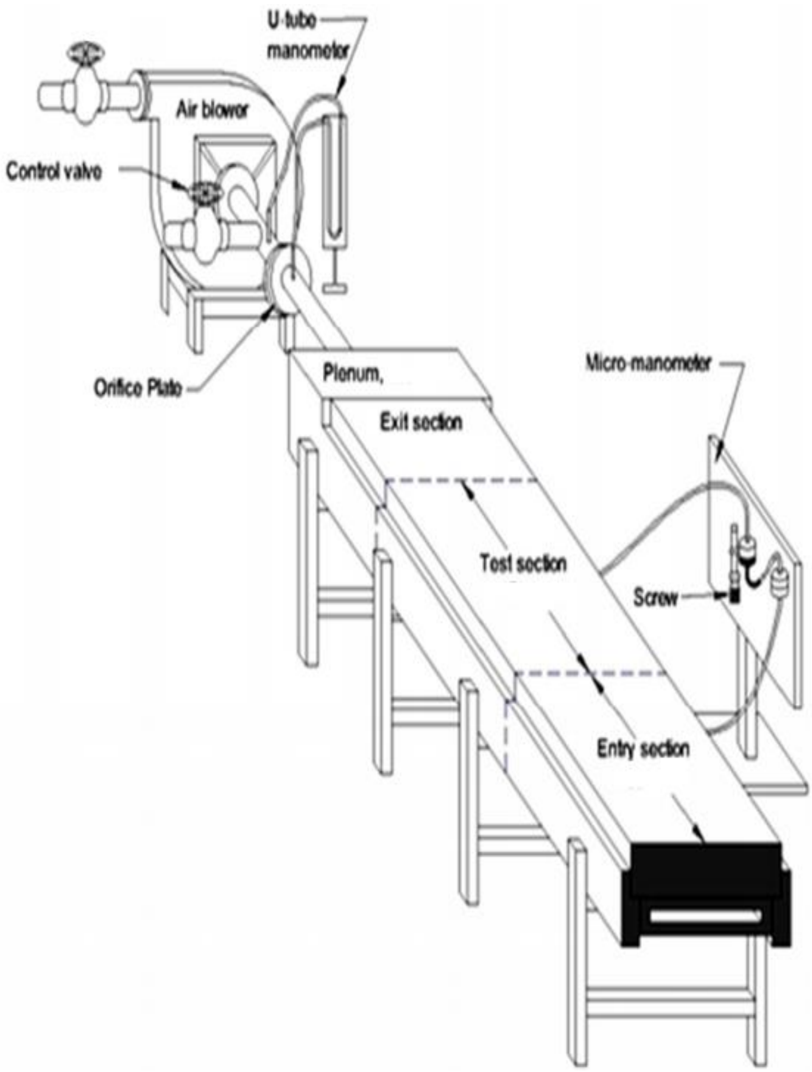

Figure 1: Experimental setup

The pressure drop created in the test section during the experiment was measured with a micronometer. The absorbent plate is made of GI plate (galvanized iron plate) with dimensions of 1500 mm x 200 mm x 1.5 mm and is provided using coarse copper wire with a height of 1.5 mm. The top of the absorbent plate is coated with black paint to increase its ability to absorb heat. Both sides of the absorbent plate, namely the air inlet section and the duct outlet section are covered with 8 mm thick plywood and the entire outer surface of the configuration is covered with 25 mm thick polystyrene foam with thermal conductivity 0.037 W / mK insulation.

Table 2: System and roughness parameters

Sl.No.	Roughness parameters	Range
1.	Roughness height (e)	1.5 mm
2.	Angle of attack (α)	30°, 45° and 60°
3.	Width of duct (W)	200 mm
4.	Height of duct (H)	25 mm
5.	Aspect ratio (W/H)	8
6.	Relative roughness pitch (P/e)	6, 8, 10 and 12
7.	Number of gaps on half of inclination (Ng)	1, 2 and 3

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8.	Relative gap size (g/e)	1, 2 and 3
9.	Reynolds number (Re)	4000-12000

The plate is fabricated by using copper wires of small diameter (1mm and 1.5mm) and it is sticking over the surface of GI sheet to get the required geometry with predefined parameters.

IV. RESULTS AND DISCUSSION

Table 3: Experimental and theoretical Nusselt number of smooth surface

Sl.No.	Reynolds number	Experimental (Nu_s)	Theoretical (Nu_s)	Error in (Nu_s) in %
1	4000	18.56	15.35	0.13
2	6000	23.56	21.23	0.10
3	8000	28.26	27.15	0.04
4	10000	32.56	32.62	-0.02
5	12000	36.42	37.85	-0.04

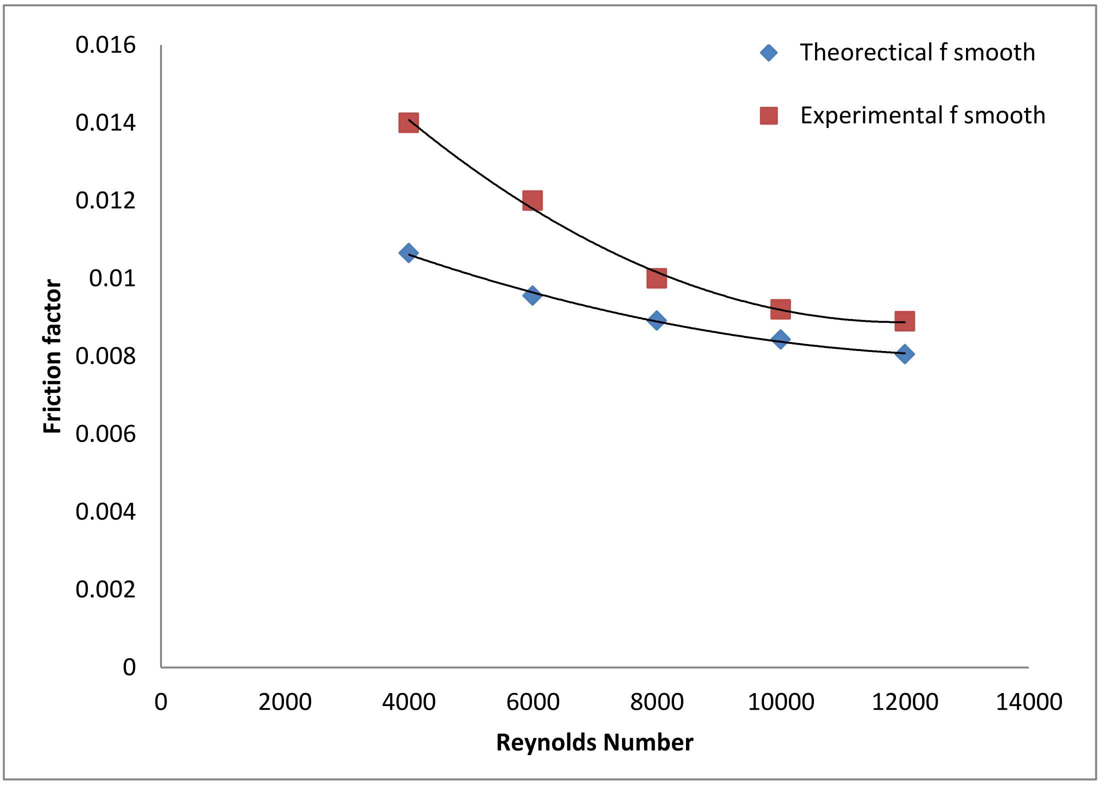

Figure 2: Plot between theoretical and experimental Nusselt number of smooth plate

Table 4: Experimental and theoretical friction factor of smooth surface

Reynolds number	Experimental (f_s)	Theoretical (f_s)	Error in (f_s) in %
4000	0.014	0.01065	0.24
6000	0.012	0.009557	0.20
8000	0.01	0.008917	0.11
10000	0.0092	0.008426	0.08
12000	0.0089	0.008046	0.10

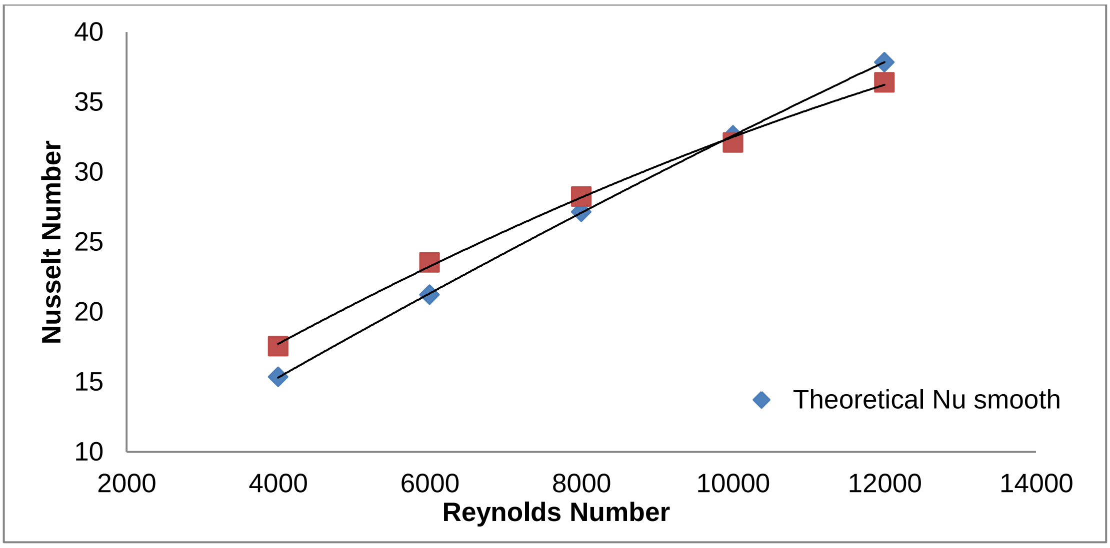

Figure 3: Plot between theoretical and experimental Friction factor of smooth plate

V. CONCLUSION

The results obtained from the correlation and the results of the experimental data for the Nusselt number and the friction factor were compared as shown in the Table. 3, 4 respectively. The experimental and theoretical results of the Nusselt number and the friction factor are shown in Figures 2 and 3, respectively. From the graph, the deviation in the theoretical and experimental Nusselt number of the flat plate shows that the results are in the considerable range and therefore the available test facility is authenticated. From the graph, the deviation in the theoretical and experimental friction factor of the flat plate shows that the results are in the considerable range and therefore the available testing facility is authenticated.

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