Estimation of Energy Gain of Solar Thermal Collector With Nano Carbon-MnO_2 Coated Absorber

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Abstract- *The present research is focused on the design and development of solar collector. It is also focused on the estimation of energy gain of the designed and developed solar collector in outdoor conditions. The present research proved that the solar collector could be designed and developed with nano textured glass cover, nano composite coated absorber and novel wool. The observation on research outcomes showed that the energy input varied from 1729.1W/m^2 to 2085.7W/m^2. The observation on research outcomes also showed that the energy output ranged between 916.4W/m^2 and 1326.6W/m^2. It could be concluded that enhanced energy gain would be reaped in solar collector integrated with nano textured, nano composite coated and novel components.*

Keywords- Collector-Nano Carbon-MnO_2 Coated Absorber-Estimation of Energy Gain

I. INTRODUCTION

The solar collector is the central component of any solar thermal gadget. It is developed to capture incident solar radiation. It is also developed to transfer the captured energy to any working fluid [1]. It is pertainant to mention here that the usage of nano textured, nano composite coated and novel components in solar collector can yield enhanced temperature of working fluid and improved energy gain of solar collector [2]. In this connection the present research work was devoted (i) to design and develop solar collector (ii) to assess the input and output energy of solar collector and (iii) to estimate the energy gain of solar collector. All these objectives were materialized by utilizing standard materials and standard methods. The obtained research outcomes have been documented in the research paper for the benefit of researchers, manufactures and end users of solar products.

II. MATERIALS AND METHODS

Design and development of solar collector:

The design of the solar collector was framed on the basis of specifications in Bureau of Indian Standards (BIS) by giving due considerations in sizes of components, spacings between components and sizes of collector. On the basis of the framed design, the primary components such as nano textured glass cover, nano carbon-MnO_2 coated GI absorber and novel wool were integrated for the development of the collector. On the basis of the framed design, the secondary components such as aluminium channel section, aluminium angle section, aluminium bottom sheet, EPDM gasket and EPDM grommets were also integrated for the development of the collector [3].

Estimation of energy gain of solar collector:

The solar collector was tested in outdoor conditions as per BIS specifications. During the testing tenure, the incident solar radiation, atmospheric temperature, wind speed, inlet temperature of working fluid and outlet temperature of working fluid were periodically monitored [4].

The energy input was calculated by multiplying the parameters such as solar radiation and gross area of the solar collector. At the same time, the energy output was calculated by multiplying the parameters such as mass flow rate, specific heat capacity and difference in output and input temperatures of working fluid. The energy gain was calculated by taking the ratio of the calculated energy output and input parameters [5].

III. RESULTS AND DISCUSSION

The design, development and estimation of thermal energy gain of solar collector is the present research. The technical specifications of the designed and developed collector have been presented in Table 1. At the same time, the research outcomes of thermal energy gains have been presented in Table 2, Table 3, Table 4 and Table 5.

Table 1. Technical specifications of solar components

Components	Materials	Thickness (mm)	Sizes (mm)
Glass cover	Nano textured glass cover	4.10	2080 ×1070
Absorber	Nano carbon-MnO_2 coated absorber	0.21	2060 ×1050
Insulator	Novel wool	20.00	2060 ×1070
Channel section	Aluminium	1.70	2082 ×1072
Angle section	Aluminium	1.30	2082 ×1072
Bottom sheet	Aluminium	0.80	2080 ×1070

Table 2. Energy gain of solar collector (At inlet fluid temperature 30˚C)

Time (Hr)	Solar radiation (W/m^2)	Energy input (W/m^2)	Energy output (W/m^2)	Energy gain (%)
11:00	795.2	1769.3	1185.4	67.0
11:30	812.5	1807.8	1193.2	66.0
12:30	864.3	1923.1	1288.5	67.0
13:00	903.4	2010.1	1326.6	66.0

Table 3. Energy gain of solar collector (At inlet fluid temperature 40˚C)

Time (Hr)	Solar radiation (W/m^2)	Energy input (W/m^2)	Energy output (W/m^2)	Energy gain (%)
11:00	800.5	1781.1	1122.1	63.0
11:30	848.5	1887.9	1227.1	65.0
12:30	868.3	1932.0	1236.5	64.0
13:00	890.1	1980.5	1267.5	64.0

Table 4. Energy gain of solar collector (At inlet fluid temperature 50˚C)

Time (Hr)	Solar radiation (W/m^2)	Energy input (W/m^2)	Energy output (W/m^2)	Energy gain (%)
11:00	798.4	1776.4	1083.6	61.0
11:30	812.5	1807.8	1084.7	60.0
12:30	882.6	1963.8	1237.2	63.0
13:00	937.4	2085.7	1293.1	62.0

Table 5. Energy gain of solar collector (At inlet fluid temperature 60˚C)

Time (Hr)	Solar radiation (W/m^2)	Energy input (W/m^2)	Energy output (W/m^2)	Energy gain (%)
11:00	777.1	1729.1	916.4	53.0
11:30	835.3	1858.5	1022.2	55.0
12:30	890.1	1980.5	1089.3	55.0
13:00	918.2	2043.0	1082.8	53.0

In the present research, the solar collector with nano textuted, nano composite coated and novel components was designed and developed. The developed collector was tested in outdoor conditions as per BIS specifications.

In the present research, the input energy, output energy and energy gain were calculated. The input energy was found to vary from 1729.1W/m^2 to 2085.7W/m^2. The output energy was found to range between 916.4W/m^2 and 1326.6 W/m^2. At the same time, the percentage of energy gain was found to range between 53.0% and 67.0% with variations in temperatures of working fluid. The observation on these research outcomes revealed that the energy gain of present collector was higher than that of the conventional collector. In the context of increased energy gain of solar collector, it could be correlated with the design specifications such as opt sizes of components, appropriate spacings between components and standard sizes of the collector. It could also be correlated with the material specifications such as glass cover with nano textured material, absorber with nano composite coated substrate and insulation with novel wool [6]. In the same context of increased energy gain of solar collector, it could be attributed to fabrication specifications such as opt fixing of components, good workmanship of collector and good finish of collector. It could be also be attributed to structural, optical and thermal parameters such as enhanced transmittance of radiation, enhanced absorption of radiation, enhanced heat transfer to working fluid and reduced heat losses to the surroundings [7]. All these design, fabrication and material specifications along with the structural, optical and thermal characteristics of components would have caused the enhanced energy gain of the solar collector.

IV. CONCLUSION

On the basis of research outcomes, it could be concluded that nano textured, nano composite coated and novel components would be used in solar collectors instead of the conventional components. On the basis of research outcomes, it could also be concluded that enhanced energy gain would be reaped in solar collector integrated with nano textured, nano composite coated and novel components.

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