THERMAL ANALYSES ON NANO CARBON AND *COCCINIA GRANDIS*EXTRACT COATED SOLAR ABSORBER IN LABORATORY AND LAND CONDITIONS

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Abstract

Thermal analyses on nano carbon and Coccinia grandis extract coated solar absorbers is mandatory for their effective photo thermal applications. In this connection, the present research was devoted not only to thermally analyse the solar absorber in outdoor conditions but also to evaluate the thermal performance of solar collector integrated with the prepared solar absorbers. In this continuation, the solar absorbers were tested in outdoors and the enhancements in temperature along with influencing meteorological parameters were noted. The solar collectors with newly prepared absorbers were also tested in field conditions and the thermal performances were experimentally evaluated. It was found that the temperature enhancements on single coated solar absorber in outdoor conditions varied from 2.6^{0}C to 9.1^{0}C. It was also found that the thermal performances of solar collector integrated with nano carbon and coccinia grandisextract coated absorbers ranged between 62 to 65.2%. It could be conducted through the end user would prefer the solar collector integrated with nano carbon and coccinia grandisextract coated solar absorber for heating applications.

Key words: *Nano carbon - Coccinia grandis -Preparation ofSolar absorber -Development of solar Collector - Thermal characteristics*

Introduction

The preparation and utilization of energy efficient, eco friendly and economically effective solar absorbers are essential for their effective applications in solar collector. The assessments of thermal characteristics of solar collectors integrated with this solar absorbers are also essential for its effective application in the utilization avenues[1]. In this connection, the objectives such as (i) preparation of nano carbon and *coccinia grandis*extract coated solar absorbers (ii) Characterisation of nano carbon and *coccinia grandis*extract coated solar absorbers (iii) assessment of the thermal durability of the prepared solar absorbers (iv) assessment of thermal characteristics of the prepared solar absorbers and (v) elevation of the thermal performance of solar collector intergrated with the nano carbon and *coccinia grandis*extract coated absorbers were framed for the present research investigation. The standard materials, calibrated instruments and prescribed test set ups were used for materialising these objectives of the present research investigation[2,3]. The research outcomes have been documented in this research article for the benefits of manufacturers, researchers and end users of solar thermal devices in application sectors.

Materials and Methods

The charcoal was collected and it was powdered. At the same time, *Coccinia grandis* leaves were collected and their extract was prepared. The prepared carbon powder was mixed thoroughly in *Coccinia grandis* extract by using a mechanical stirrer. The prepared absorptive solution with nano carbon and extract of *Coccinia grandis* was coated on the pre cleaned zinc plate. The single coated zinc plate were used to serve as solar absorbers. The prepared solar absorbers were thermally analyzed in laboratory and land conditions.

During thermal analysis in laboratory conditions, the samples of the prepared solar absorbers were heated in an oven at a temperature of 175^{0}C for two hours. After the heating process was over, the heated absorbers were taken out from the oven and they were cooled at room temperature. The peeling of coating, fading of coating and flittering of coating, if any, on the absorbers was noticed [4].

During thermal analysis in the land conditions, the prepared solar absorbers with single coating were kept in test set up. They were kept so as to be free from shadow effects. They were also kept so as to be free from dust effects. During experimentation on zinc substrates and absorbers, the incident solar radiation on them was monitored periodically by using the sunmeter. In addition, the temperature enhancements on them were monitored periodically by using thermometers. It would be worth mentioning that the thermal analysis was carried out on clear sunny days. It would also be worth mentioning that the thermal analysis was carried out before, after and at solar noon so as to test the zinc substrates and solar absorbers in all meteorological conditions [5].

Results and Discussion

The present research investigation was conducted not only to prepare and characterise the novel absorbers but also to thermally analyse the solar collector integrated with the novel absorbers. While the technical specifications of solar absorbers and solar collectors have been presented in Table 1 and 2, the test results of thermal characteristics of the solar absorbers and solar collectors have been presented in Table 3 and Table 4 respectively.

Table 1 Technical Specifications of Solar Absorbers

Details of Absorbers	Specifications
Material	Zinc
Coating	Nano carbon and *coccinia grandis*extract
Thickness	1.08mm
Area	$2m^2$
Solar absorptance	85%
Solar emittance	13%

Table 2 Technical Specifications of Solar Collector

Details of Components and Collector	Specifications
Glass cover	Plain
Absorber plate	zinc
Insulation	Rock wool
Shape of collector	Flat plate
Size of collector	$2m^2$

Table 3: Test results on nano carbon and *coccinia grandis*extract coated and non coated absorbers

Time (hours)	Solar Radiation (W/m^2)	Ambient Temperature (^0C)	Relative humidity (%)	Temperature(^0C)	
				On zinc substrate	On zinc absorber
09:00	383.5	34.6	61.2	33.2	34.2
09:30	521.5	35.9	59.7	34.7	38.5
10:00	616.6	36.3	57.8	36.1	41.3
10:30	638.3	37.9	54.1	37.5	38.0
11:00	686.4	48.6	52.0	38.9	40.4
11:30	749.1	39.2	50.3	41.3	45.1
12:00	776.6	40.9	49.7	43.6	47.2
12:30	785.5	39.1	43.6	39.0	45.9
13:00	763.7	39.7	44.4	37.2	42.7
13:30	734.2	40.0	40.3	42.4	46.2
14:00	689.6	40.1	43.3	41.4	44.9
14:30	573.2	36.8	39.4	45.6	47.5
15:00	421.6	36.5	38.6	41.0	41.3

Table 4: Thermal Performances of Solar Collector

Solar radiation (W/m^2)	Inlet fluid temperature (^0C)	Outlet fluid temperature (^0C)	Thermal performance of solar collector (%)
600 to 700	30	34.2	62
700 to 800	30	36.9	65.2

In the present research, zinc plate for the preparation of solar absorbers was procured. It was cut into wuitable sizes and the substrates were prepared. The thickness and area of all there substrates were chosen as per BIS specifications. The prepared absorptive coating with nano carbon with *Coccinia grandis* extract was spray coated on these metal substrates and the solar absorbers were prepared.

In the present research, the outcomes of thermal analysis with reference to thermal durability in laboratory conditions showed that there was no peeling of coating on the absorbers. They also showed that there was neither fading nor flittering of the coating on the solar absorbers. So, the prepared absorbers would be used in stagnant and operative conditions of solar collectors[4].

In the present research, nano carbon powder was indigenously prepared and its crystallize size was found through XRD to be 36 nm. As the crystallize size was in nano ranges, the effected absorptive coating on solar

absorber would have more number of carbon particles per unit area. This would cause not only enhanced absorption of radiation but also enhanced heating of solar absorber[5,6].

In the present research, the developed solar absorbers were kept in outdoor conditions. It was found that the temperature on absorbers varied from 38.5 to 47.5^{o}C. It could be ascribed with the level of incident radiation, ambient temperature and relative humidity. It could also be ascribed with the level of optical absorptance, thermal conductivity and thermal durability of solar absorbers. It could as well be ascribed with the material of the substrates, chemical constituents of coating effected on substrates and thicknesses of coatings on substrates[7,8].

In the present research, the thermal performance of solar collector was experimentally estimated. It was found that the thermal performance varied from 62 to 65.2%. The test results related to these performances could be correlated with the transmittance of glass cover, optical characteristics of solar absorber and thermal properties of insulator. It could also be correlated with the fluid proof, heat proof and workmanship solar collector. It could as well be correlated with the influencing meteorological conditions, test conditions and operative conditions of solar collectors[9,10]. As the thermal enhancements on solar absorbers and thermal performance of solar collector were found to be substantial. It could be conducted through the end user would prefer the solar collector integrated with nano carbon and *coccinia grandis*extract coated solar absorber for heating applications.

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