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GENERATION OF THERMAL PROFILE OF NANO CARBON AND *DATURASTRAMONIUM* EXTRACT COATED SOLAR ABSORBER

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Abstract

Generation of thermal profile of nano carbon and Datura Stramonium extract coated solar absorbers is mandatory for their effective photo thermal applications. In this connection, the present research was devoted (i) To generate thermal profile of single coated solar absorber in outdoor conditions (ii) To generate thermal profile of double coated solar absorber in outdoor conditions and (iii) To evaluate the thermal performance of solar collector with the prepared solar absorbers in field conditions. In continuations, the single and double coated solar absorbers were kept in outdoor conditions and the thermal profile of the absorbers was generated. The solar collector with the coated absorbers was kept in field conditions and its thermal performance was experimentally assessed. It was found that the temperature enhancement of fluid 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 temperature enhancement of fluid on double coated solar absorber in outdoor conditions ranged between 3.2^{0}C and 10.6^{0}C. It was as well found that the thermal performance of solar collector with single and double coated absorbers was 65% and 67.2% respectively. It could be concluded that the end user would prefer the solar collector with either single or double coated absorbers as per temperature requirements of fluid in photo thermal applications.

Keywords: *Nano Carbon, Datura Stramonium, Solar Absorber, Fluid Temperature Solar Collector, Thermal Characteristics*

Introduction

Synthesis of energy efficient, eco friendly and cost effective solar absorptive coatings are mandatory for their effective utilization in solar absorbers[1]. In this connection, it is essential to prepare energy efficient nano powder for its usage in absorptive coatings effected on solar absorbers[2]. It is also essential to prepare eco friendly and cost effective plant extracts for their utilizationin absorptive coatings effected on solar absorbers[3]. At this juncture, the present research work was (i) To generate thermal profile of single coated solar absorber in outdoor conditions (ii) To generate thermal profile of double coated in outdoor conditions and (iii) To evaluate the thermal performance of solar collector with the prepared solar absorbers. All these objectives were materialized by using specified materials, specialized methodology and calibrated test instruments. The research outcomes

have been documented in this research paper for the benefits of manufacturers, researchers and endusers of solar thermal gadgets.

Materials and Methods

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

During thermal analysis in laboratory conditions, the prepared solar absorbers were heated in an oven at temperature of 175^0C 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 and double coatings 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 single and double coated 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 is to be noted that the thermal analysis was carried out in clear sunny days. It is also to be noted that the thermal analysis was carried out before, after and at solar noon so as to test the metalsubstrates and solar absorbers in all meteorological conditions[5].

Results and Discussion

The present research was conducted not only to prepare energy efficient, eco friendly and cost effective absorptive coating and to effect the coating on different metal substrates, but also to analyse thermally the prepared solar absorbers in laboratory and land conditions. While, the technical specifications of solar absorbers have been presented in Table 1. In addition, the temperature and temperature enhancement on solar absorbers with and without collectors have been presented in Table 2 and Table 3 respectively.

Table 1 Technical Specifications of Solar Absorbers

Solar absorbers	Specifications	
	Area (cm^2)	Thickness(mm)
Copper plate coated with nano carbon and *Datura Stramonium* extract	225	1.08
Zinc plate coated with nano carbon and *Datura Stramonium* extract	225	1.08
Aluminium plate coated with nano carbon and *Datura Stramonium* extract	225	1.09

Table 2 Temperature on Single Coated and Double Coated Metal Plates

Time (hours)	Solar Radiation (W/m^2)	Temperature (^0C)					
		On copper plate		On aluminium plate		On zinc plate	
		With single coating	With double coating	With single coating	With double coating	With single coating	With double coating
09:00	380.5	33.2	35.8	32.4	34.6	33.2	34.8
09:30	532.5	33.4	36.8	34.6	37.7	35.7	39.8
10:00	606.6	34.6	39.9	36.6	40.6	35.9	42.6
10:30	642.3	36.4	40.3	37.0	41.3	36.0	38.0
11:00	693.4	37.0	41.9	37.8	42.4	3/.8	40.4
11:30	768.1	38.5	44.2	39.8	45.9	40.9	45.9
12:00	785.6	40.6	49.7	42.0	49.7	42.2	48.0
12:30	781.5	38.5	47.4	41.4	48.2	39.0	46.6
13:00	774.7	39.4	46.4	40.6	47.6	37.9	42.0
13:30	765.2	41.5	47.8	43.6	46.1	42.8	46.9
14:00	710.6	40.7	45.8	40.1	43.1	41.6	45.7
14:30	580.2	41.6	45.4	41.9	44.1	45.0	47.1
15:00	410.6	37.9	40.8	38.2	41.2	40.0	41.7

Table 3 Thermal Performance of Solar Collector with Single and Double Coated Absorbers

Solar collector	Inlet fluid temperature (^{0}C)	Outlet fluid temperature (^{0}C)	Thermal performance (%)
Solar collector with single coated absorber	30	36.4	65
Solar collector with double coated absorber	30	37.1	67.2

In the present research, three different metal substrates for the preparation of solar absorbers were procured. They were cut in suitable sizes and they were used as substrates the thickness and area of all these substrates were chosen to almost be the same. The prepared absorptive coating with nano carbon with *Datura Stramonium* extract was effected on these metal substrates.

In the present research, nano carbon powder was indigenously prepared and its crystallize size was found through XRD to be 43 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 increased absorption of radiation but also increased heating of solar absorber[6].

In the present research, the outcomes of thermal analysis 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[7].

In the present research, the outcomes of thermal analysis in land conditions showed that the double coated solar absorbers had better thermal efficacies than those of the single coated metal substrates. The better thermal efficacy in solar absorbers could be attributed with optical absorptive, heat retentive and heat transfer characteristics of the absorptive coating effected on solar absorbers[8,9]. The outcomes of thermal analyses also showed that the copper based solar absorbers had better thermal efficacies than those of the aluminium and zinc solar absorbers. The better thermal efficacy of copper based solar absorbers could be attributed with the relatively better thermal conductive properties of material used as solar absorbers[10].

As the prepared absorption coating had desirable non peeling, non fading and non-flittering properties, it could be effectively used for photo thermal applications. As the prepared soar absorbers had desirable optical and thermal properties, they could also be used for photo thermal applications[7,8]. It could be concluded that the end user would prefer the solar collector with either single or double coated absorber as per temperature requirements of fluid in photo thermal applications.

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