Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

International Conference on Momentous Role of Nanomaterials in Renewable Energy Devices

Volume 5, Special Issue 07, April-2018 (UGC Approved)

EXPERIMENTAL ANALYSIS OF THERMAL PERFORMANCES OF SOLAR COLLECTORS WITH NANO-CARBON AND METAL OXIDE COATED FLIPPERS

N.S.Saravanan[1], G.Uma Maheshwari[2], R.V.Jeba Rajasekhar[3]

[1]*Arumugam Pillai seethai ammal college,Thirupattur, Sivagangai, Tamilnadu.*
[2]*Govt Girls Hr sec School, Mahaboopalayam, Madurai, Tamilnadu.*
[3]*PG & Research Department of Physics, Govt of Arts & Science College, Melur, Madurai, Tamilnadu.*

ABSTRACT - *This applied research is devoted not only to develop the nano-carbon and metal oxide coated solar flippers but also to experimentally analyze the solar collector integrated with the nano-carbon and metal oxide coated flippers. In this connection, the present research work was carried out with the objectives such as (i) preparation and deposition of absorptive coatings with nano sized carbon and metal oxides(ii) characterization of absorptive coatings effected on aluminium substrates and (iii) experimental evaluation of thermal performances of solar collectors with the nano carbon and metal oxide coated flippers. In the present research work, the absorptive coatings with optimized composition of carbon and metal oxides were prepared and they were spray coated on aluminium substrates. The prepared solar absorbers were characterized and it was found that the crystallite sizes of carbon and metal oxides were in nano sizes. Subsequently, the thermal performance and losses of solar collectors integrated with the optimized flippers were experimentally estimated. The experimental results showed that the thermal performance of solar collectors with flippers of different nano-carbon and metal oxide coatings was higher than 65.0 %. The experimental results also showed that the thermal loss of solar collectors with flippers of different nano-carbon and metal oxide coatings was lower than 4.0 Wm^{-2} ℃. On the basis of generated database, it could be concluded that solar collectors with nano-structured flippers would be used due to their enhanced thermal performances and reduced thermal losses*

Keywords: *Nano coated flippers, solar collectors, solar absorbers, estimation of figures of merit, absorpative coting, characterisation.*

I. INTRODUCTION

A solar flipper is the integral component of any solar collector. It is a device to absorb incident solar radiation and to transfer the energy by means of conduction to a fluid passing in conduct with it. The fundamental component of the flat plate solar collector is solar flipper and so it is required to study its characteristics for its effective utilization in solar thermal devices. In the present investigation, solar flippers of different materials were collected and their characteristics were extremely studied. All the objectives such as identification of materials analysis on the chemical composition of coatings and characterization with reference to structural analysis on the coatings were materialised. Standard methodology was adopted and the research out comes have been documented in this research paper for the benefits of manufacturers and researchers worldwide.

II. MATERIALS AND METHODS

Merge of solar technology and nano technology is the need of hour as this combination can enhance the optical efficacy of nano carbon and metal oxide coated flippers and thermal efficiency of solar collector. In this connection the following objectives have been framed such that preparations and deposition of absorptive coatings with nano sized carbon and metal oxide, characterization of absorptive coatings effected on aluminium substrates and experimental evaluation of thermal performance of solar collectors with the nano carbon and metal oxide coated flippers standard methodology was adhered to materialize the objectives. Nano-sized carbon and nano-sized metal oxide were commercially procured. Nano-sized carbon and metal oxide was mixed up in different ratios such as 75:25, 50:50 and 25:75 and the present nano-composites were blended in black emulsion. Resultant solution was coated on the pre-cleaned metal substrates by spray coating method. Coated absorbers were characterized through XRD and SEM analyses. Ratio optimization of nano-composites with reference to thermal analysis was conducted by testing the solar absorbers in outdoor conditions.

In the present research developed absorber was characterized through X-ray diffractometer and the diffractogram was generated. The crystalize in the coating on the absorber was calculated by using the Debye-Scherrer formula that has been presented in equation 1

$$D = x \lambda/\beta \cos\theta \quad \ldots(1)$$

where D is particle size, X is correction factor, λ is wave length of X-ray used and β is the FWHM of the observed peaks and it was found to be in nano-sizes.

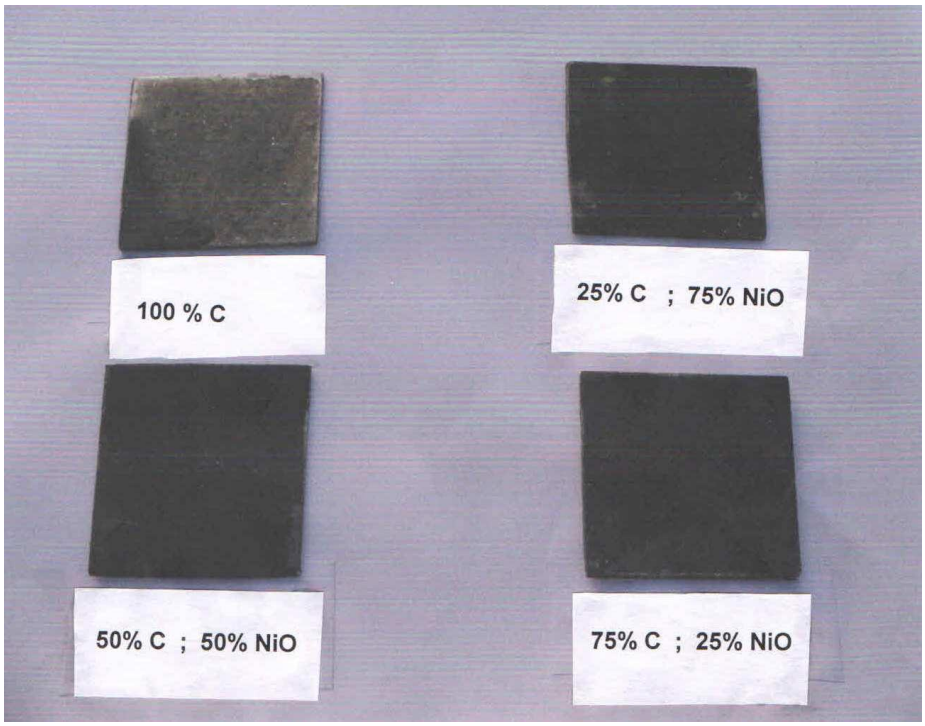

Figure 1. Absorbers wuth different proportions of C and NiO

Figure 2. Measurement of temperature on absorber

III. RESULTS AND DISCUSIONS

In the present study a nano structured flipper was developed. In addition, a solar collector integrated with the nano structured absorber was developed. In the photographs of the developed absorber has been presented in the figure. The developed absorber was characterized and the outcomes of XRD, SEM are presented in figure respectively the sizes of the indigenously prepared and commercially procured graphite and metal oxide would determine the thermal performance of photo thermal collectors and so they were to be structurally characterized. The SEM results of the carbon nano particles and these images could reveal the surface characteristics of the nano carbon coated absorber used in solar collector.

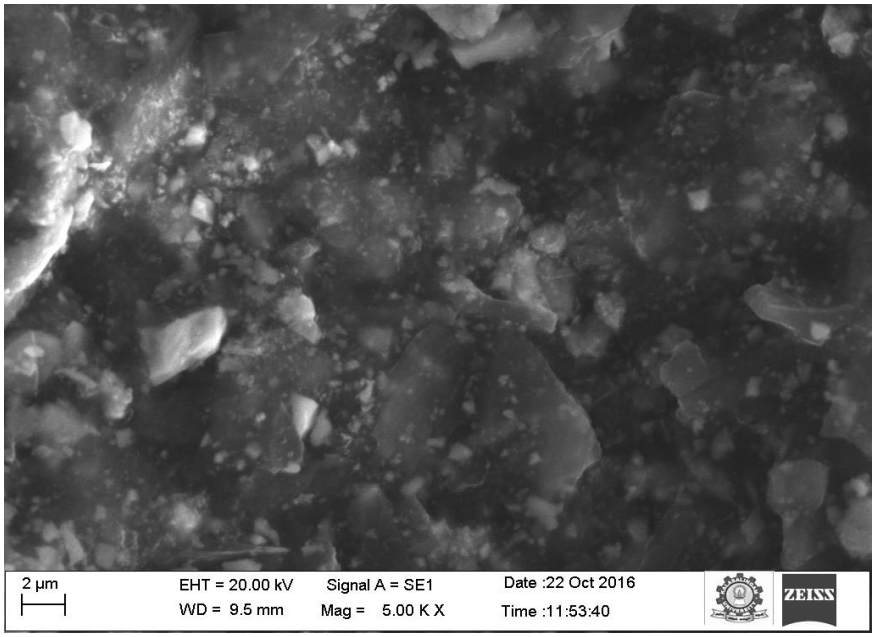

Figure 3. SEM images

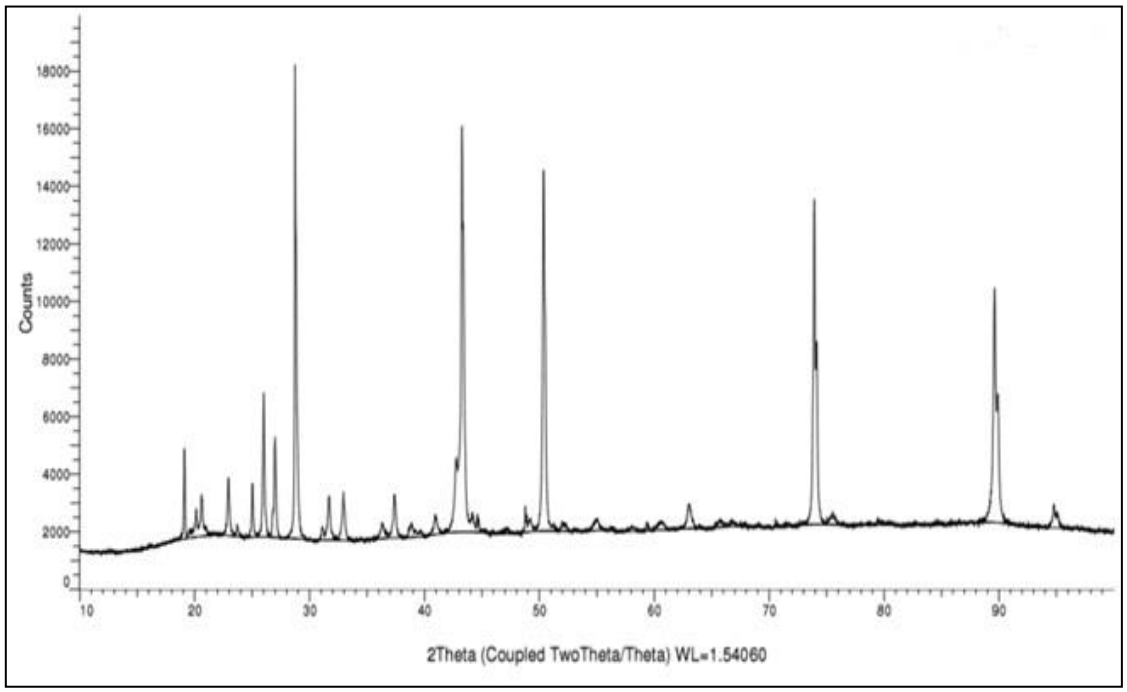

Figure 4. XRD pattern of coating

In the present investigation, the structural characterization of solar absorber was performed by XRD measurement by using X-ray diffractometer of make BRUKER ECO D8 ADVANCE operating at 40kv and 20mA with normal scanning. The required parameters were obtained from the diffractogram and they were substituted in Scherer formula. The grain size was calculated and it was found to be 29.65 nm.

The temperature enhancement of the conventional coating based substrate was noted. In addition the temperature enhancement on the substrates with different compositions (100:1, 75:25, 50:50, 25:75) of nano sized graphite and metal oxide was noted. It was found that the temperature enhancement on nano composite coated substrate was higher than that of the conventional coating based substrate. It was also found that the substrate with 25:75 ratio coating on absorber had higher enhancement of temperature than those of absorber with all other ratios of coating of nano composite.

Table 1. Temperature enhancement in solar absorbers

Time	Absorber temperature°C			
	Sample - 1	Sample - 2	Sample - 3	Sample - 4
10:00 a.m	40.7	42.4	43.8	46.4
10:10 a.m	42.6	43.6	44.2	48.2
10:20 a.m	44.3	45.4	46.7	50.5
10:30 a.m	45.6	47.7	48.3	52.4
10:40 a.m	47.2	48.9	50.6	53.7
10:50 a.m	49.1	51.1	52.3	55.1
11:00 a.m	50.4	52.6	53.4	58.3
11:10 a.m	52.6	55.3	55.3	61.7
11:20 a.m	54.4	57.8	58.2	62.4
11:30 a.m	57.3	59.4	60.1	63.6
11:40 a.m	59.8	61.3	63.6	65.3
11:50 a.m	61.3	63.8	64.8	67.6
12:00 Noon	63.2	65.1	66.7	70.4
12:10 p.m	65.4	66.6	68.1	72.6
12:20 p.m	66.9	67.5	69.4	73.4
12:30 p.m	68.3	70.4	73.6	73.9
12:40 p.m	67.4	68.9	72.7	72.9
12:50 p.m	66.5	67.4	70.1	71.8
1:00 p.m	65.7	66.9	69.3	70.3
1:10 p.m	64.9	65.6	67.4	69.9
1:20 p.m	63.6	64.3	66.3	68.3
1:30 p.m	62.4	63.2	65.1	67.4
1:40 p.m	61.3	62.3	64.2	66.2
1:50 p.m	60.8	61.6	63.4	65.4
2:00 p.m	59.2	60.3	62.8	64.3
2:10 p.m	58.7	59.9	61.3	63.2
2:20 p.m	57.9	58.3	60.1	62.5
2:30 p.m	56.3	57.1	59.3	61.7
2:40 p.m	55.6	56.4	58.4	60.3
2:50 p.m	54.3	55.2	57.1	59.7
3:00 p.m	52.9	54.2	56.3	58.5

Table 2. Thermal performance of solar device

Solar radiation (W/m^2)	Ambient temperature (°C)	Wind speed (m/s)	Inlet water temperature (°C)	Outlet water temperature (°C)	Thermal performance (%)
747.4	29.9	3.1	30.0	36.4	71.0
768.2	32.3	3.5	30.0	36.3	68.0
811.4	33.3	3.1	30.0	36.9	70.0
860.9	34.1	3.0	30.0	37.2	69.0
Overall thermal performance					69.5

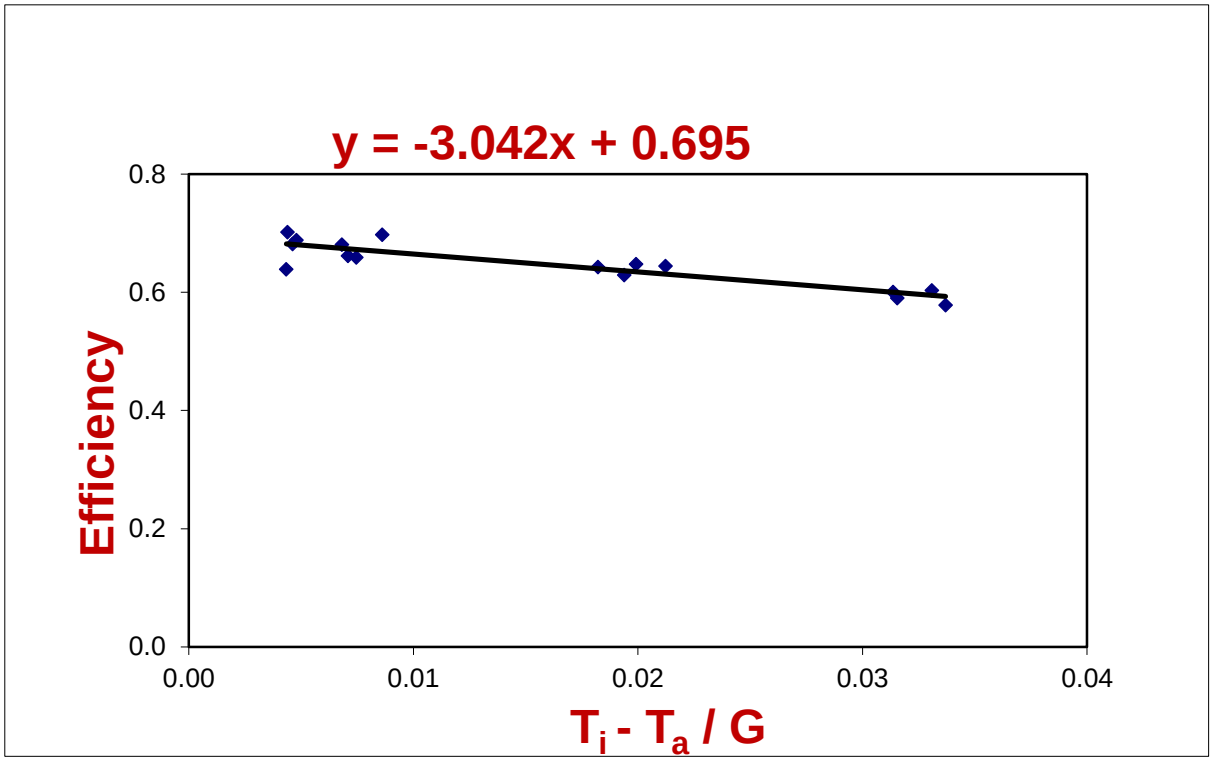

Figure 5. Graphical parameters of solar flippers with nanomaterial coated absorber

The thermal enhancement on solar absorber was measured periodically in diverse meteorological conditions in outdoor atmospheres. It was found that the maximum temperature enhancement of sample 1 is 68.3^0C. The maximum temperature enhancement of sample 2 is 70.4^0C similarly, the maximum temperature enhancement of sample 3 & 4 are 73.6^0C and 73.9^0C respectively. It was also found that the temperature on absorber rate varied from 68.3^0C to 73.9^0C in moderate radiation conditions. Therefore the text results also revealed that the temperature on absorber rate had the minimum of 68.3^0C and the maximum of 73.9^0C in high radiation conditions. Even though the recorded temperatures on solar absorber would be correlated with the material of absorber, nano absorptive coating and related convective losses, it could be asserted that the temperature enhancement could be specifically correlated with presence of large number of absorbing particles on absorber plate.

IV. CONCLUSION

On the basis of the research out comes pertaining to nano composite based absorptive coating and nano composite absorptive coating based solar absorber, it could be concluded that solar flippers with selective coatings would be utilize in solar collectors not only to have enhanced absorptance of solar radiation but also to have enhanced thermal performance of solar collectors and reduced thermal losses. Therefore it could be concluded that solar collectors with nano-structured flippers would be used due to their enhanced thermal performances and reduced thermal losses.

REFERENCES

[1]. Duffie, J.A., Beckman, W.A., 1980, Solar thermal engineering processes, A Wiley Interscience publication, New York, U.S.A.
[2]. IS 12933 (Part 1, 2 & 5: 1992 together with amendment No.1 of amendment 2000), Bureau of Indian Standards, India.
[3]. IS 12933 (Part 1, 2, 3 & 5: 2003 together with amendment No.1 of June 2005), Bureau of Indian Standards, India.
[4]. Kalogirou, S.A., 2004, Solar Thermal Collectors and Applications, Progress in Energy and Combustion Science. New York: Elsevier Science Publishing Company, 30: 231 - 295.
[5]. Jeba Rajasekhar, R.V., 1996, Comparison of thermal performance of two types of solar air heaters in a fruit dehydration unit. M.Phil., Dissertation. School of Energy Sciences. Madurai Kamaraj University. Madurai. India.
[6]. Jeyasankar, P., Jeba Rajasekhar, R.V., 2014, Experimental Studies on Nano carbon coatings for heat transfer enhancements in solar collectors, Proceedings of National Conference on Advancements in Mechanical Engineering and Nano Technology, PSN Engineering College, Tirunelveli
[7]. Jeyasankar, P., Uma Maheswari, K., Jeba Rajasekhar, R.V., 2015, Studies on nano-sized carbon coated fin, C/Al_2O_3 coated absorber and TiO_2/SiO_2/Ag thin film coated reflector, Proceedings of the National Seminar on Modern Trends in Chemistry, Vivekananda College, Tiruvedakam West, Madurai: 24-28.