International Journal of
Scientific Research in Science and Technology (IJSRST)
Print ISSN : 2395-6011, Online ISSN : 2395-602X
International Conference on Advanced Materials
Held on 14, 15 December 2017, Organized by Department of Physics,
St. Joseph's College, Trichy, Tamilnadu, India

Study of Cost Effective Solar Selective Surface for Spiral Concentrator

T.K. Jayaleka, J. Packiam Julius
Department of Physics, Pioneer Kumaraswamy College, Nagercoil, Tamilnadu, India
Email: gituniversel16@gmail.com

Abstract

Solar selective surface has great importance in practical uses in solar energy thermal techniques. In this attempt, the use of lamp black + SiO_2 in different proportions as selective coating has been studied. Efforts have been taken to know whether the amount of SiO_2 in the mixture could be used to enhance the efficiency of the spiral concentrating type solar cooker. Spraying technique has been used for coating the material over the absorber. The absorber material used was Aluminium. Water heating tests were carried out during summer season. The Study revealed the fact that the amount of SiO_2 in SiO_2 lamp black mixture would decide the value of overall efficiency of the spiral concentrator and its performance. The studies were carried out in the natural weather conditions.

Key Words: Solar energy, selective surface, thermal conversion.

1. Introduction

For effective thermal conversion, the absorber should have high absorptance in the solar range but low thermal emittance. The selective surfaces maximize solar absorption and they suppress thermal re-radiation. At the operational temperature, the optical and thermal properties of the selective surface should be stable.

2. Analysis of selective coating

The solar selective coating with lamp black & SiO_2 was used in concentrating type solar cookers. The performance of an absorber coated with a solar selective surface is determined by the absorptance and thermal emittance.

For opaque materials,

spectral absorptance $\alpha(\lambda,\theta)$ in expressed using Kirchoff's law as,

$$\alpha(\lambda,\theta) = 1 - \rho(\lambda,\theta) \quad \ldots (1)$$

$$\& \ \varepsilon(\lambda,T) = \alpha(\lambda,T) \quad \ldots (2)$$

where $\rho(\lambda,\theta)$ is the sum of collimated and diffuse reflectance, λ is the wavelength, θ is the incidence angle of light and T is the given temperature.

The solar reflectance is studied using spectrophotometers in 0.3 – 2.5 μm wavelength range at near – normal $\theta = 0$ angle of incidence [1,5,6].

Emittance is measured at room temperature as

$$\varepsilon = \int_{\lambda\min}^{\lambda\max} \left(\left[1-"("("(",T)\right]B("(",T)d"(")/("(T4)\right) \quad \ldots (3)$$

where (= 5.6696 × 10^{-8} $Wm^{-2}K^{-4}$ is the Stefan – Boltzmann constant

B(λ,T) is the spectral irradiance of a black body curve from,

$$B(\lambda,T) = c1/\left(C^5\left[e(c2/(T)-1\right]\right) \quad \ldots (4)$$

where c1 = 3.7405 × 108 W $\mu m^4 m^{-2}$

c2 =1.43879 × 104 μmK

which are Planck's first and second radiation constants.

The efficiency of a concentrator depends mainly on the absorber coating. selective coatings can degrade high temperature because of oxidation, humidity, atmospheric pollution, chemical reactions etc [2,3,7,8].

3. Experimental

SiO_2 mixed with lamp black has high degree of spectral selectivity. The coating is carried out by spraying technique. The use of this layer of lamp black on Aluminuim has been found to stabilize Aluminimum [4]

Lamp black and SiO_2 were mixed together in various proportions, a colloidal solution was got. It was coated on an Aluminimum absorber. Eight different vessels were used for eight proportions of lamp black & SiO_2. The concentrator along with the

International Journal of
Scientific Research in Science and Technology (IJSRST)
Print ISSN : 2395-6011, Online ISSN : 2395-602X
International Conference on Advanced Materials
Held on 14, 15 December 2017, Organized by Department of Physics,
St. Joseph's College, Trichy, Tamilnadu, India

stand was kept in position to receive maximum solar radialion. 1 kg of water in taken in the absorber. It is allowed to boil. It took nearly 20 minutes to boil. These tests were carried out during the month of May. The readings and calculations were tabulated as follows.

Table 1. Efficiency of the concentrator for different proportims of lampblack and S_iO_2

Lamp black (in gram) + S_iO_2 (in gram)	Efficiency %
1 +1	82
1.2 +0.8	81
1.4 +0.6	80.4
1.6+0.4	80.1
0.8 +1.2	82.2
0.6 +1.4	82.6
0.4+1.6	84.2

Date : 1-5-2017 Ambient temp:.30°C

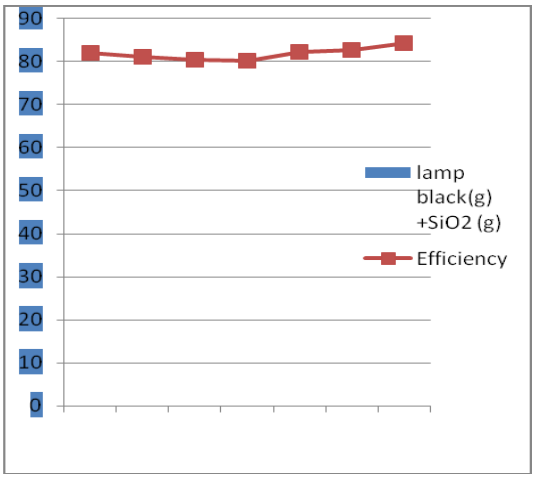

Figure 1. the graphical representation of the data.

It was found that the amount of S_iO_2 is directly proportional to the efficiency of the concentrator.

The average efficiency of the concentrator was calculated which is depicted in the following table

Table 2. Average Efficiency of Spiral Concentrator

Date	Direct Solar Radiation	Efficiency %
May 1	680	82
May 5	685	85
May 10	720	85
May 15	740	81
May 20	750	86
May 22	760	82
May 24	913	80
May 26	850	84

The experimental setup used is shown below.

Figure 2. Experimental setup

5. Conclusion

The technical parameter of the newly tried cost effective selective coating was found to be more effective than commercially available black coatings and pure lamp black. It was found that the mixture of lamp black and S_iO_2 is a promising one in the field of solar selective surfaces.

Acknowlegements

The authors are thankful to the Management and Professors of Department of Physics Pioneer Kumaraswamy College, Nagercoil for the help offered in doing experiments.

References

[1] Fuad Mammadove, 'Study of Selective Surface of Solar Heat Receiver' International Journal of Energy Engineering 2012.2 (4) 138-144.

[2] S. Brunold.U.Frei.B.Carisoon, K.Molier and M.Kohi.' Acceterated life testing of solar absorber coatings, testing procedure and results' Solar energy 68, 4,313(2000)

[3] W.D Duff and L. Hamasaki, 'Experimental Evaluation of Selective Surface Evacuated Solar Collectors. Proceedings of American solar energy conference.1978, P.345.

[4] Y.Noguchi, K.Naka, Isao, K.Naku Mara S.Sawada, T.Tani & S.Gords 'Fatrication of Zr Cx / Zr and Cr – Cr Ox films for practical solar selective absorption systems" SPIE,324,124(1982).

[5] G.Hass, J.B.Ramsey, J.B.heancy and J.J.Trilo. 'Reflectance, Solar Absorptivity and Thermal, emissivity of SiO_2-coated Aluminium Applied Optics Vol.8 Issue 2, 1969, pp. 275.

[6] D.M. Trotter Jr and A.J. Sievers. 'Spectral selectivity of high temperature solar Absorbers. "Applied optics Vol. 19, No.5, March 1980 PP 711.

[7] Zueco and Fr Alhama "Inverse estimation of temperature dependent emissivity of solid metals "Journal of quantitative spectroscopy & radiative transfer Vol.101.iss.1 pp 73.

[8] Ravindra N.M, Abedrabbo. S. Wei Chen Tong F.M. Nanda AK, Speranza A.C. 'Temperature dependent emissivity of silicon related materials and structures Semiconductor Manufacturing IEEE Transactions on Volume II. Issue 1, Feb.1998.pp 30.