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SELECTIVE NICKEL-TIN COATINGS FOR SOLAR WATER HEATER

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This paper presents the results of solar hot water system using electroplated selective black nickel-tin coating. The performance of the hot water system was evaluated using Hottel-Williar-Bliss equation.

Key words: Selective coating, nickel-tin black coating, solar hot water, electrodeposition

INTRODUCTION

As a result of the worldwide energy crisis, increasing emphasis is being placed upon the use of solar energy. Solar collectors —flat plate collectors or concentrators or evacuated tube collectors, are employed depending upon the application and required temperature range [1 –3]. The solar hot water system uses flat plate collector and can utilize both direct and diffuse radiation and it does not require a tracking mechanism.

In the conventional solar water heater system, use of right selective coating improves the efficiency and maintains these properties during long term exposure to solar radiation [4 –8].

This paper presents the results of solar hot water system using selective black nickel-tin coating developed in this Institute.

EXPERIMENTAL

The flat plate collector is fabricated using mild steel with an effective area of 1.62m^2 with suitable head and distribution pipes for water circulation. The absorber is placed in a wooden box with back insulation of glasswool. Cover glass is of 2 mm thickness. The collector is kept at an inclination of 25° facing south. The edges of glass were sealed to prevent heat loss by convection and also to minimise water leakage into the box due to rain. Storage tank is made of GI with a capacity of 140 lit. with double tank configuration. The gap in between the tanks is insulated with thermocol.

The absorber matrix is processed in the following sequence: The absorber is alkaline cleaned, washed, pickled in 20% v/v hydrochloric acid and washed well in running water, and nickel plated from [9].

Nickel sulphate	... 115 g/l
Nickel chloride	... 45 g/l
Boric acid	... 35 g/l
Saccharin	... 0.4 g/l
pH	... 3.8 –4.2
Current density	... 3.6 $A.dm^{-2}$
Temperature	... 328 K

After depositing 20 μm of nickel, the absorber is washed, and transferred to the selective black nickel-tin bath [10].

Nickel chloride	... 100 g/l
Stannous chloride	... 5 g/l
Ammonium bifluoride	... 25 g/l
Triethanolamine to pH	... 6.0
Current density	... 3 $A.dm^{-2}$
Temperature	... 303 K
Plating time	... 20 sec

The black coated absorber is washed, dried and assembled in the collector. The optical properties of the coatings were measured with alphotometer and emissometer and found to be $\alpha = 0.96$ and $\epsilon = 0.14$.

The performance of the hot water system was evaluated using the Hottel- Williar-Bliss equation. Instantaneous efficiency was also calculated based on the measurement of solar insolation, inlet and outlet water temperature, and mass of water collected in specific time. The efficiency of the system is calculated using the formula [11].

$$\eta = \frac{Q}{IA}$$

where, Q = Quantity of heat absorbed, I = Solar insolation, A = Area of collector panel, and η = Efficiency.

RESULTS AND DISCUSSION

Overall performance of the system as calculated from the standard Hottel- Williar-Bliss equation works out to 28 –33%. This again depends on the season, solar insolation and other weather data. The instantaneous efficiency works out to 19 –43% depending on the time of the day, solar insolation, cloudiness and wind velocity.

Manufacturing cost of the system works out to Rs.3050/-.

CONCLUSION

Solar hot water system using black nickel-tin selective coating exhibits an overall efficiency of 28 –33%.

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