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Effect of Insulation and Transparent Glass Cover on the Performance of Salt Gradient Solar Pond

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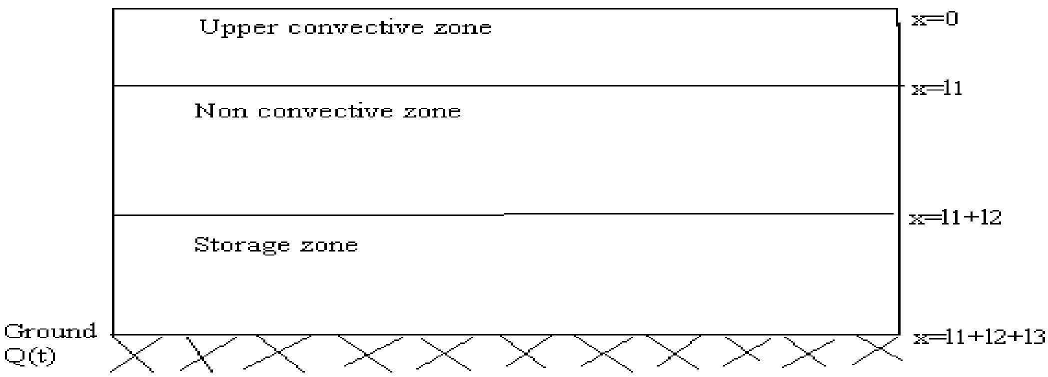
Abstract: In this study a salt gradient solar pond of 6ftx4ftx2ft was constructed whose surface was insulated and covered with transparent glass. The effect of insulation and transparent glass cover on the performance was investigated. Several sensors and thermo couples were placed at different height within the pond to predict to thermal behavior. By measuring of various points of the pond on different dates the temperature profiles of the wall as well as of salt water within the pond were obtained the result shows good agreement with the expected production of solar energy reaching to the reason and metrological air conditions.
Keywords: Salt gradient, temperature profile, solar energy.

I. Introduction

The increase in oil princes in 1970 several countries began to exploit solar energy solar energy. Solar energy equipment has two important equipments **(I) Solar collector (ii) Solar storage**. The simplest and cheapest way to trap solar energy is through use of solar pond. The Solar pond is one of the relatively simple, inexperience methods of collecting and storing solar energy on large scale. The solar energy storage is an important objective for the future utilization. A solar pond has been known as and attractive cheap means for collecting and storing solar energy. Solar pond is a shallow body of water containing dissolved salt to generate stable density gradient.(fresh water on the top and dense salt water at the bottom)Part of the incident solar radiations entering the pond surface is absorbed throughout the depth of the pond. The remainder which penetrates the pond is absorbed at the black bottom of the pond. If there is only fresh water in the pond the lower layer would heat up, expand and rise to surface, only a small temperature rise in water could be realized. The convection currents can be eliminated by initially creating a sufficiently strong salt concentration gradient. Thus thermal expansion in hotter layer is insufficient to destabilize the pond. With convection suppressed the heat loss from the lower layers is only by conduction. Because of relatively low thermal conductivity water acts as insulation and permits high temperature approximately 90^0c to develop in the bottom layer.

The salt gradient pond usually consist of three zones namely

1. Upper convective zone (UCZ) of low salinity.
2. Non convective zone INCZ) increased salinity then UCZ
3. Low convective Zone (LCZ) highest Salinity



Theoretical Studies have concentrated on modeling and predicting solar pond performance. These studies were based on one dimensional models which did not account in detailed for dynamical thermal interaction between the pond and surrounding soil and UCZ and Air. In present study a mathematical model of rectangular surface insulated glass covered solar pond has been analyzed.

II. ABSORPTION OF INCIDENT SOLAR RADIATION

As we know that part of solar radiation reaches the surface of the pond is reflected and the rest entering the pond is attenuated throughout its depth. Amount of radiation reflected is dependent on the angle of incidence. Weinberger has calculated the ratio of radiation penetrating the pond surface and incident on a horizontal surface.

$E=2n\,(a^2+b^2)\cos i.\ \cos r$ where

$a= (\cos r+n\cos i)^{-1}$ $b= (\cos i+n\cos r)^{-1}$

n=index of refraction.

I & r= angle of incidence and angle of refraction. The incident radiation is refracted according to SNELLS law sini=nsinr.

Angle of incidence on a horizontal surface can be calculated by using solar radiation analysis. Large angle of incidence gives large reflection loss. If diffused radiation is assumed to come out at equal intensity then fraction of diffuse radiation penetrating the surface is given by

$2\int ECosi.sini.ds$

Which was calculated to be 0.93 from WEINBER

The value of refractive index n increases concentration but are not too different from 1.33. After entering the pond the radiation is attenuated along its path by absorption and scattering. The absorption of radiation in a semi transparent medium may be described by BOUGHNER'S LAW which states that a thickness of homogenous absorber ds reduces the incident radiation of wavelength by amount $\boldsymbol{dq_\lambda}$ which is proportonional to both the intensity $\boldsymbol{q_\lambda}$ and ds thus

$\boldsymbol{dq_\lambda} = -\boldsymbol{k_\lambda q_\lambda}$ **ds** where **k** is spectral absorption coefficient

III. Material and Method

For this studies and insulated glass covered salt gradient solar pond having surface area 6ftx4ftx2ft was built near heat engine laboratory at **BIT, Sindri, Dhanbad, Jharkhand**. The storage zone was 0.7 meter high from the bottom of the pond and 1.20 gram per centimeter^3 brine density above which was filled up with gradually decreasing density brine having thickness 1.2 meter. This region is so called non convective zone or insulation zone of the pond. Finally approximate 0.1 meter on the top was fresh water making up UCZ. From UCZ to storage zone down to density 1.00 gram per centimeter^3.Several thermocouples and sensors were placed into the walls and also the pond. The solar energy which can be stored in the form of temperature in the storage zone of salt gradient solar pond, whose surface was insulated and covered with the transparent glass .Energy obtained from this system, can be stored below the boiling point of the brine. Temperature profiles obtained from both condition were obtained. It has been observed that profiles are consistent with each other in terms of quality. According to these profiles the temperature of storage zone has increased from 48^0c to 53^0c and the temperature of UCZ from 23^0c to 28^0c.These values were closed to each other which shows that profiles obtained from the model are in consistency with experimental conclusion. so if the upper surface of the pond were covered with glass upper convective zone temperature would increase 8^0 to 9^0c during the first week and 12^0c to 14^0c after four week.

Finally in solar pond where the upper surface covered with glass the heat losses from the upper zone into air and radiation can be minimized. At the same time if the physical features of the transparent surface covering the top are known if is possible to estimate the dispersion profile of temperature profile of temperature of insulated solar pond.

IV. APPLICATION

(I) **Hea**ting and cooling of building.
(II) Production of power using organic liquid (feron,propane etc)
(III) Supplying industrial process heat.
(IV) Desalination.
(V) Heating animal house and drying crops in farms.
(VI) Heat for biomass conversion such as production of alcohol etc.

V. Conclusion

In solar pond where the upper surface covered with glass the heat losses from the upper zone into air and radiation can be minimized The upper surface of the pond were covered with glass upper convective zone temperature would increase 8^0 to 9^0c during the first week and 12^0c to 14^0c after four week

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