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Small Scale Multipurpose Solar Pond for the Farmers

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Abstract

A small scale prototype multipurpose solar pond (SSMSP) in the form of a farm apparatus is indigenously prepared having the dimensions 11.5 x 7.5 x 5.5 inches with a view to provide a technique for collecting and storing solar energy. The solar pond (SP) was filled with fertilized salt by maintaining definite concentration of halocline vertically with three zones -i) UCZ - Upper Convective Zone < 5% salt concentration called as Surface convective zone, ii) Non- Convective Zone NCZ- (Salinity increases with depth) (20-30% salt concentration) with 1-1.5m depth and iii) LCZ-Lower Convective Zone with Salinity 20% called storage zone with the bottom of thick durable liner of butyl rubber or lampblack. The NCZ is much thicker and occupies more than half the depth of the pond, both concentration and temperature increases with depth in it. It serves as mainly insulating layer and reduces heat loss in the upward direction. LCZ acts as main heat collector as well as thermal storage medium.

The SSMSP could be utilized to generate limited power, industrial process heating, water desalination, solar crop dryer, green house for vegetables heating, cooler, algae lamps, and soak-pit for the farmers.

Keywords: Apparatus, multipurpose, fertilized salt, lamb black, halocline.

1. Introduction

Solar ponds (SP) represent one of the simplest methods for direct conversion of collected solar radiation in to thermal energy so termed as two in one thermal system i.e. solar power collector and a thermal storage unit. They are artificially created to provide capacity for long term heat storage using indigenous resources such as land, salt and water that collect, store and supply thermal energy. This field of research in the solar energy storage and its application is comparatively easy to handle, cost effective and still open for the unification when compared with other applications.

The salt water naturally forms a vertical salinity gradient known as “halocline”, in which low salinity water floats on top of high salinity water. The layers of salt solutions increase in concentration (density) with depth. Below a certain depth, the solution has a uniformly high concentration. All natural ponds and lakes convert solar radiation into heat although most of that energy is lost to the atmosphere mainly as a result of convection and evaporation. The principle of the salinity gradient solar pond, on the other hand, is to prevent vertical convection and/or evaporation depending upon the type of SP (1). The basic principle of SP is shown below in the Figure 1. Based on the convection behavior of the saline solution majorly solar ponds are classified into two main categories as convective and non- convective type. The convective type often referred to as shallow solar pond (SSP) known since the beginning of the twentieth century.

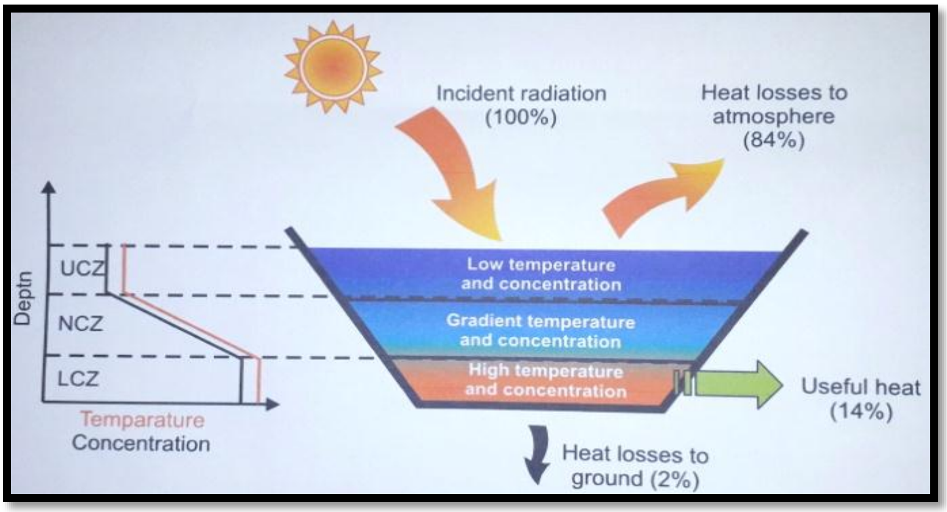


Figure 1: The basic principle of solar pond

Here the depth of water is relatively small, usually between 4 and 15 cm (28) where the layer is homogeneous. When the sun's rays contact the bottom of SSP water there in the pool is heated, becomes less dense than the cooler water above it, and convection begins. This greatly reduces heat loss, and allows for the high-salinity water to get up to 90 °C while maintaining 30 °C low-salinity water (2). High-salinity water at the bottom of the pond does not mix readily with the low-salinity water above it, so when the bottom layer of water is heated, convection occurs separately in the bottom and top layers, with only mild mixing between the two. This hot salty water can then be pumped away for use in electricity generation, through a turbine or as a source of thermal energy. In 1906 and 1908, Willsie and Boyle succeeded in raising the temperature from 38 to 80 ^{o}C by using dual stages, and single and double glass covers (of 110m^2) consequently they have obtained 11kW of peak power and used the idea to produce shaft power (3). Also in the beginning of the twentieth century, Shuman ran a steam engine by using the above developed system (4). Also SSPs were used in Japan for domestic purposes in the 1930s (5).

From the literature survey it is observed that more research carried out on SSP due to accessibility in obtaining the maximum possible temperature at the bottom layer acting as a heat resource to provide continuous heat through an internal or external heat exchanger at any time of the year (6). They tried various designs of solar pond and one of these was composed of a wooden tank lined with tar paper and covered with a double glass window, while each side and bottom were insulated with hay. The water level in the tank was 7.5cm. Other designs included asphalt and sand for insulation; however, the latter could not be kept dry, so the heat loss from the base was high. After about half a century ago D'Amelio (7) suggested SSP technique to produce power, which was adopted by the office of Saline Water, US Department of Interior (8). More recently, a research team at the University of Arizona developed a SSP combing with a multiple effect solar still for the purpose of desalination. This system produced 19m3/day of distilled water using 5 ponds (each about 90m x 2m) (9). Some of the solar ponds at the world level with their names, purpose and location are listed for different applications in Table 1.

Table 1: Solar ponds at world level with their respective names, purpose and locations

Sl. No.	**Name of the Solar Pond**	**Purpose**	**Location**
1	EinBokek Solar pond power project	150 kW	EinBokek, Israel
2	BeitHa‘ Arava Solar pond power project	5 MW	BeitHa' Arava , Israel
3	El Paso solar pond	Process heating, desalination and Power generation of 100 kW	El Paso, Texas, USA
4	University of Illinois solar pond	Space heating	Illinois, USA
5	University of new Mexico	desalination	Albuquerque, USA
6	Pyramid Hill Solar pond	Process heating	Victoria, USA
7	RMIT solar pond	Experimentation	Melbourn, Australia
8	Bafgh Solar pond	Experimentation	Yazd, Iran
9	Rajamangala university Solar pond	Experimentation	Isan, Khonkaen , Thailand
10	Kuwait Solar pond	Experimentation	Kuwait

A group of researchers at Texas A&M University tried to improve the SSP by using a completely black butyl rubber bag (10). However, the temperature of the top surface of the bag was 30^{o}C hotter than the water directly underneath. So, the conclusion confirmed that the upper cover should be a transparent film. Around 1975, the Lawrence Livermore Laboratory in California, USA and the Solar Energy Laboratory at the Institute for Desert Research in Israel were established and teams were formed for solar energy research respectively (11, 12). The former research centre constructed several large-scale SSP projects in different designs (1) and soon after, many significant results were obtained and published by Dickinson and other researchers (13). In the latter centre, the SSP was involved in a large-scale project of solar energy and good experiment results were delivered. After that, Kudish and Wolf (14) designed a portable shallow pond for camping and military use. During the past 30 years, Iran and Egypt created a typical SSP consists of a low-depth volume of water enclosed in 60m x 3.5m (approximately) plastic bag so as to achieve high temperature (15, 16).

Salinity Gradient Solar Pond (SGSP) Non-convective solar ponds are simple in design and can be constructed at reasonable cost; they can provide heat for domestic, agricultural, industrial and desalination purposes and they can also generate power. A typical salinity-gradient solar pond consists of three main zones namely the upper convecting zone (UCZ); this part is sometimes called the surface layer. This involves the least cost, has the lowest level of salinity, and its temperature is close to ambient temperature. The thickness of this zone is typically 0.3m and it should be kept as shallow as possible. The cost of constructing the UCZ is usually neglected, as it can be constructed and operationally maintained through the use of any low-salinity water such as fresh, brackish water or seawater. This layer is essential for preventing the lower layers from being exposed to evaporation, wind effects and falling impurities. The NCZ are called the gradient zone or the middle layer. It is located between the upper and the lower zones of the pond. As the temperature and salinity increase with depth, this layer is not homogeneous. If the salinity gradient is large enough, the NCZ exhibits convection phenomenon. The lower convecting or storage zone (LCZ); this is a homogenous layer and has considerably high salinity and high temperature. Heat is stored in this zone and it can be exchanged in or out of the pond. As the LCZ’s depth increases, the heat storage unit increases and the temperature variation decreases. The gradient layer consists of multi sup-layers in which each sup-layer is heavier and hotter than the ones above it. This stratification can make the saline molecules heavy enough to not obey to the convection phenomenon.

Membrane ponds utilize the same concept as solar gradient solar ponds, except for the fact that a thin transparent membrane is fixed to separate each zone of the pond. Heat can be exchanged from the pond using the same procedure. The salt type contribution to SGSP stability was appreciably considered with essential features that (i) the salt solubility value must be high enough to meet the highest level of solution density required, (ii)the salt solubility should not change significantly with solar pond temperature variations, (iii) when the salt is dissolved in water, the solution must be sufficiently transparent to permit solar irradiation to the bottom of the pond, (iv) must be environmentally friendly ,(v) must not cause any contamination to the ground water and (vi) economical viable , abundant, and near to the pond's location and (vii) the salt molecular diffusivity Ks should be low so as to enhance the pond's performance and stability (5, 17-22). The firmness of salt solubility against solar pond temperature variation with time and with depth of the pond is quite important for solar pond stability.

The vast majority of the US SGSPs have been using sodium chloride (23, 24, 25). However, another commonly used salt in salinity ponds is magnesium chloride ($MgCl_2$), which is considered the second largest salt constituent of sea and ocean water, although it is the largest proportion of salt in the Dead Sea (as well as in some salt works brines). This salt is exceptionally stable during operation; it also exhibits great solubility in producing brine with high density, as it is able to dissolve between 35 and 40% according to the solution temperature (plotted in Fig. below) This salt has been used in two ponds in Israel and a large pond in the USA (23,24,25) . In comparison with sodium chloride, magnesium chloride is able to produce higher salinity brine, and is more stable during the solar pond's operation. However, it is much more expensive than sodium chloride. The brine most widely used in Israeli gradient ponds is Dead Sea brine, as it is costless and can be drawn directly from the sea. The Dead Sea is unlike other seas and oceans as magnesium chloride represents the major salt in percentage terms, at about 13%, while NaCl stand for only 8%. MgCl2 is the densest brine in the world; its average density is about 1230kg/m3s in a SGSP.

From the above cited essential features for the stability, optimization of preparative parameters like dimension, type of insulation and salt concentration and consistency in obtaining the optimum temperature leading to difference of opinions and disparity. Also there is no unified model directly connected to law of Thermodynamics. Therefore, it is thought imperative to develop a prototype small scale multipurpose solar pond with dimensions 11.5 x7.5x 5.5 inches is artificially designed using water, Fertilized salt free from chloride potash and lamp black primarily to provide a technique for collecting and storing solar energy for not only to generate limited power but also a multipurpose farm apparatus towards the applications like; power generation, industrial process heating, water desalination, solar crop dryer, green house heating, cooler, algae lamps, soak-pit for the farmers of central part of India, known as Vidarbha region of Maharashtra. It is necessary to achieve maximum temperature at the bottom LCZ for any application of solar pond.

2. Materials and Methods

2.1 Theoretical concept

The measurement of solar radiation at every location is not feasible, so engineers have developed empirical equations by utilizing the meteorological data like numbers of sunshine hours, the day's length and the number of clear days. For accurate calculations the hourly, daily and monthly time scales are used.

Angstrom (1924) suggested linear equations as follows for determining the amount of sunshine at a given location as below:

$$H_g / H_c = a + b\,(D_l / D_{max}) \quad \textbf{(1)}$$

Where,

H_g = Monthly average of daily global radiation on a horizontal surface at a given location in $MJ/m^2/day$

H_c = Monthly average of daily global radiation on a horizontal surface at the same location on a clear sky day.

D_l = Monthly average measured solar day length in hours.

D_{max} = Monthly average of the longest day length in hours

With a , b = Constants for the location

It is difficult to define a clear sky day, so it was proposed that should be replaced by Ho. Here, Ho is the monthly average of daily extra-terrestrial radiation that would face on a horizontal surface at the given location. After having the theoretical concept for the availability of solar radiation, the present solar pond was indigenously fabricated by pond thoughtfully choosing the actual dimensions of solar as per the requirement. The depth of three zones in meters is kept as:

a) Surface Convective Zone (SCZ) :- Around 5.5 or 6cm roughly thicker with small thickness and low concentration and uniform temp of ambient air temp

b) Non-Convective Zone (NCZ) :- Much thicker and occupy more than half the depth of pond act as an insulating layer and reduces heat loss in upward direction nearly 12cm in thickness.

c) Lower Convective Zone (LCZ):- It is also called as storage zone and is comparable in thickness to NCZ nearly cm thicker and this zone traps the heat for long periods.

The salt used (Fertilized salt) in solar pond for creating density gradient is chosen with the following criteria:

i) It must have high value of solubility to allow high solution densities

ii) The solubility should not vary appreciably with temp.

iii) The solution must be adequately transparent to solar radiation.

iv) Economically viable.

Even the site is selected for construction of SP with the following attributes that:

i) It should be close to the point where thermal energy from the pond will be utilized.

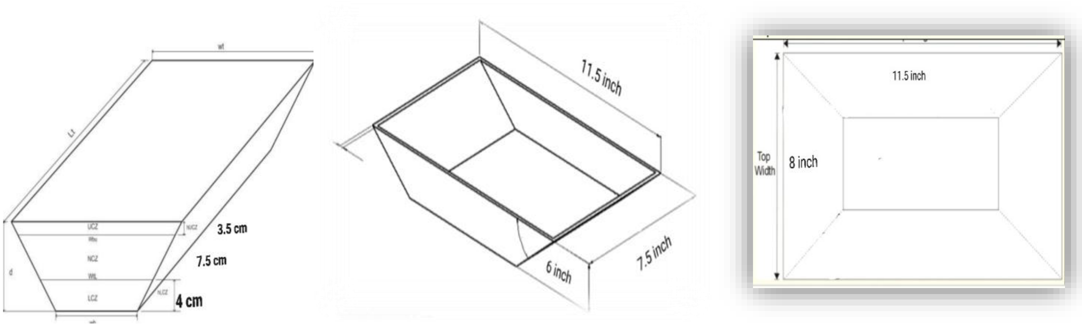
ii) It should be close to a source of water for flushing the surface mixed –layer of the pond.

iii) The thermal conductivity of the soil should not be too high.

iv) The water table should not be too closed to the surface.

2.2 Dimensions

Our prototype Solar Pond was designed based on the standard module for solar ponds. In order to construct the present pond the required materials like plywood with 14 mm thickness, high density polyethylene sheet to insulate the inside layer of the pond, glass, solar power meter, thermocouple, water and salt were used. The pond is made of plywood by keeping the surface area of 11.5 x 2.5 inches at the top and bottom with a depth of 5.5 inches and inclined at an angle of 45°C. It has the low thermal conductivity of 0.13 W/mK. Firstly, the thickness of the polyethylene sheet was kept 2 mm. For getting better temperature at the LCZ, 2mm thick lampblack and 4 mm thick glass plate with the dimensions of its trapezoidal surface were placed at the bottom and on the top surface respectively.



(a) (b) (c)

Figure 2: Schematic diagrams (a, b, c) of solar pond with Dimensions =11.5x7.5x5.5 inches.

2.3 Optimization of the Preparative Parameters:

2.3.1 Salt Selection

To determine the heat capacity of each salt, an experiment is carried out. Five beaker of 500 ml capacity were taken and each beaker is filled with 100 ml of water that to be used in our solar pond. In each beaker 50 grams of sodium sulphate, 50g of sodium carbonate, 50g sodium nitrate, 50g Magnesium chloride and 50g sodium chloride are dissolved separately. Thermometers have been inserted into the five beakers and kept in sunlight and for every half an hour, each thermometer readings are noted and the two high heat absorbing salt is selected for our experiment (26).

The pond contains of three layers namely UCZ (upper convective zone), NCZ(Non convective zone) and LCZ (Lower convective zone).The depth of the pond is set at approximately centimeters and is meters in width The UCZ is the topmost layer and acts as an extra shield for the insulating layer i.e. the NCZ. Here, the NCZ characteristics are similar to that of a barrier in a p-n junction diode. The NCZ acts as an insulation zone that forbids the heat energy trapped in the LCZ to escape. The LCZ through total internal reflection and by having a butyl or lampblack surface in the interior enables us to trap most of the energy received. The depth of three zones in meters is kept as:

(i) Surface Convective Zone (SCZ) : around 5.5 or 6cm roughly thicker with small thickness and low concentration and uniform temp of ambient air temp, (ii) Non-Convective Zone (NCZ) : much thicker and occupy more than half the depth of pond act as an insulating layer and reduces heat loss in upward direction nearly 12cm in thickness and (iii) Lower Convective Zone (LCZ): also called as storage zone and is comparable in thickness to NCZ nearly cm thicker and this zone traps the heat for long periods.

The LCZ is the most important unit of the pond in terms of achieving efficiency and we believe that there is more to be achieved in terms of achieving efficiency and limiting the constraints in order to determine the exact parameters that affect the ability of LCZ to trap heat energy. The water from the LCZ is distributed to the various connected channels for application of various tasks listed in the abstract. In the above classification of zone a solar pond with the standard dimensions, depth may vary from 1m to 2m but can be half (storage zone), the surface convective zone usually has a small thickness around 10cm to 20cm. It has a low uniform concentration which is close to zero as well as with fairly uniform temp, which is closed to ambient temp.

Secondly, temperature recorded for NaCl salt gave optimum temperature not exceeding 55^0C a day earlier with fertilized salt has much higher heat capacity then tested with fertilized salt, which offered the temperature rise from 55^0C - 70^0C. Typical value of salt concentration at the top surface is 20kg/ cubic meter, increasing to 260 -300kg/cubic meter for sodium chloride and fertilized salt at the bottom much better.

2.3.2 Purpose of Top Surface Insulation:

Most of solar ponds are designed with uncovered surface, however 50-60% of heat lost is exchanged with the air via the surface during autumn and winter (if there is no mechanical heat extraction) (27). The effect of having a surface cover was studied by Shah et al. [27]; they used varying thicknesses of polystyrene insulation, from 0 - 40cm. It was estimated that the heat losses were reduced by 55% and that the stored heat was increased by 80% when the cover's thickness was increased from 0 to 10cm at the peak temperature on 10th September. When the thickness was increased from 10 to 20cm, heat loss was further reduced by 6%, while the stored energy was raised by another 15%. There was no further significant change in heat loss or storage by increasing the thickness up to 40cm. The surface insulation had no considerable effect if there was heat extraction, or during the summer and spring seasons.

2.4 Making of Experimental setup

During the day solar intensity with bright sunshine it consists of few heliostats installed at various elevations which reflects the sun rays to the concentrators parallel to its optic axis. The parabolic concentrator with required height, focal length and aperture ratio for obtaining desired temperature were installed as per desired and experimental requirement. Water is filled in the pond and fertilized salt is dissolved in, thereby, converts in to 3 zones. Each layer contains two J type thermocouples. The six J type thermocouples are dipped in the water and difference in the temperature recorded. The most important function that the solar pond has to perform is to obviously heat the water in the pond.

Figure 3: Entire experimental setup as buildup in the laboratory

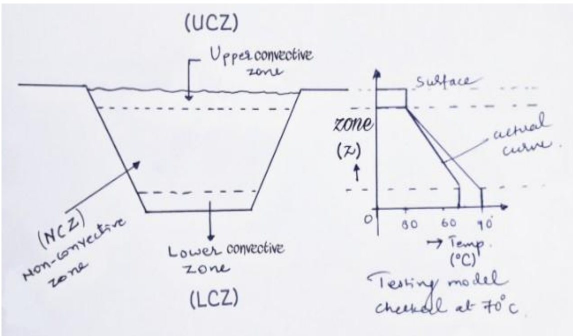


Figure 4a: Different zones in solar pond

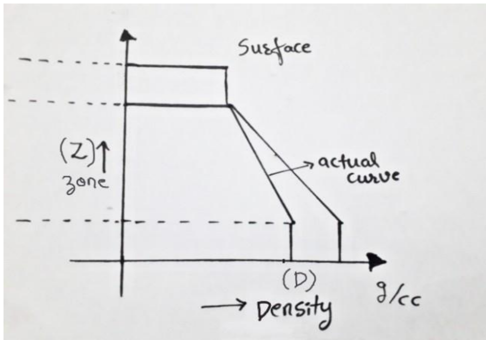


Figure 4b: Variation of density

Schematic diagrams of different zones in a solar pond indicating zonewise variation of temperature and that of density of salt concentration as shown in the above Figures 4a and Figure 4b respectively.

3. Results and Discussion

On the bright sun light day the experimental data in terms of time and temperature was recorded, which is given in the following Table-2 and Figure 5.

Table 2: Recorded data after every ½ an hour.

Time of the Day	Temperature (°C)	Time of the Day	Temperature (°C)
10:00	41	14:00	70
10:30	45	14:30	65
11:00	47	15:00	60
11:30	50	15:30	55
12:00	53	16:00	50
12:30	58	16:30	40
13:00	60	17:00	38
13:30	64		

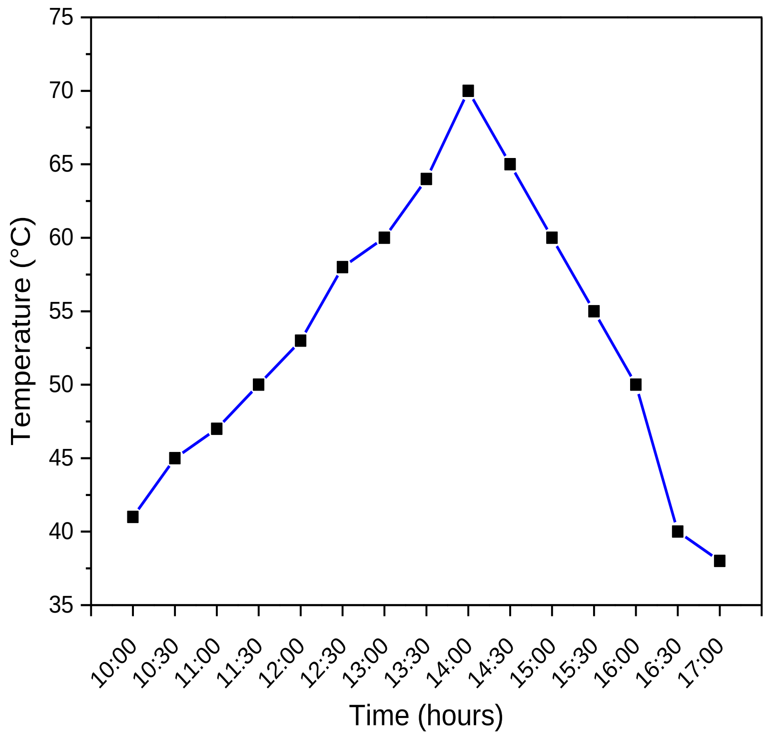


Figure 5: Temperature Vs time variation.

The duration so chosen was to use the hottest hours of the day Nagpur city in the month the month of June. The data collection started in effect from 9:30 am on the morning of 08/06/2018 and it continued till 17:00 in the evening of the same day. The hottest time of the day in the city of Nagpur in the summer (month of June) is from 12:00 pm to 14:00 pm and the following data shows that the temperature steadily increases in this time and thereafter, it decreases, while the temperature rose from 41 to 53^0C and it rose from 53 to 70^0C in successive 2 hours. This obviously shows that the increase in temperature of the water is directly proportional to the sophistication of the design of the experiment optimization of the preparative parameters.

The data given below in Table 2 indicates that in order to carry out solar energy harnessing in the city has wide spectrum of tapping solar energy with 574 available days. The sun being at very large distance from the earth, solar rays subtend an angle of only 32 minutes on earth. Energy flux received from the sun before entering the earth atmosphere is a constant quantity. The solar constant, is the energy from the sun received on unit area perpendicular to the solar rays at the mean distance from the sun outside the atmosphere, based on experimental measurement the standard value of solar constant is 1367W/m^2 or 1.44KJ/s/m^2.

Table 3: Season wise available days for tapping the solar energy.

Name of city	Winter period	Summer period	Monsoon period
Nagpur	Dec-Feb	March-May	June-Sept
Actual days	436 days	574 days	421 days

For the availability of solar radiation the values of ‘a’ and ‘b’ (equation 1) obtained for our location in Nagpur following observations were made on the day

Theoretical maximum possible sunshine hours = 9.5hrs

Average measured length of a day during the day = 9.0hrss

Solar radiation for a clear day

Ho = 2100KJ/m^2/ day

Constants a = 0.27

b = 0.50

So, Average daily global radiations …

H g = H o [a + b (D l / D max)]

= 2100 [0.27 + 0.50 x (9.0 /9.5)]

= 1554 KJ/m^2/day.

Spectral distribution of extra-terrestrial radiation is the measure of solar radiation that would be received in the absence of atmosphere. As per the curve rises sharply at a wavelength of 0.48micrometre and reaches the maximum value of 2074W/m^2/µm. It then decreases asymptotically to zero showing that 99% of sun's radiation is obtained up to wavelength of 4µm. Spectral distribution of extraterrestrial radiation is displayed in Figure 6a and Figure 6b (31).

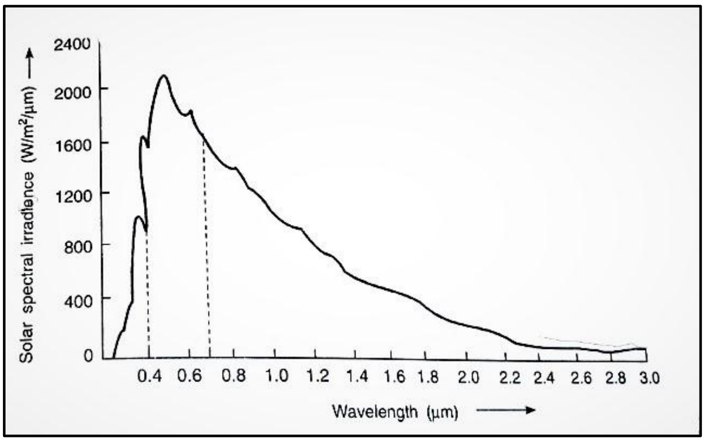


Figure 6a: Spectral distribution of extraterrestrial radiation

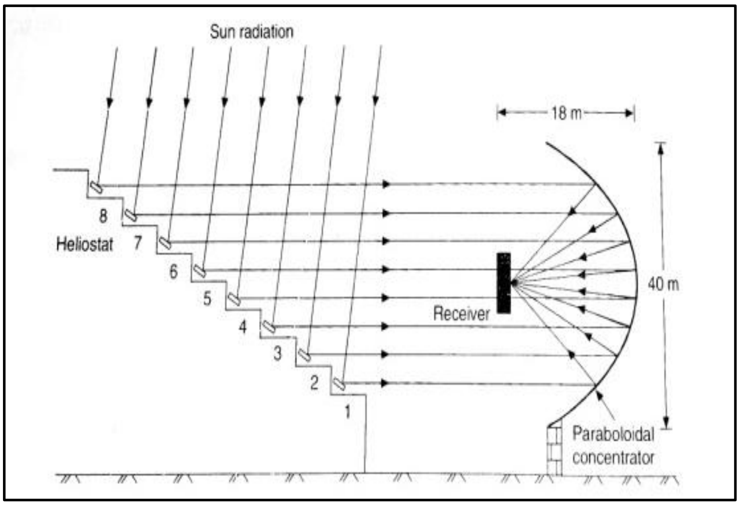


Figure 6b: Solar furnace with Heliostats.

Thermal efficiency of solar pond is strongly dependent upon the clarity of the pond, which is reduced by the presence of algae or dust. As bits or debris dust or leaves lighter than water float or the surface can be skimmed off. Dust and debris much heavier than water will sink to the bottom. In 1987 Shrinivasan and Guha have reported that the dust accumulating at the bottom of the pond does not adversely affect the absorption of solar radiation at the bottom of the pond. The dust floating in the gradient zone can be settled by adding alum (29). The growth of Algae can be controlled by adding bleaching powder or copper sulphate.

The production of Algae in SP could be boon for the farmers. In the present case, the grown up algae was taken out and used as algae lamps which ultimately produce light and control pollution of the entire field area of the solar pond and at the same time good source of income for the farmers and make them economically more sound even though change of seasons take place is one of the best utility of solar pond. So by means of which we are able to make our farmers more reliable and independent so that they would be in a position to pay even government taxes rather government provides any packages for them.

Extraction of thermal energy stored in the lower layer of the pond can be easily tapped without disturbing the non-convecting salt gradient zone above; hot water can be extracted from a solar pond without disturbing the concentration gradient. This is achieved by installing the water outlet at the same height as the water inlet. Hot brine can be withdrawn and cold brine returned in the laminar flow pattern because of presence of density gradient. The hot brine in our prototype not undergoing any thermodynamic process or any Rankine cycle we have used rather for our model we by-passed the same and we developed indigenously by installing various heliostats at different locations and making use of parabolic concentrators possible to create highly vaporized pressure in order to rotate the turbine of generator which is directly linked to it for generating electricity 30).

Design of our prototype solar pond has the dimensions of 11.5x 2.5 inches with 15cm depth installing by typical heliostat arrangement at various possible locations tested and thereafter with few permutation and combination, the arrangement helps to generate the required temperature finally confirmed as shown in diagram with three zones UCZ, NCZ and LCZ. With depth of approximately 15cm, salt concentration of UCZ is almost zero (< 5%), the NCZ is 20% -30% and the LCZ is 20%. The UCZ, the top most layer acts as a shield for the LCZ. The NCZ is the insulator that prevents heat loss from the LCZ and its action is similar to that of barrier in the p-n junction diode. The LCZ is coated with lamp black to trap radiant energy. The temperature reaches 70^0C, heat can be used to generate electricity or as source of hot water for multipurpose applications like; power generation, industrial process heat, desalination, solar crop dryer, cooler, soak-pit, green house heating and algae lamp. As soon as the temperature of the day reached 2:00 pm the temperature of the bottom layer increased to 70^0C, then immediately hot brine was processed for heliostat arrangement. Here high pressurized steam was generated to rotate the turbine that generated electricity of limited power, which was tested by connecting 2-LEDs. The glow of LEDs gave P.D. approximately 4V.

3.1 Thermal Efficiency Calculations

Area =11.5 inches × 7.5 inches = 0.2875 m × 0.2 m = 0.0575 m^2

V = 0.00138 m^3

//for Trapezoidal pond

For UCZ => V = 0.0575 × 0.035 m = 0.0020105 m^2

NCZ => V = 0.0375 × 0.075 m = 0.0043126 m^2

LCZ => V = 0.0575 × 0.04 m = 0.0023 m^2

$Q = ms\Delta T$ =0.25 × 4186 J/kg°C x 3 = 3139.5J

= 0.5 x 4186 J/kg°C x 13 = 27209J gives % Efficiency = 1.13%

Similarly, that of fertilized salt is 1.33%, which proved that this salt is more effective. So we have used the fertilized salt, which is more effective for getting optimum temperature (70^0C) in LCZ.

Table 4: Comparison between NaCl and Fertilized salt.

Zone	**Salt density (Kg/m^3)**	**Height [h] (cm)**	**Area [A] (m^2)**	**Volume [V] (m^3)**	**Mass (Kg)**	**Max Temp (°C)**	**Δ T**	**Q=ms ΔT For** NaCl
UCZ	0	3.5cm	0.0575	0.0020	0	37°C	0	0
NCZ	100	7.5cm	0.0575	0.0043	0.25	40°C	3	3139.5
LCZ	300	4cm	0.0575	0.0023	0.50	50°C	13	27,209
								Fertilized salt
UCZ	0	3.5	0.0575m^2	0.0020	0	40°C	0	0
NCZ	100	7.5	0.0575m^2	0.0043	0.25	50°C	10	10,465
LCZ	300	4	0.0575m^2	0.0023	0.5	70°C	20	41,860

Conclusion

It has been seen that SP enables temperature rise from 40^0C to 55^0C between 10:00AM to 1:00PM and further to 70^0C by 2:30PM where hot brines transfers to next step of Heliostat Arrangement helped in rising the temperature by boiling point and steam produced. The high pressurized steam was generated to rotate the turbine that generated electricity of limited power, which was tested by connecting 2-LEDs. The glow of LEDs gave P.D. approximately 4V. This is a very first result of generating limited power, by-pass the Rankyne cycle or any thermodynamics concept, however, results obtained is found to be quite satisfactory. The hot brine bifurcated to various applications like desalination, crop drying, industrial process heating, cooler etc and also to carry out multipurpose tasks at the same time. Salts like magnesium chloride, sodium chloride or sodium nitrate are dissolved in water, the concentration varying from 20% to 30% at the bottom to almost zero percent at the top. In the above classification of zone a solar pond with the standard dimensions, depth may vary from 1m to 2m but can be half (storage zone), the surface convective zone usually has a small thickness around 10cm to 20cm. It has a low uniform concentration close to zero as well as with fairly uniform temp, which is closed to ambient temperature. The

NCZ is much thicker and occupies more than half the depth of the pond, both concentration and temperature increases with depth in it. It serves as mainly insulating layer and reduces heat loss in the upward direction. LCZ acts as main heat collector as well as thermal storage medium. It is found that the deeper the zone more is the heat stored as well as at the same time the lowest zone traps heat for a long period. Solar pond filled with particularly fertilized salt by maintaining definite concentration of halocline vertically with three zones compared to NaCl helped in getting high temperature.

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