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SOLAR POND

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Abstract

We all are facing energy crises from last few decades, for full filling those needs we have solar energy, wind powertechnology and tidal waves power technology which is renewable source of energy but, this technology need batteriesfor storing energy which required lots of funding. To overcome that entire drawback, the solar pond concept is one of the good options. The cost of solar panel is Rs. 447-575per watt and that of solar pond is Rs. 200-400per wattso, solar pond is good option according to the economic viability.The solar pond estimating cost can be reduce by choosing the side where salt is available at reasonable price.The solar pond is first established in 20th century. It is adapted from nature. In solar pond, the energy produced by heating the water with the help of salts and sun rays in the pond commonly known as 'Solar pond'. Practical uses of solar pond are many but generally used for a thermal energy production.Solar pond can store energy in form of heat for long time period.

There is a rapid growth of solar pond in the last thirty years. AsIndia is planning to consume about 60% of energy from renewable source of energy by 2027. Solar pond is one of the options for it. The aim of this paper is togive details about the Solar Pond as an energy source, its construction procedure, practical application in India and other country,its advantages and disadvantages.

Index term*:solar ponds, solar energy collection, solar energy storage, renewable energy.*

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1. INTRODUCTION

The concept of solar pond is generally based on salinity of water. The heat produced by sunlight and salinity of water helps the heat engine. That heat is widely used for mechanical technology, chemical and industrial heat processes as well as production of electricity and desalination. It is also used for storing heat for long period with minimum losses.

Why solar pond is required?

Solar energy is cheaper but energy storing device such as battery or the device which stores the energy is very costly in nature so overcoming through the drawback the concept of solar pond is essential for the production of heat energy, electricity, etc.

2. CONSTRUCTION

Solar pond is the large scale solar thermal collector arranged accordingly to the heated water and weather. The area of solar pond is generally 2,000-4,000m^2 and 1-2m depth. Wire nets are installed at every 10m in square structure to control wave formation due to wind. The base of pond made up of a thick durable plastic layers liner is laid. Materials used for liners include butylrubber, black polyethylene and hypalonreinforced withnylon mesh.The pond is consists of three layers namely:

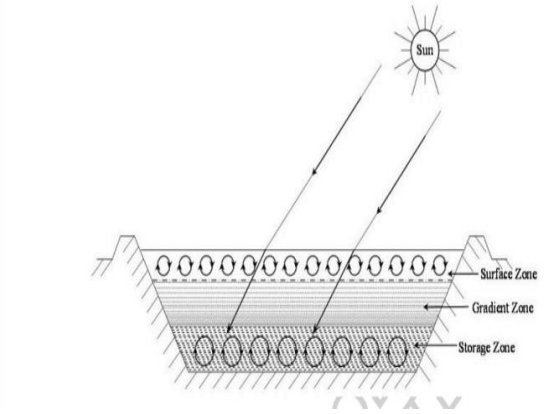

Fig- 2.1: Zones of the solar pond

2.1. The lower convective zone

The lower convective zone is also called as storage zone as it stores the heat and has large salinity of water and it decreases gradually as the height increases. The lower convective zone has highest density.

2.2. Non-convective zone

The non-convective zone is the middle layer of the pond and also known as gradient zone. Itoccupies half of the part.

2.3. Upper convective zone

The upper convective zone is the upper most part of the solar pond and it also known surface zone. It has low salinity of water or fresh water.

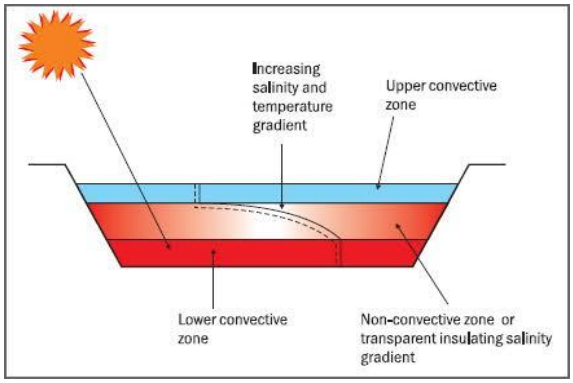

Fig- 2.2: Showing the Salinity in the pond.

3. REQUIREMENTS

3.1. Source of water

The water used in the pond for the energy production is generally fresh water or must be law salinity of water (the density of water must be less than 1050kg/m^3). The rate of adding of water must be more than the rate of evaporation of water from the storage zone.

3.2. Salts

The salt used in the solar pond is generally common salt, magnesium chloride, sodium carbonate. The water heated in the storage zone and magnesium–potassium rich salt solution remains as the byproduct after the evaporation of water.

3.3 Polyethylene

Polyethylene brings the greenhouse effect and traps the concentration of solar energy in the LCZ and minimizes salt and thermo diffusion.

4. MECHANISM

The solar pond is inspired by nature. As water get heated it start expanding and losses heat whereas, in solar pond water doesn't expand after heated due to high density at lower zone. The pond contains salt water having high density,alkaline water with low density. Water in pond forms various layer of density in it. Pond water has high Salinity gradient. The salinity gradient also known as halocline. There are three layers of pond the high salinity of water floats to the low salinity of water. Generally, alkaline water is used for solar pond which is having less than 50,000 ppm concentration and less than 1050kg/m^3 density at upper zone. When sunrays fall on surface of solar pond heat get absorbed throughout the pond and due to black color of bottom, heat get absorbed at bottom and increases ittemperature up to 80-90^{0}Cand upper layer is also get heated but due to evaporation and wind blowing across the zone of pond get cooled. As the lower surface get heated there is large possibility of heat losses, level expanding in it, but due to relatively low conductivity ,the water at upper end act as an insulator and prevent heat loss in it. The lower layer acts as heat storage zone. As the depth of lower zone increase the heat storage capacity of pond also increases. The main advantage of solar pond is storing the heat for long period of time without minimum losses.

The lower convective zone is full of salt water as the sunrays incident on it the water get heated due to the salt present in the water so that water gets heated up to 90^{o}C and concentration of salt is about 20-30% at bottom. LCZ or storage zone have the highest temperature.

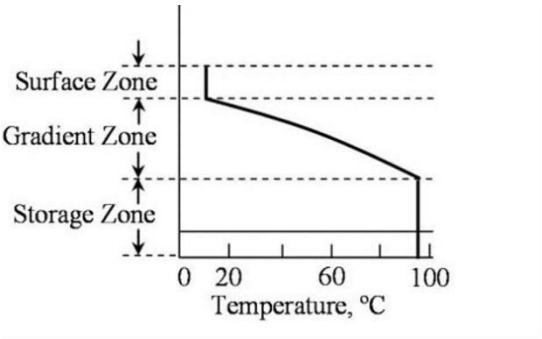

Fig- 4.1: Temperature vs. zone

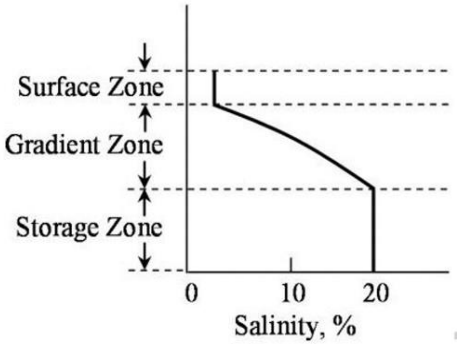

Fig-4.2: Salinity percent vs. zone

Above the LCZ there is nonconvective zone, the NCZ or gradient zone has the temperature of 30-40^{o}C salinity of water is less than the salinity ofwater present in the LCZ. The upper convective zone is only filled with pure or fresh water which salinity of water is very less so the temperature of water is in the room temperature.

The salt is poured directly into the storage zone with the help of pipe so that the maximum dissolution of salt is in the LCZ so the temperature is maximum at this stage comparatively other two zones. Then this heated water is transfer to heat exchanger with the help of insulated pipes without minimum losses. The productionof electricityform hot water is carried out by various thermodynamic processsuch as organic Rankine cycle.

5. SALT REPLENISHMENT

Salt replenishment is very important for maintaining salt gradient. There is diffusion of salt due to salt crystal formation. In small pond 60kg/m^2 per year. The additional salt is transport through the side wall heating.

Energy Source	Generating Cost (Euro per kWh)	Range of Power
Oil	0.25	1kW-10MW
Coal	0.03	1MW-1GW
Gas	0.03	1MW-1GW
Solar PV	0.80	10W-10MW
Wind	0.07	100W-100MW
Biomass	0.04	1kW-150MW
Solar Pond	0.133	1kW-5MW (unlimited)

Fig-5.1: Energy comparison

6. ADVANTAGES & DISADVANTAGES

Advantages:

1. Heat stores for long duration of time without losses.
2. In cold places, cloudy areas for purpose of heating.
3. It is operate in cloudy weathers, humidity area i.e. 24*7 *365.
4.It is 100% ecofriendly.
5. It low maintenance cost and chipper for construction.
6. The solar pond technology is attractive for rural areas in developing countries.

Disadvantages:

1. Due to direct contact with sunlight, air, alkaline water at surface zone results in formation of algae at surface of pond.
2. Floating dust particles, bits of debris, leaves and algae reduces its efficiency.
3. The accumulated salt crystals have tobe removed regularly and it increases maintenance expense.
4. Cannot operate in heavy rainfall.

6. CONCLUSION

So, the conclusion is solar pond is easier and cheapest way of storing heat energy. The drawback of solar pond is such that algae, it can be control by adding the bleaching powder in the pond. Dust can also be controlled by adding alum in pond. The important factor is salt gradient or salt density layer shouldn't mixtogether. Solar pond has proper manage of the salinity of water with respective layer.

8. PRACTICAL APPLICATIONS

The largest solar pond in India was constructed in 1993 at Bhuj, Gujarat and has power out-put of 220,000,000 kWh of thermal energy per year. Thesecond largest solar pond is US has area of 0.8 acres and send 20% energy to Bruce food corporation's in EI Paso, Texas.

REFERENCES

[1]. Renewable energy magazine, 2013,-vol 1

[2]. Aliakbar Akbarzadeh and John Andrews "Solar Pond", "Solar Energy Conversion and Photo Energy Systems"-Vol-I

[3]. Karakavalasa Goutham, Chukka Siva Krishna, "Solar pond technology", (Dec. 2013), International Journal of Engineering Research and General Science- Vol-I, ISSN 2091-2730.

[4]. D. B. Sifuna, T. K. Kinyanjui, F. G. Ndiritu, R. G. Ngubu,"Comparison of Thermal Storage Efficiency of Solar Pond with and without a Polyethene Membrane",(September 2014) International Journal of Scientific and Research Publications, Vol- 4, Issue 9,ISSN 2250-3153

[5]. "Non-convective solar pond as a thermal energy source"

[6]. "Bhuj solar pond project, Gujarat".

[7]. ASME: Solar engineering technology, 2013