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# A Review: An Experimental Investigation For The Stability Of Solar Pond

[1]Rahul R. Pawar,[2]Prof. M. P. Thakur,[3]Prof. T. A. Koli

[1]Student, Dept. of Mechanical Engineering, GF'S Godavari College of Engineering, Jalgaon, India,
[2]Assistant Professor, Dept. of Mechanical Engineering, GF'S Godavari College of Engineering, Jalgaon, India,[3]Assistant Professor & HOD, Dept. of Mechanical Engineering, GF'S Godavari College of Engineering, Jalgaon, India

Abstract: A solar pond is a man-made pond that has a distinct temperature rise at its bottom due to the prevention of convection. Salt water is used in the pond to prevent convection. These ponds are called "salt gradient solar ponds". In the last 15 years, many salt gradient solar ponds of various sizes ranging from hundreds to thousands of square meters have been built in many countries. These days, mini solar arbors are also built for different thermal applications. This project work built a solar pond system with better insulation, a clear top cover and an improved absorbing coating. The temperature of the pond was measured at various levels and compared with other works. In this work, solar pond performance was observed at different salinity levels. It can be seen that the maximum temperature occurring in the storage zone increases with increasing salinity. The pond also serves as storage. This is because the temperature that occurs in the storage zone reaches a maximum at the end of his day with varying solar intensities. Therefore, solar ponds also work with diffuse radiation. The current system performs better than the previous work. The maximum temperatures developed in the storage zone are higher than those developed in the previous work. This indicates that the heat transfer properties of the system are excellent

***Index Terms* – introduction, literature review, Working Principle etc.**

## I. Introduction

As technology advances, the energy needs of communities are increasing. This energy requirement is provided by various energies Sources known as traditional energy sources such as coal, fuel oil, geothermal energy, hydroelectric energy and nuclear energy. These energy sources have some drawbacks. The first three of these energy sources have a limited lifetime. hydraulic energy Inadequate energy sources and nuclear energy have unresolved environmental and safety issues. There the researchers summarizes research on new alternative energy sources known as renewable energy sources . solar energy is renewable energy sources. Solar energy is radiation produced by nuclear fusion reactions in the depths of the sun. Sun It provides nearly all of the heat and light that the Earth receives and supports all life.

Humans can indirectly harness naturally generated solar energy. Earth's atmosphere, oceans, plants, etc. For example, it collects solar energy that people later use for energy technology. Currently, salt gradient solar technology is one of them. A clever form of using solar energy. This is the common name for applying a salt gradient to a body of water. For the purpose of collecting and storing solar energy. One of his types of salt gradient technology is called a salt gradient solar pond. Solar ponds are shallow salt waters several meters deep designed to increase salinity. depth. Solar radiation that enters the pond is stored as heat in the lower layers. This heat (up to 80°C) is available for 24 hours. basis .

Solar ponds are used for a variety of thermal applications, including greenhouse heating, process heat in the dairy industry, desalination, and power generation. Solar Pond offers a unique opportunity to conduct research in areas such as double diffusive convection, wind/wave interactions, laminar fluid flow, and computer modeling. Additionally, state-of-the-art equipment on site provides excellent opportunities for energy efficiency studies, cost analysis, system studies, and heat exchangers.

A few years ago there was work on a bachelor's degree project on a solar pond system built and tested using ferrocement. However, it had the following limitations. B. Inadequate side wall insulation, limited lifetime absorber surface coatings with no attempt to prevent convective and radiative heat loss from the top surface to the air, etc. The main aim of the current work is to improve the performance of Solar Pond by removing the above limitations and comparing with previous ones. To do this, several steps were taken considering various factors that affect the performance of the solar pond, such as water turbidity, soil reflectance, and insulation. This should be more durable than the coatings used in previous work. There are two types of commercially available coatings: epoxy coatings and synthetic enamel paints (matte finish). The former is better, but too costly. Lanterns are a type of cement paint with excellent adhesion. Gloss and Matte He is available in two finishes and adheres to all primers[4]. A transparent cover was used on the surface of the pond to increase the efficiency of the pond to prevent water turbidity and convection and radiant heat loss to the air from the top surface.

## II. LITERATURE REVIEW

2.1 A. Ramalingam and S. Arumugam: Sodium chloride (NaCl) solution has been found to be widely used in the heat storage zone (HSZ) of salt gradient solar ponds (SGSP) at concentrations ranging from 20% to 25% (wt) for solar energy collection and storage. energy and its acquisition in the form of thermal energy. A NaCl solution with concentrations ranging from 25% to 0% was used to create a salinity gradient called the non-convection zone (NCZ) that is stacked across the HSZ SGSP. The less dense layer floats above the heavy layer by eventually resting on top of each other. The main purpose of establishing a salinity gradient is to prevent convective heat loss from the heat storage zone (HSZ) by suppressing convection due to solar heating. Values of specific heat capacity at elevated temperature and concentration are useful for accurate estimation of heat energy extractable by decantation of hot brine from HSZ SGSP. A number of compilations of thermophysical properties of NaCl solutions have been published, but the literature detailing the specific heat capacity of NaCl solution at various concentrations and temperatures necessary to estimate SGSP efficiency was found to have the same high salt concentration. missing. In this study, an attempt was made to experimentally measure and theoretically predict the specific heat capacity of NaCl salt solution at elevated temperatures and at different concentrations of the solution. An adiabatic calorimeter was made to determine the specific heat capacity of the salt solution at elevated temperatures above ambient temperature. Design, fabrication and performance analysis of a single tank vacuum solar still.

2.2 KarakavalasaGoutham, Chukka Siva Krishna: Energy is an important input in all sectors of economic growth of any country. A country's standard of living can be directly related to its per capita energy consumption. Due to the rapid increase in population and living standards of people, the problem of energy crisis arises. The supply of oil will not cover the growing demand of the population. Therefore, it was necessary to choose an alternative energy source that would cover future energy demands. Currently, a number of alternative energy sources and methods of energy harvesting have been discovered. Among the most widespread and cleanest renewable energy sources, solar energy is one of the effective solutions to environmental pollution and the lack of fossil fuels. Solar energy is an abundant and renewable source of energy. The ring solar energy hitting the ground in India is about 20,000 times greater than current electricity consumption. Therefore, a very small amount of solar energy is sufficient to meet the main energy requirements, especially in tropical countries. But the use of solar energy was very limited. This is because solar energy is a time dependent and intermittent energy source. And above all, solar energy is a daily source of energy. The main task that lies here is the storage of solar energy to cover energy needs. Energy must therefore be collected over large areas with a high initial investment. These solar energy storage systems must take care of collecting solar energy during cloudy and winter periods. They should have the ability to store energy during the night hours in the Oder, in order to supply energy in a uniform manner when needed. This can result in a further increase in the overall capital cost of building such systems. One of the best ways to overcome this problem is to use large amounts of water to collect and store solar energy. This concept is called Solar Pond.

## III. WORKINGPRINCIPLE

Most people know that fluids such as water and air rise up when heated. The salinity gradient stops this process when large quantities of salt are dissolved in the hot bottom layer of the body of water, making it too dense to raise to the surface and cool

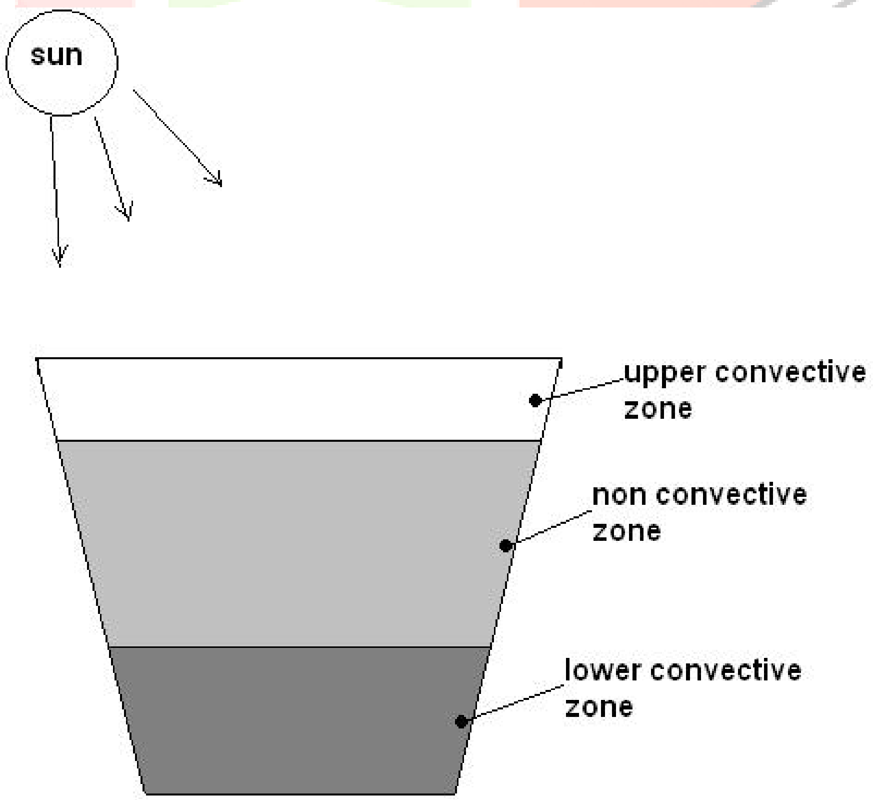


Fig. 3.1: Schematic Diagram of a typical Salt Gradient Solar Pond

A typical salinity gradient solar pond has three areas. The upper region is called the surface zone or upper convective zone (UCZ). The middle region is called the main gradient zone (MGZ) or nonconvective zone (NCZ). The lower region is called the accumulation zone or lower convective zone (LCZ). The lower zone is a homogeneous, concentrated brine that may be convective or thermally stratified. Above it, the NCZ forms a thermally insulating layer that contains a salinity gradient. This means that the water closer to the surface is always less concentrated than the water below

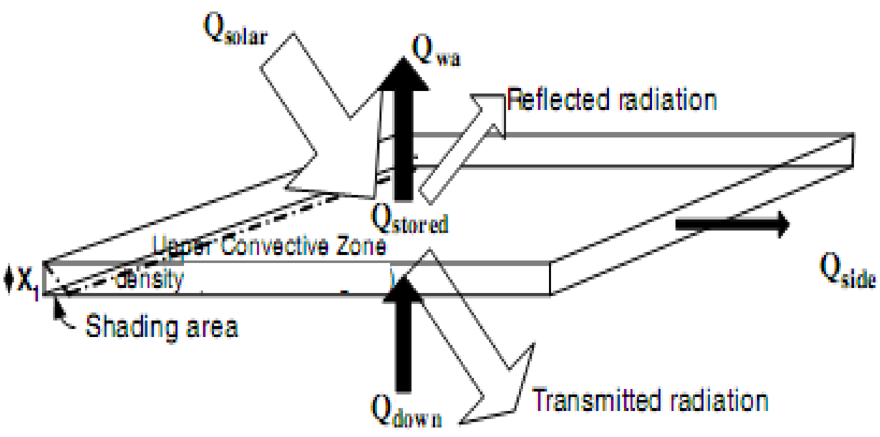


Fig. 3.2: Schematic Diagram of the UCZ Layer

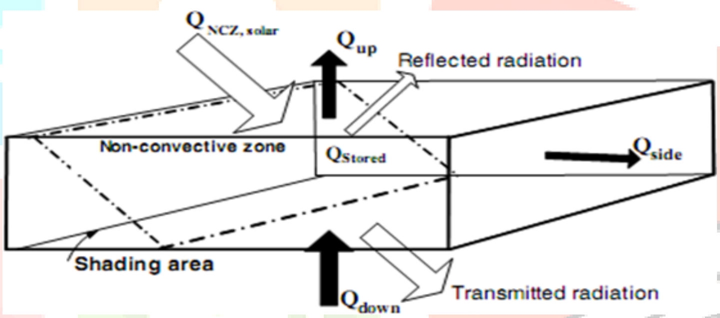


Fig. 3.3: Schematic Diagram of the NCZ Layer

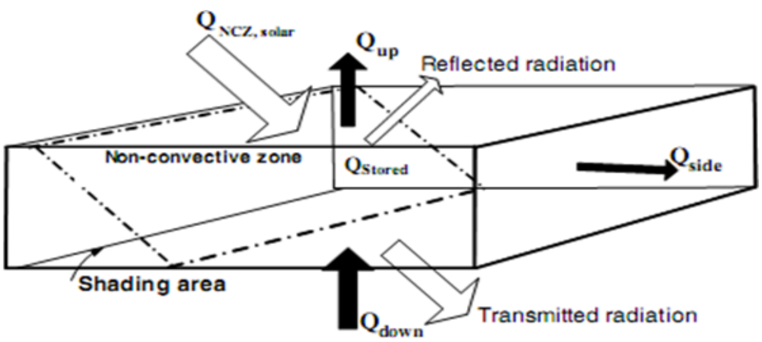


Fig.3.4: Schematic Diagram of the LCZ Layer

The surface zone is a homogeneous layer of slightly salty brine or fresh water. If the salinity gradient is large enough, no convection occurs in the gradient zone, even though heat is absorbed in the lower zone, because the warmer, saltier water at the bottom of the gradient remains denser than the cooler, less saline water above it.

Because there is water Transmissive to visible light but opaque to infrared, energy in the form of sunlight that reaches the lower zone and is absorbed there can only escape through conduction. The thermal conductivity of water is moderately low, and if the main gradient zone (MGZ) has considerable thickness, heat escapes upwards from the lower zone very slowly. The insulating properties of the main catchment zone in combination with the high heat capacity of water and the large volume of water make the solar pond both a thermal collector and a long-term storage device.

## IV.TYPES OF SOLAR PONDS:

There are two main categories of solar ponds [8]:

1) Nonconvecting solar ponds, which reduce heat loss by preventing convection from occurring within the pond.
2) Convecting solar ponds, which reduce heat loss by hindering evaporation with a cover over the surface of the pond.

### 4.1 Nonconvecting Ponds:

Non-convective solar ponds can be divided into two types: salt gradient ponds and membrane ponds. A salt gradient pond has three different layers of different concentrations of brine (a mixture of salt and water). Salt water becomes denser with increasing salinity, so the most concentrated layer forms at the bottom. The least dense layer is on the surface. Commonly used salts are sodium chloride and magnesium chloride. A dark material - usually butyl rubber - covers the pond. A dark lining improves the absorption of solar radiation and prevents salt from contaminating the surrounding soil and groundwater. When sunlight enters the pond, the water and the liner absorb the radiation. As a result, the water at the bottom of the pond warms up to 93.3°C (200°F). All layers retain some heat, but the bottom layer retains the most. Even as it warms up, the lower layer is denser than the upper layer, which limits convection. Heat is extracted from this lower layer by feeding the brine into an external heat exchanger or evaporator. Another method of heat removal is to extract heat with a heat transfer fluid while pumping it through a heat exchanger at the bottom of the pond. Another type of non-convective pond, the membrane pond, Physical separation of layers by a thin transparent membrane. Similar to salt gradient ponds, heat is extracted from the bottom layer.

### 4.2 Convecting Pond:

A well-studied example of a convective pond is a shallow solar pond. This pond consists of pure water enclosed in a large bag that allows convection but prevents evaporation. The bottom of the bag is black, with foam insulation on the bottom and two types of glazing (plastic or glass panels) on the top. During the day the sun heats the water in the bag. At night, hot water is pumped into a large thermal storage tank to minimize heat loss. Excessive heat loss from pumps to store hot water has limited the development of shallow solar ponds. Another type of convective pond is a deep unsalted pond. This convection pond differs from a flat solar pond only in that water does not need to flow in and out of the reservoir. Double glazed covers are typically used in unsalted deep ponds. At night or when solar energy is not available, insulation is placed over the glass to reduce heat loss.

A non-convective solar pond built according to the above characteristics offers a number of important advantages. First, although the lower layer is not completely impermeable, very little leakage occurs as the pumping means push liquid back into the middle layer. Pressure increase due to liquid above the lower impermeable layer. Furthermore, the gas generated at the bottom of the pond is released to the atmosphere before the sump drained liquid is returned to the pond, so the generated gas can disrupt the concentration gradient of the pond or contaminate its water. There is nothing to do. In addition, the bottom structure of the solar pond can be made of relatively inexpensive materials (e.g. compacted soil for impermeable layers, coarse sand and/or crushed stone for permeable layers), thus reducing the need for expensive refractory materials. can be avoided .

### 4.3 Application of Solar Pond:

The solar ponds are widely considered as the low temperature energy storage devices having use in wide range of process applications. The following section deals with the scope of the applications of solar pond heat adopted in various processes.

#### 4.3.1 Greenhouse Heating:

As was described in, Sokolov and Arbel showed how to use a fresh water solar pond to heat a greenhouse. The pond was made up of an earthen excavation with a liner and a thin top cover. When there was solar radiation, water was used as a heat-transfer medium. Pumping hot water from the pond's upper layer through a heat exchanger provided energy to the greenhouse. Following heat extraction, the water retreated to the solar pond's bottom. In a different study, Arbel and Sokolov investigated various collector materials with various material qualities and came to the conclusion that using the right material enhances the effectiveness of the solar pond. Before building a larger pond with a 140–160 $m^2$ area, Riva spent two years studying a 20 m2 solar pond, as reported in. During preliminary testing, it was discovered that the energy efficiency ranged from 10% to 20%. The energy was meant to heat the air in a dryer with a 40–50 $m^2$ surface area

#### 4.3.2 Process Heat in Dairy Industries:

When significant amounts of hot water are required, such as in the dairy and textile industries, studies have shown that there is excellent potential for process heat applications. A 6,000 m2 solar pond provides the hot water needed for sterilization and pasteurization at a dairy in Bhuj, Gujarat state, India. During the operation of the pond, the temperature of the hot water ranged from 84 to 95 degrees Celsius.

4.3.3 Desalination:

Desalination involves the manner of acquiring clean water for ingesting and irrigation from both brackish or saline water after suitable remedy. The solar energy has been utilized for distillation of brackish or saline water for a totally long time. The clean water is produced thru repetitive cycles of evaporation and condensation, the usage of low temperature heat from the solar ponds. As referred to in, Tabor showed that a pond of one/three $km^2$ vicinity should function a multi-effect distillation unit, with an annual suggest output of 4000 $m^3$ /day at a charge of us $ 0.sixty seven/ $m^3$. He in addition remarked that a solar pond desalination plant produces approximately 5 times the amount made out of simple tray kind solar nevertheless. A 20000 $m^2$ solar pond in Italy was used for desalination of seawater to produce 120 ton of fresh water/day.

4.3.4 Power Production:

In solar pond power plants, the solution from the lower convective zone is pumped to a heat exchanger that acts as evaporator for an organic Rankine cycle. As mentioned in [10], Trieb made a comparative analysis of different solar electricity generation options and found that solar pond produces electricity at a cost of 0.254 German Marks (DM)/kWh as against 1.198 German Marks (DM)/ kWh for photovoltaic cells [10].

4.3.5 Hot Water Applications in Agriculture:

Many agricultural operations use hot water for a variety of purposes. Some of these include soaking paddy in parboiling, processing sugar cane waste, blanching vegetables, washing cans in the dairy industry, and using hot water at home. Traditionally, the parboiling process involves soaking uncooked rice in room temperature water in brick tanks for three days, then steaming the dry rice. improved by soaking in boiling water for several hours. This method eliminates the unwanted odors associated with traditional methods and reduces soaking time from days to hours. Heat treatment of sugar cane plants prior to planting is desirable for growing crops free of seed disease and certain pests. Usually, it is treated with hot water at 50°C for 2 hours and with hot moist air at 54°C for 4 hours. It is clear that solar ponds have wide application in agricultural applications with low temperature requirements.

4.3.6 Economics of Solar Ponds for Heating:

It is estimated that a solar pond in a climate similar to northern Victoria can generate process heat (40-80°C) for a variety of applications at an average cost of $10-$15/GJ. Current project results provide real-world data on the cost of energy supplied to demonstration plants and commercial systems. Heat from solar ponds is therefore expected to be comparable to the use of LPG and electricity in rural areas. Local heating costs are currently over $20/GJ for his LPG (43c/liter). Heat from electricity (that is, direct heating rather than heat pumps) costs $45/GJ during peak hours and over $9/GJ during off-peak hours. Heating a solar power plant typically costs only $4-5 per GJ, making it uncompetitive in areas where natural gas is available.

4.3.7 Industries with Potential Applications for Solar Ponds:

Solar ponds have the potential to provide low-grade heat in industries such as the following:

- salt production (for enhanced evaporation or purification of salt, that is production of vacuum quality salt)
- aquaculture, using saline or fresh water (to grow, for example, fish or brine shrimp)
- dairy industry (for example, to preheat feed water to boilers)
- fruit and vegetable canning industry
- grain industry (for grain drying)
- water supply (for desalination)

The applications of the technology are certainly not limited to these industries. Basically the generic requirements for a practical solar pond application are these:

- no access to natural gas, and hence reliance on more expensive fuels such as LPG, electricity or fuel oil
- demand for heat in the 40 to 80 °C temperature range
- saline water and salt preferably available locally
- availability of relatively flat land on which to construct the solar pond
- relatively high annual average solar radiation

Solar ponds may also be considered as a source of heating factory and office space and water heating at suitable rural sites [2].

## V .ADVANTAGES AND DISADVANTAGES:

The solar pond system has some advantages and disadvantages. These are mentioned as follows:

- Low investment costs per installed collection area.
- Thermal storage is incorporated into the collector and is of very low cost.
- Diffuse radiation (cloudy days) is fully used.
- Very large surfaces can be built thus large scale energy generation is possible.
- Expensive cleaning of large collector surfaces in dusty areas is avoided [11].

## VI. EXPECTED CONCLUSION

Solar pond was constructed in which three modifications were made. Transparent cover was placed over the system, cork sheet was used as insulator for the side walls and special type of absorber surface coating was used. The present work shows better output than the previous work. In the previous work, maximum temperature obtained at the LCZ was 32oC where as the maximum temperature obtained in the present work is 40oC. Temperature difference between UCZ and LCZ was 6oC in the previous work where 10oC temperature difference between UCZ and LCZ was obtained in the present work. Increased lifetime of the solar pond is expected because of insulation provided at the bottom and absorber coating used are of better quality.

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