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# Eco-Friendly Water Purification Through Solar Energy and Post Treated Water Analysis

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*Abstract:*
*Water is one of the natural resources which sustains life on earth. The total water resources on the earth are around 1360 million cubic kilometres. The water resources available to humanity can be classified as surface and sub-surface water resources. Surface waters include the permanently or intermittently occurring inland waters on the earth's surface, either in liquid or solid conditions. Nowadays, many water resources are polluted by anthropogenic sources, including household and industrial processes. As the population of cities and towns grows, the demand for clean water increases. However, this demand often exceeds the available supply of freshwater resources, leading to the use of alternative sources such as raw water, i.e. Chemical coagulation, adsorption, activated sludge, have been applied to remove pollution. However, there are still some limitations especially that of high operation costs.The treatment of raw water involves several stages of removing impurities and contaminants to make it suitable to be discharged back to the environment. Accessing to clean water is a critical issue worldwide, particularly in developing countries where many people do not have access to safe drinking water. Solar water treatment plants offer a solution to this problem by providing a sustainable and cost-effective way to purify water. These plants are typically located in areas with abundant sunlight, making them ideal for countries with a warm and sunny climate. Water treatment system suppliers use a combination of solar panels and water treatment equipment to purify water from natural sources like sea, river, lakes, ponds, etc... In this paper, we will establish a mini-solar water treatment plant and purify different water samples obtained from the above-mentioned natural sources. Analysis and interpretation of results will show the suitability of the above-treated water for drinking and other purposes.*
*Key Words: Renewable resources, water distillation, water analysis, evaporation and condensation.*

## INTRODUCTION

Water purification is a critical process that ensure access to clean and safe drinking water, which is essential for health and wellbeing. The sustainability of the environment is decreasing day by day. Due to this, awareness of environmental protection is very important. In today's world, protective methods are improved for environmental sustainability. Traditional methods of water purification, such as chemical treatments or mechanical filtration, often require significant energy inputs, which can be both costly and environmentally taxing. Solar energy, as a renewable and sustainable energy source, has emerged as a promising alternative for powering water purification processes, particularly in regions with abundant sunlight and limited access to conventional energy source. This research aims to investigate and improve the efficiency of water purification systems powered by solar energy by exploring various design modifications, systems configuration, and optimization techniques. By integrating advances technologies like solar phoyovaltic(PV) cells, solar thermal collectors, and hybrid systems, the goal it's develop an affordable and sustainable water purification solution that can be scaled for both individual and

community use. This approach holds promise for addressing water scarcity and ensuring access to clean water in underserved and off-grid communities.

Water treatment is a critical process for ensuring the provision of safe and clean drinking water, especially in areas with limited access to reliable water sources or where energy costs are high. In recent years, there has been a growing interest in integrating renewable energy sources, such as solar power, into water treatment systems to make the process more sustainable, cost-effective and environmentally friendly. The integration of solar energy into water treatment involves using solar power to operate various treatment processes, such as filtration, desalination, and disinfection. This approach significantly reduces the reliance on traditional energy sources like electricity from the grid, which can be unreliable or expensive, especially in remote or off-grid areas.

The following sections outline the specific methodologies employed to modify and enhance water purification processes through the use of solar energy, including experimental setups, system design considerations, and performance evaluations.

2.0 Study Area :Water samples for testing were collected from NTR district,Andhra Pradesh,India.

**METHODOLOGY** :

3.1 Block Diagram :

Water purification using the sun is often done through methods like solar distillation or solar disinfection. These processes take advantage of solar energy to clean and purify water making it safe for drinking. The water purification methodology is as follows:

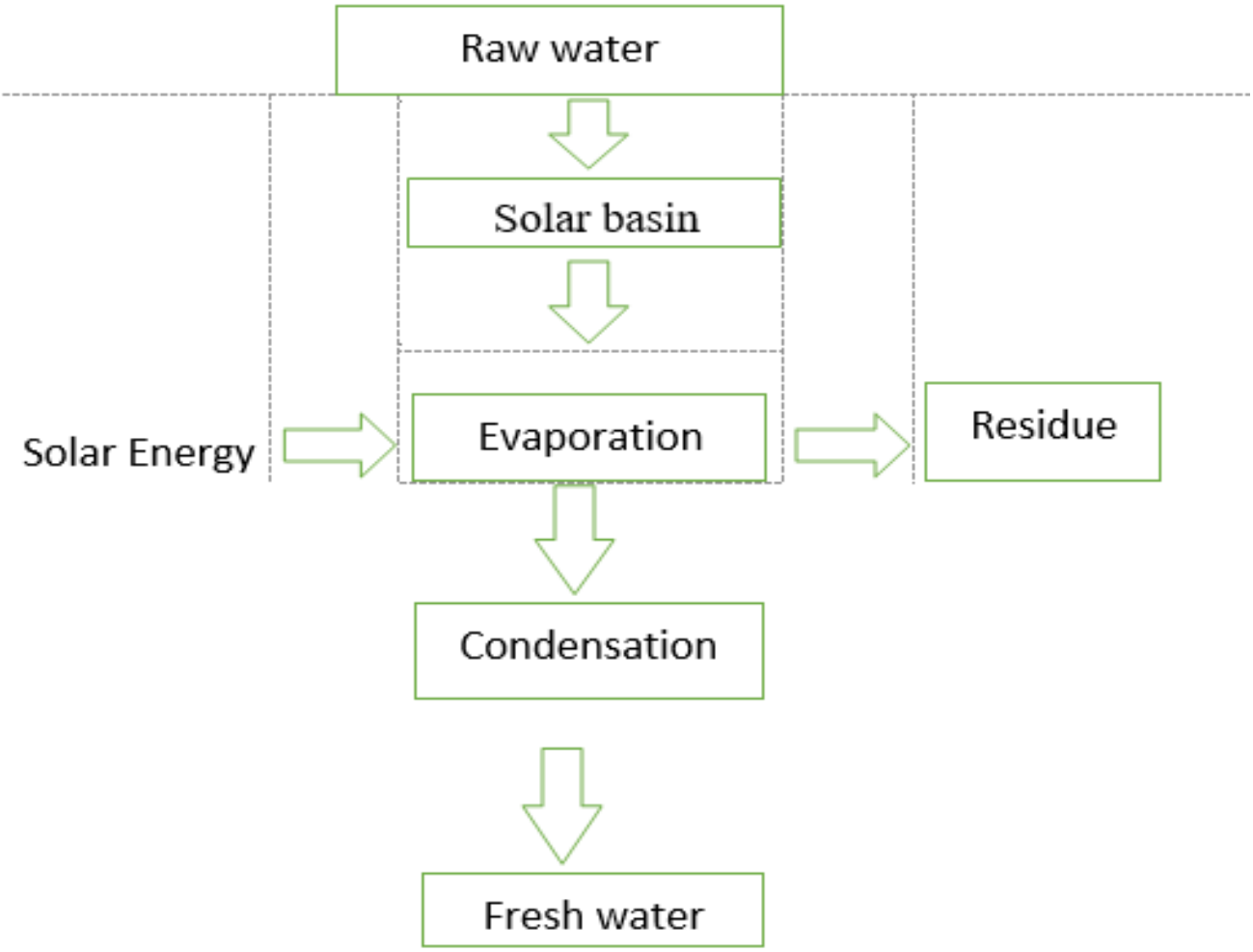


Fig. 1 Water Purification Process

Dirty (or) Raw water: It refers to water that is in its natural state, directly sourced from bodies like rivers, lakes, or underground springs, before it undergoes any treatment processes such as filtration, purification, or disinfection. It often contains minerals, organic matter, bacteria, and other contaminants that need to be removed before its safe for consumption or use in other processes. Raw water is sometimes marketed as a "natural" or "pure" alternative to treated water, but consuming it without proper treatment can pose health risks due to the presence of harmful microorganisms and pollutants. Solar energy: It is the energy harnessed from the sun's rays, and it's one of the most abundant and sustainable energy sources available on Earth. It can be used in various ways to produce electricity, heat, and even fuel Solar basin: It is a type of solar energy technology used primarily in solar thermal systems, specifically in Concentrated Solar Power (CSP) applications. The idea behind a solar basin is to use large, reflective surfaces to concentrate sunlight onto a receiver, which is typically a basin or pool of liquid that absorbs the solar energy. Solar basins are being developed as part of the broader effort to improve CSP technology, making it more efficient and cost-effective. As energy storage technologies improve (like molten salts for storing thermal energy), solar basin systems have the potential to provide a reliable and sustainable source of power, even in areas with fluctuating sunlight. Residue: It refers to any remaining substances or materials left behind after water undergoes a specific process, such as evaporation, filtration, or distillation. The nature of the residue depends on the process applied to the water and what it contains. Here are some common scenarios in which the residue of water might be mentioned In general, the "residue of water" refers to whatever substances are left behind when water has undergone a physical or chemical process (like evaporation, distillation, filtration, or drying). It typically consists of dissolved minerals, salts, contaminants, or particulate matter.Evaporation: It is the process by which a liquid changes into a gas or vapour, typically occurring at the surface of the liquid, without the need for boiling. It happens at temperatures below the boiling point of the liquid and can occur at any temperature. For water, evaporation is a key component in the water cycle and plays an important role in many natural and human made processes. Evaporation is a vital process where liquid water changes to vapour due to heat energy, playing an important role in the natural environment (such as in the water cycle) and in various human-made applications. It depends on factors like temperature, surface area, air movement, and humidity. Condensation: It is the process by which a gas or vapour changes into a liquid when it cools down. It is essentially the reverse of evaporation, where a liquid turns into a gas. Condensation occurs when the temperature of a gas decreases enough for the gas molecules to lose energy and cluster together, forming liquid droplets. Fresh water: It is water that has low concentrations of dissolved salts (salinity), making it suitable for drinking, irrigation, and other essential human activities. It is different from saltwater, which has high salt content, such as seawater in oceans and seas. Fresh water is crucial for life on Earth, as it supports ecosystems, human consumption, agriculture, and industry. While fresh water covers a significant portion of the planet, it's relatively scarce compared to saltwater.

4.0 Test Results and Analysis :

4.1 Purification of different water samples( i.e.Lake Water,Pond Water,Sea Water,Tap water and Ground water) done by Solar water purification device through solar energy.

Table: 1 – Analysis of Test results of different water samples( i.e. Lake Water,Pond Water,Sea Water,Tap water and Ground water) before and after Purification as follows:

Table: 1.1 – Test Data of Lake Water before and after Purification

| Water sample | Test | Before Purification value | After Purification value |
|---|---|---|---|
| Lake Water | Ph | 8.06 | 7.8 |
| | EC | 1.1 Ms | 2.8 Ms |
| | Turbidity | 52.06 NTU | 12.06 NTU |
| | Alkalinity | 3.21 ppm | 22.21 ppm |
| | TDS | 795.3 | 495.3 |

| | | | |
|---|---|---|---|
| | Hardness | 23.5 | 53.5 |
| | Colour | Light green | Light green |
| | Odour | Alga smell | Alga smell |

TABLE: 1.2 – Test Data of POND WATER before and after Purification

| Water sample | Test | Before Purification value | After Purification value |
|---|---|---|---|
| Pond Water | Ph | 8.06 | 7.6 |
| | EC | 1.06 Ms | 50.06 Ms |
| | Turbidity | 36.70 NTU | 12.30 NTU |
| | Alkalinity | 3.11 ppm | 23.6 ppm |
| | TDS | 491.3 | 105.9 |
| | Hardness | 7.47 | 9.6 |
| | Colour | Pale yellow | Pale yellow |
| | Odour | Fish smell | Fish smell |

TABLE: 1.3 – Test Data of TAP WATER before and after Purification

| Water sample | Test | Before Purification value | After Purification value |
|---|---|---|---|
| Tap Water | Ph | 7.66 | 7.32 |
| | EC | 0.56 Ms | 0.4 Ms |
| | Turbidity | 5.03 NTU | 15.4 NTU |
| | Alkalinity | 5.56 ppm | 3 ppm |
| | TDS | 382.3 | 282 |
| | Hardness | 7.73 | 3 |
| | Colour | Colour less | Colour less |
| | Odour | Bleach smell | Bleach smell |

TABLE: 1.4 – Test Data of GROUND WATER before and after Purification

| Water sample | Test | Before Purification value | After Purification value |
|---|---|---|---|
| Ground Water | Ph | 7.01 | 6.96 |
| | EC | 2.9 Ms | 1.9 Ms |
| | Turbidity | 35.93 NTU | 19 NTU |
| | Alkalinity | 4.2 ppm | 3.5 ppm |
| | TDS | 141.3 | 105 |
| | Hardness | 25.53 | 10.3 |

| | | | |
|---|---|---|---|
| | Colour | Light green | Light green |
| | Odour | No odour | No odour |

TABLE: 1.5 - Test Data of SEA WATER before and after Purification

| Water sample | Test | Before Purification value | After Purification value |
|---|---|---|---|
| Sea Water | Ph | 9.17 | 7.2 |
| | EC | 59.6 Ms | 62.6 Ms |
| | Turbidity | 36.6 NTU | 22.8 NTU |
| | Alkalinity | 128.3 ppm | 58.6 ppm |
| | TDS | 1947.13 | 1716.02 |
| | Hardness | 6407 | 5109 |
| | Colour | Peal yellow | Peal yellow |
| | Odour | Different smell | Different smell |

**CONCLUSIONS :**

5.1 Lake Water Test Data :

PH: water before test value is 8.06 and after test is 7.8. Since both values fall within the acceptable pH range for freshwater, So both can be considered freshwater. However, the water with a pH of 7.8 is closer to neutral (7.0) and may indicate a slightly purer freshwater condition compared to 8.06. EC: water before test value is 1.1 Ms and after test is 2.8 Ms. before the test is not ideal but possibly drinkable if properly treated and tested for contaminants after the test is not drinkable due to high dissolved solids.

TURBIDITY: water before test value is 52.06 NTU and after test value is 22.06 NTU. The water is not drinkable in both cases. Even after the test, the turbidity is still too high (>5 NTU) and requires further filtration and disinfection (e.g., boiling, chlorination, or UV treatment) before it is safe for consumption.

ALKALINITY: water before test value is 3.21 ppm and after test value is 22.21 ppm. before test the water will too low, water may be corrosive, affecting pipes a releasing metals (e.g., lead, copper). after test the water is safe for drinking within the acceptable range for drinking water.

TDS: water before test value is 795.3 and after test value is 495.3. before the test is moderate tds is acceptable but not ideal for drinking (not safe), after the test is better quality falls in good category which is safe for drinking.

HARDNESS: water before test value is 23.5 and after test value is 53.5. both before and after are drinkable and fall within the soft water category no health risks are associated with hardness in this range.

5.2 Pond Water Test Data :

PH: water before test value is 8.06 and after test value is 7.6. Based on pH alone, the water is safe to drink (recommended pH range: 6.5 - 8.5). EC: water before test value is 1.06 Ms and after test value is 50.06 Ms. Just based on EC, the water might be drinkable. However, EC does not measure bacteria, heavy metals, or toxins it is not safe to drink without further testing for contaminants.

TURBIIDITY: water before test values is 5.03 NTU and after test value is 12.30 NTU. The water is not safe to drink in its current state high turbidity can indicate potential microbial contamination.

ALKALINITY: water before test value is 5.56 ppm and after test value is 23.6 ppm. After test the water is safe to drink and fall within the soft water category no health risk. TDS: water before test value is 382.3 and after test the value is 105.9. before test the water is moderate level, within safe drinking range and after test the water is low level, very safe in terms of TDS.

HARDNESS: water before test value is 7.73 and after test value is 9.6. both after and before based on hardness alone, the water is safe to drink.

5.3 Tap Water Test Data :

PH: water before test value is 7.01 and after test value is 7.32. before test the water is neutral, safe for drinking and after test the water is still neutral, slightly alkaline, and safe for drinking. EC: water before test value is 0.56 an after-test value is 0.4. before test the water is very low conductivity and after test the water is even lower conductivity, the water is safe and very low in dissolved salts.

TURBIDITY: water before test value is 5.03 NTU and after test value is 6.02 NTU before test the water is above the recommended limit and after test the water is even higher making it more unsafe.

ALKALINITY: water before test value is 5.56 ppm and after test value is 3 ppm.The water is low alkalinity is not directly harmful to health.

TDS: water before test value is 382.3 and after test value is 282.th water before test it moderate within safe drinking range and after test is lower better quality.

HARDNESS: water before test value is 7.73 and after test value is 3.the water before test is very soft water after test is extremely soft water,the water is safe to drink based on hardness.

5.4 Ground Water Test Data :

PH: water before test value is 7.01 and after test value is 6.96. the water before test is neutral safe for drinking the water after test is slightly acidic but still within the safe range.

EC: water before test value is 2.9 Ms and after test value is 1.9 Ms. Based on EC alone the water is safe to drink and within the safe range but this does not confirm overall drinkability.

TURBIDITY: water before test value is 35.93 NTU and after test value is 19 NTU. The water has dangerously high turbidity and is not safe to drink.

ALKALINITY: water before test value is 4.2 ppm and after test value is 3.5 ppm. The water has extremely low alkalinity which may cause corrosion but is not directly harmful to health.

TDS: water before test value is 141.3 and after test value is 105. The water is at a safe level but this does not guarantee overall drinkability.

HARDNESS: water before test value is 25.53 and after test value is 10.3.the water is very soft which is safe but may cause pipe corrosion over time Sea Water.

PH: water before test value is 9.17 and after test value is 7.2. the water before test it have highly alkaline not suitable for drinking and after test the water within the safe range for drinking.

EC: water before test value is 59.6 Ms and after test value is 62.6 Ms. The water is not safe to drink due to its extremely high EC (high salinity) and desalination (salt removal) is required to make water drinkable.

TURBIDITY: water before test value is 36.6 NTU and after test value is 22.8 NTU. The water has dangerously high turbidity and is not safe to drink and even after treatment it is still too high and requires further purification, the water also contains high salinity, which must be removed through desalination before drinking.

ALKALINITY: water before test value is 128.3 ppm and after test value is 58.6 ppm. Although alkalinity is in a safe range the water is still not safe drink due to high salinity and potential contamination seawater requires desalination (salt removal) before it becomes drinkable.

TDS: water before test value is 1947.13 and after test value is 1716.02. the water has very high TDS and is not safe for drinking, desalination (salt removal) is required to make it safe.

HARDNESS: water before test value is 6407 and after test value is 5109. The water is extremely hard and not safe to drink desalination (salt and mineral removal) is required before it consumed.

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