

## AI Based Hybrid Water Purifier for Rural People

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**Abstract** - India faces a growing challenge of providing clean water. Solar energy offers a sustainable and promising solution for water purification, particularly in rural areas, remote area and ocean water purification while fishing without access to reliable electricity. India faces a growing challenge of providing clean water. Solar energy is a clean, renewable resource available in most parts of the world. Unlike fossil fuels, it doesn't contribute to greenhouse gas emissions or air pollution. Solar-powered water purification systems operate independently of the electricity grid, making them ideal for rural or off-grid communities. Solar panels are affordable, and their long lifespan makes them a cost-effective investment in the long run. Solar energy can power various water purification processes, including solar disinfection and solar powered desalination. Reverse Osmosis method effectively remove harmful bacteria and viruses from water, making it safe for drinking and various purposes. It removes 95-99% dissolved salt reduction.

**Key Words:** Health, Purified Water, Cost efficient to rural people.

### 1. INTRODUCTION

The decreasing availability of water has necessitated in the search for fresh sources of drinking water. The available water in many areas in the country is brackish, saline or impure. Salinity is

a major problem in the coastal areas of Kutch and Gujarat. In our country pure drinking water is a major problem in tribal/rural area. There are many processes available for purification of drinking water like Chlorine tablets, Pot chlorination of wells, Slow and rapid sand filters, Fluoride removal, Reverse osmosis plants, etc. In this project, we are making a water purifier which works on solar energy. The basic principle behind this project is reverse osmosis.

We are using solar energy which is a renewable source, abundant and cheap. In case of power failures, this purifier will continue to work as solar energy can be stored. Here, we use microcontroller 328p for TDS Sensor. This purifier can be used in remote and rural areas where there is no electricity. It can also be used in places affected by natural disasters. It also reduces the salt content in sea water.

Access to clean and safe drinking water is a fundamental human right, yet millions globally, especially in rural and remote areas, face significant challenges in accessing this vital resource. The scarcity of potable water and the contamination of existing supplies pose severe health risks and impede socioeconomic development. Addressing this critical issue, renewable energy technologies offer promising and sustainable solutions, with solar power emerging as a particularly viable and ecofriendly option for water purification. The integration of solar energy with water treatment

technologies creates decentralized and off-grid systems that can deliver safe drinking water efficiently.

Solar-powered water purifiers harness the abundant and renewable energy of the sun to drive processes like filtration, disinfection, and desalination. The environmental benefits are significant as solar energy reduces reliance on fossil fuels and minimizes greenhouse gas emissions, promoting a cleaner and healthier environment. Additionally, the decentralized nature of solar-powered purifiers is particularly beneficial for remote and underserved communities, offering a reliable and independent water supply without the need for extensive infrastructure. Consequently, solar-powered water purification stands out as a crucial innovation in the global effort to ensure universal access to clean and safe drinking water, aligning with both human rights objectives and environmental sustainability goals.

## 2.1 METHODOLOGY

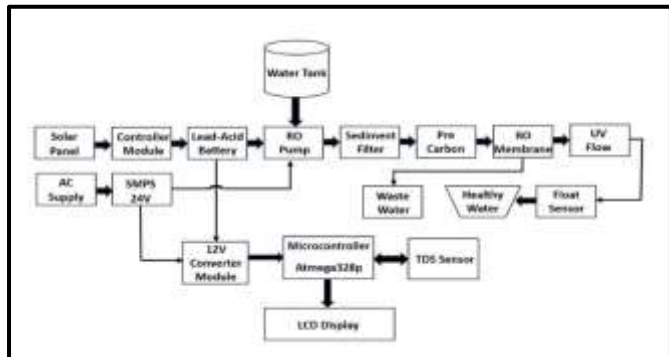


Fig.1 Block diagram of Solar Powered water purifier

**SOLAR PANEL:** Solar panels used in solar water purification systems are a key component responsible for converting sunlight into electricity. Here's how solar panels are utilized in such systems. Solar panels consist of photovoltaic cells that convert sunlight into electricity through the photovoltaic effect. In a solar water purification system, solar panels generate electricity to power various components such as pumps, sensors, controllers, and other electrical devices involved in the purification process.

**CONTROLLER MODULE:** A solar charge controller is a critical component in a solar power system that manages the charging of the battery from

the solar panels and protects the battery from overcharging and over-discharging. The solar charge controller receives DC electricity from the solar panels. The voltage and current produced by the panels vary with the amount of sunlight.

**LEAD ACID BATTERY:** A Lead Acid Battery can serve as a crucial component in a solar water purification system, especially in off-grid or remote locations where consistent power supply is needed. Here's how it can be utilized in such a system. Solar panels generate electricity during daylight hours when sunlight is available. However, this energy may not always match the demand for water purification, which can vary throughout the day or during periods of low sunlight. A 24V battery serves as an energy storage solution, storing excess energy generated by the solar panels during peak sunlight hours for later use when sunlight is unavailable or insufficient.

**POLLUTED WATER TANK:** A sediment filter plays a crucial role in purifying water from various sources, targeting specific impurities present in each. For polluted water, it effectively captures contaminants such as dirt and organic matter, enhancing the water's clarity and safety. In sand water, the filter acts as a barrier, preventing sand and granular particles from entering the plumbing system and causing damage or blockages. While not designed for desalination, the filter removes larger debris from saltwater, preparing it for subsequent filtration stages. In bore well water, the sediment filter efficiently traps silt, mud, and other particulates commonly found in such sources, safeguarding downstream equipment and improving overall water quality.

**SEDIMENT FILTER:** A sediment filter is an essential component in a reverse osmosis (RO) filtration system, playing a crucial role in the multi-stage purification process to ensure optimal performance and longevity of the system. This pre-filter stage is designed to remove particulate matter from the water, including dirt, sand, silt, and rust, which can otherwise clog and damage the more delicate and expensive RO membrane.

**PRE-CARBON FILTER:** A pre-carbon filter, often utilized in reverse osmosis (RO) systems, serves as a

crucial initial stage in the water purification process. It is typically made from activated carbon, which has a high surface area that effectively adsorbs a wide range of impurities. The primary function of the pre-carbon filter is to remove chlorine, chloramines, volatile organic compounds (VOCs), and other chemicals that can cause unpleasant tastes and odors in water. This is essential because chlorine, commonly used in municipal water supplies as a disinfectant, can degrade the RO membrane if not removed beforehand.

**RO PUMP:** In a solar water purification system, a Reverse Osmosis (RO) pump is a crucial component responsible for pressurizing the feed water and driving it through the RO membrane to separate impurities from the water. Here's how an RO pump is typically utilized in such systems. RO membranes require a certain level of pressure to effectively remove contaminants from the water. The RO pump pressurizes the feed water from a source such as a well, a storage tank, or a reservoir, ensuring that it meets the pressure requirements for optimal filtration.

**RO MEMBRANE:** Reverse osmosis (RO) membranes are a critical component of RO water filtration systems, designed to remove a wide range of contaminants from water, making it safe for consumption and use in various applications. These membranes are made from semi-permeable materials that allow water molecules to pass through while blocking larger molecules and ions, effectively filtering out impurities. The RO membrane functions based on the principle of osmotic pressure. In an RO system, water is forced through the membrane under high pressure, counteracting natural osmotic pressure. This process separates the water into two streams: purified water, known as permeate, and concentrated waste containing the removed contaminants, known as brine or reject water. The efficiency of this separation depends on the quality and properties of the RO membrane.

**WASTE WATER TANK:** In an RO (Reverse Osmosis) system, the wastewater tank serves a vital role in the purification process. As water passes through the RO membrane, impurities are removed,

leaving behind concentrated wastewater. This wastewater is directed into the tank for temporary storage. The tank helps regulate the flow of purified water, allowing it to accumulate for on-demand use while the concentrated wastewater is safely contained. When the purified water is needed, it is drawn from the tank, providing a continuous supply of clean, filtered water for various household or industrial purposes.

**Ultraviolet (UV) Light:** UV (Ultraviolet) light is commonly utilized in solar-powered water purification systems to enhance the disinfection process. In such systems, UV light is employed as a supplementary treatment stage to target and neutralize harmful microorganisms, including bacteria, viruses, and protozoa, present in the water.

**FLOAT SWITCH:** A float switch is a device used to detect the level of liquid within a tank or reservoir. In a solar water purification system, a float switch can serve several purposes. Float switches are commonly used to monitor the water level in storage tanks or reservoirs. In a solar water purification system, the float switch can detect when the water level in the storage tank drops below a certain threshold. This information can be used to trigger the operation of the system's water purification components, such as pumps or valves, ensuring that water purification processes are initiated when water is available.

## 2.2 WORKING PRINCIPLE

The solar-powered water purification system integrates multiple components to harness solar energy effectively and deliver clean water efficiently. Solar radiation is captured by photovoltaic panels, converting sunlight into electrical energy. This energy is then stored in a battery via a charge controller, ensuring a continuous power supply even during periods of low sunlight. The charge controller regulates the charging process, preventing the battery from overcharging and maximizing its lifespan. The battery powers various components, including the high-pressure motor, reverse osmosis (RO) system, and water tank.

Within the purification unit, the high-pressure motor plays a crucial role in creating the

necessary pressure for reverse osmosis, a process that effectively removes contaminants from the water. Additionally, the system incorporates UV sterilization for further purification. A microcontroller, such as the at mega 328P, is specifically dedicated to managing the TDS (Total Dissolved Solids) sensor. This sensor measures the concentration of dissolved solids in the water, providing feedback on water quality. Moreover, the system may integrate other sensors such as a float sensor for monitoring water levels. The float sensor prevents overflow by issuing a warning when the water tank reaches capacity.

Through this comprehensive process, impure water undergoes purification, with the microcontroller overseeing the TDS sensor to ensure optimal water quality. Notably, the system not only produces purified water for drinking but also utilizes waste water efficiently, minimizing resource wastage. By leveraging renewable energy and advanced purification technologies, this solar-powered water purification system represents a sustainable solution for addressing water scarcity and improving access to clean water, particularly in off-grid and remote areas. Its modular design and integration of smart control mechanisms make it adaptable to various environmental conditions and scalable for different community needs, ultimately contributing to enhanced public health, environmental conservation, and socio-economic development.

## RESULTS

We have developed a solar water purifier system that combines solar panels with water purification technology to utilize renewable solar energy for filtration and disinfection processes. The system comprises solar panels, a battery storage unit, and purification components like filters, UV lamps, or reverse osmosis units. This integrated setup ensures the delivery of clean, drinkable water, particularly in off-grid or rural areas, by harnessing the plentiful and sustainable energy provided by the sun. This solar water purifier design also incorporates a smart control system to optimize energy usage and ensure continuous operation even during low sunlight

conditions. By using solar energy, the system reduces dependency on conventional electricity, making it eco-friendly and cost-effective in the long run. The implementation process involves careful site assessment, installation of solar panels at optimal angles, and regular maintenance to ensure efficiency. This sustainable solution not only addresses water scarcity but also promotes environmental conservation and energy independence in remote areas. The project begins with assessing the water quality and energy needs to determine the appropriate purification technology and solar power capacity. Following this, the solar panels are installed to capture and convert sunlight into electrical energy, which is stored in batteries to ensure continuous operation even during low sunlight conditions.



Particular	TDS Value	EC Value	Purity of Water
Borewell Water	765	1.83	Impure
Salt Water	4340	4.15	Impure
Impure Water	960	2.11	Impure
Pure Water	78	0.19	Pure

Fig. 2 Automatic motor controller

Table1: TABLE OF WATER TDS AND EC VALUES

## 3. CONCLUSIONS

The conclusion of a project on solar-powered water purifiers underscores the transformative potential of this technology in addressing water scarcity and quality issues, particularly in rural and off-grid areas. Solar-powered water purification



systems harness renewable solar energy to operate various purification processes, offering a sustainable, efficient, and cost-effective solution for providing safe drinking water. Firstly, the environmental benefits of solar-powered water purifiers are significant. By utilizing solar energy, these systems reduce reliance on fossil fuels, thus decreasing greenhouse gas emissions and the overall carbon footprint. This aligns with global efforts to combat climate change and promotes the adoption of green technologies. Solar energy is abundant and renewable, making it an ideal power source for water purification, especially in regions with high solar irradiance. This shift towards renewable energy not only helps in mitigating environmental impact but also ensures a consistent and reliable power supply, which is crucial for the continuous operation of water purification systems. The economic advantages of solar-powered water purifiers are equally noteworthy. Although the initial investment in solar technology and purification systems may be higher compared to conventional methods, the long-term savings are substantial. Solar panels have low maintenance costs and a long lifespan, leading to reduced operational expenses over time. This cost-effectiveness is particularly beneficial for rural communities with limited financial resources. Furthermore, the decentralized nature of solar-powered systems means that they can be installed and operated independently of central power grids, reducing infrastructure costs and providing a viable solution for remote areas. From a health perspective, the deployment of solar-powered water purifiers has profound implications. Access to clean drinking water is fundamental to public health, and these systems effectively remove contaminants such as bacteria, viruses, and heavy metals, which are common in untreated water sources. By ensuring the provision of safe water, solar-powered purifiers help in preventing waterborne diseases, which are a major health burden in many developing regions. Improved water quality directly contributes to better health outcomes, reducing the incidence of illnesses and improving the overall well-being of communities.

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