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A Solar Water Purifier

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Abstract: Access to clean drinking water is a fundamental necessity for human health and well-being. However, many communities, particularly in rural areas, struggle with waterborne illnesses due to contaminated water sources. To address this issue, we intended to established a solar water purifier system in a village with contaminated well water. The system utilizes sediment filtration and ultraviolet light to effectively filter and sterilize the water as it is pumped to the village reservoir. Initial testing and evaluation have shown that the system effectively provides clean water to the community. Future field-testing and regular maintenance will be necessary to ensure the system's long-term effectiveness. The solar water purifier system provides a sustainable solution to the village's water treatment needs and has the potential to improve the health and well-being of the community for years to come.
Keywords: Pollution, Pure water, Rural area, Sustainable resource, Solar panel, RO technology.

I. INTRODUCTION

The project aims to address the issue of impure water and waterborne diseases, particularly affecting vulnerable populations such as the elderly and children. The focus is on purifying water using solar energy, which is especially beneficial in rural areas with insufficient electricity. Two methods, UV purification and the RO process, will be utilized for water purification.

The lack of pure water is attributed to water scarcity and contamination, caused by inadequate investment and maintenance of water systems. In developing countries, around 50% of drinking water is wasted due to leakage, illegal connections, and vandalism. Affluent individuals connected to the system receive subsidized drinking water, while the poor rely on expensive private sellers or unreliable sources. Access to safe water has a devastating impact on children worldwide, with factors including water shortage, poverty, and lack of education on the consequences of drinking contaminated water. A survey shows that approximately 2.2 million children die each year from waterborne diseases. The World Health Organization estimates that at any given moment, half of the developing world's population suffers from diseases caused by impure water and inadequate sanitation. The primary diseases include diarrhea, acariasis, dracunculiasis, hookworm, schistosomiasis, and trachoma. The economic impact on developing countries with a large proportion of people suffering from these diseases is significant. To tackle these challenges, the project aims to find sustainable and practical solutions for polluted water, with a focus on developing nations. Various water purification techniques, such as chlorination, distillation, boiling, sedimentation, and high-tech filters, have been used but face obstacles like high costs, maintenance requirements, fuel consumption, and unhygienic waiting periods. To overcome these challenges, the project proposes the development of an affordable and efficient water filter called Klar Aqua. This filter operates without electricity, is sustainable and environmentally friendly, easy to implement, and can be produced locally by artisans. It effectively eliminates bacteria, reduces turbidity, and shows potential for removing other contaminants from surface and groundwater. Additionally, the system eliminates the need for additional equipment to store purified water and can be customized to accommodate regional social and cultural considerations. A solar water purifier can resolve this problem within their reach. Though there is a lack of electricity in such urban areas, but the presence of plenty solar energy can be the source for the energy for operation a water purifier. Not only in urban area the solar water purifier can also be the sustainable purifier which will be the reduce the electricity burden in civilisation also.

II. LITERATURE SURVEY

Before this many researchers are working on this field. Among these few famous works are as follows which motivated us to involve in this field.

In 2005, Choo and his colleagues conducted a study on the removal of iron and manganese through ultrafiltration, as well as the process of membrane fouling. The study also examined the removal of residual chlorine resulting from pre-chlorination, which is commonly used to ensure safe drinking water. The oxidation of iron and manganese was found to be a major cause of membrane fouling, and was thoroughly visualized at a microscopic level. Steps were proposed to mitigate the degradation of the membrane caused by oxidation.

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In 2006, Takerlekkopoulou et al. conducted a study on the removal of iron from potable water using a combination of physio-chemical and biological methods. A model was constructed that included pilot testing and utilized a trickling filter. The oxidation of iron was achieved through both physio-chemical and biological means, and the chemical reactions and extent of oxidation were analysed in detail.

The study also examined the effect of temperature, optimal feed iron concentration, and volumetric flow rate on the process. The oxidation of iron followed first-order kinetics, while Monod-type kinetics were observed in the biological oxidation.

In 2007, Bordoloi et al. conducted a study on using banana residue ash for the removal of iron from water. They produced ashes from various materials including dry banana leaf, pseudo stem, rind, bamboo, and rice husk through controlled combustion. The removal mechanism involved the oxidation of iron at high pH or alkaline medium produced by potassium in banana, leading to the formation of potassium hydroxide.

The study analysed the chemical composition of banana ash and its effectiveness in removing iron from prefabricated water. Moreover, they applied it in a low-cost household water purification model in which the water was treated with ash and then filtered with a cotton cloth before use. XIn 2011, Ganvir and colleagues conducted a study on the removal of fluoride from groundwater using rice husk ash coated with aluminum hydroxide.

The surface of the RHA was activated by using activated aluminum hydroxide, which forms a complex with fluoride ions in water and enhances the removal process. The RHA was produced through controlled combustion of dried and crushed rice husks and treated with hydrochloric acid before activation.

In 2012, Chaturvedi conducted a comprehensive study on the removal of iron from drinking water, evaluating various methods such as electrocoagulation, oxidation-filtration, ion exchange, lime softening, activated carbon adsorption, BIRM media, anthracite, green sand, pebble and sand mixture, and ultrafiltration.

The study examined the effectiveness of each method, its advantages and limitations, and the economic feasibility of implementing it. The results of this study can help in selecting the most appropriate method for iron removal from drinking water in different contexts.

III. PROPOSED METHODOLOGY

In this paper we are proposing a better water purification method instead of tradition water purification method. The components of this method are as discussed below:

A. Solar energy & Solar panel

Solar energy has immense potential as a power source, with an estimated capacity of around 178 billion MW, which is 20,000 times the current global demand. However, its full-scale utilization is still limited. There are two primary methods to harness solar energy: thermal and photovoltaic. The sun provides an abundance of power, with solar radiation on the Earth's surface exceeding the worldwide power demand by a factor of 1,000. Solar energy can be utilized in various applications such as solar water heaters, solar cookers, and solar energy storage.

While solar energy holds great promise, there are challenges to overcome. Initial investment costs and intermittent energy generation due to weather conditions are notable obstacles.

Nonetheless, with advancements in technology and governmental support, solar energy has the potential to become a crucial renewable energy source in the future.

One practical application of solar energy is through the use of solar panels, which collect and store solar energy in batteries. This stored energy can be particularly beneficial in areas with limited access to electricity, including rural and remote regions, as well as areas affected by natural disasters. In such cases, the stored energy can be employed for water purification purposes.

To ensure efficient storage of solar energy, charge controllers are utilized to regulate the amount of energy stored in the battery. This prevents overcharging or undercharging, which can lead to reduced battery life or damage.

By using solar energy to power water purification systems, clean drinking water can be provided in areas where traditional energy sources are unreliable or unavailable. This has a significant impact on community health and well-being, particularly in developing countries facing challenges in accessing safe drinking water.

In conclusion, the use of solar energy for water purification is a vital application of renewable energy. Advanced technologies like charge controllers contribute to efficient and effective utilization of solar energy, enabling access to clean water in areas where traditional energy sources are limited.

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Figure 2: Solar Panel

B. Reverse Osmosis

Osmosis is a process by which solvent (water) flows from a region of low solute concentration to a region of high solute concentration when the two solutions are separated by a semi-permeable membrane. The pressure that drives this process is called osmotic pressure.

Reverse osmosis is a process in which a hydrostatic pressure greater than the osmotic pressure is applied on the high solute concentration side, causing the solvent to flow in the opposite direction, i.e., from a region of high solute concentration to low solute concentration through the semi-permeable membrane. This process results in the separation of pure water from salt water, as the salt and other solutes are left behind.

Reverse osmosis is widely used for water purification, particularly for desalination of seawater or brackish water. The technology is also used in a variety of industrial and commercial applications, such as the production of ultrapure water for semiconductor manufacturing and the treatment of wastewater.

Overall, reverse osmosis is an effective and efficient process for producing clean water from salt water, and its versatility and scalability make it an important technology for meeting the growing demand for clean water in a sustainable manner.

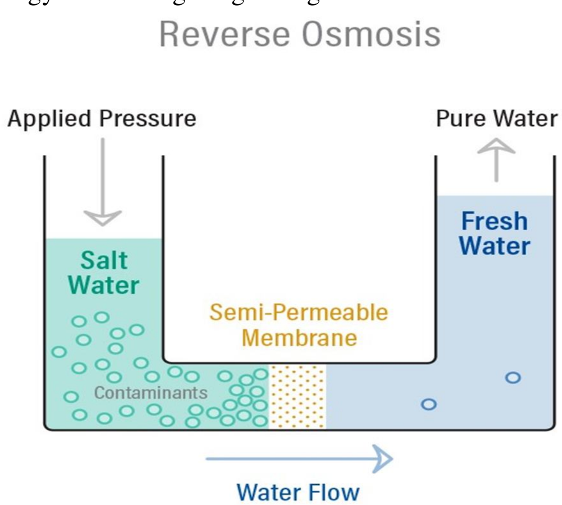

Figure 3: Reverse Osmosis

C. UV Purification

Ultraviolet (UV) radiation is a form of electromagnetic radiation that is not visible to the human eye. It has a shorter wavelength than visible light and carries more energy. Due to its high energy, UV radiation can have various effects on materials and organisms. When exposed to UV radiation, it can break bonds between atoms and molecules, leading to chemical alterations in the exposed substances. UV light also has the ability to induce fluorescence in certain materials.

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In the context of the UV treatment process, it is a rapid physical process that brings about a rearrangement of the genetic material, known as DNA, in microorganisms. This rearrangement renders the DNA inactive and prevents the microorganisms from causing infections or reproducing. The UV treatment process is effective in disinfecting water or air by deactivating microorganisms such as bacteria, viruses, and protozoa.

UV treatment is widely used in various applications, including water and waste water treatment, air purification, and surface disinfection. It is considered a reliable and efficient method for reducing the risk of infections caused by microorganisms. The UV treatment process acts quickly and does not involve the use of chemicals, making it a valuable tool in maintaining clean and safe environments.

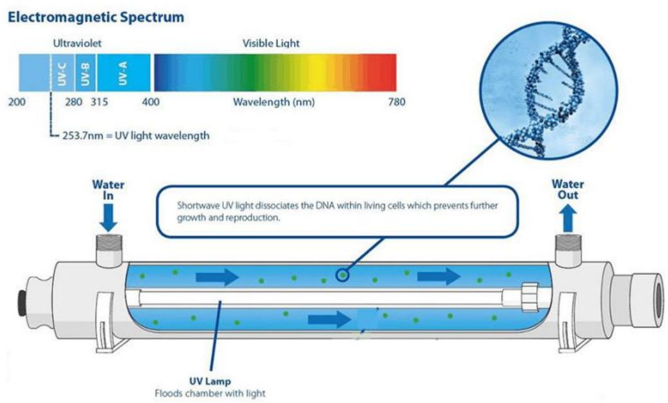

Figure 4: UV Water Purification

IV. BLOCK DIAGRAM

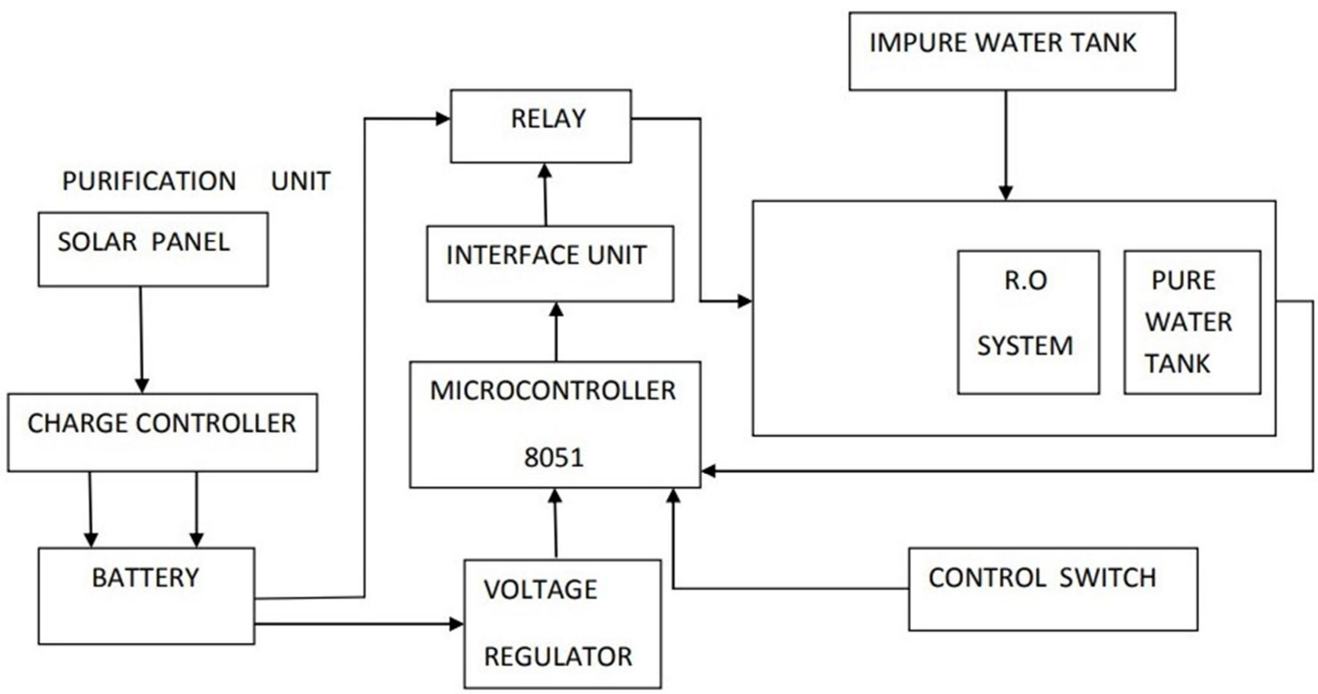

Figure 5: Block Diagram of the system

Solar radiation is collected by a solar panel to harness energy from the sun. This energy is then stored in a battery using a charge controller, which regulates the charging process to prevent overcharging of the battery. The battery is connected to a purification unit via an electromagnetic relay.

The purification unit consists of various components, including a high-pressure motor, a reverse osmosis (RO) system, and a water tank. The high-pressure motor generates the necessary pressure required for the reverse osmosis process, which is crucial for water purification. The RO system employs a semipermeable membrane to remove impurities and contaminants from the water, producing purified water.

The microcontroller, specifically the 8051 microcontroller, plays a key role in this system. It monitors the water level in the impure water tank and interfaces with the control switch. By keeping track of the water level, the microcontroller prevents the tank from overflowing, ensuring that the purification process operates smoothly. It also facilitates the control and coordination of various system components.

To power the microcontroller, a voltage regulator is employed. The voltage regulator converts the battery's 24V output to a stable +5V, which is the required voltage for the microcontroller's operation.

Ultimately, through this process, the solar energy collected by the solar panel is utilized to power the purification unit, which includes the high-pressure motor and the RO system. The microcontroller ensures efficient and safe operation by monitoring the water level, preventing overflow, and facilitating system control. The result is purified water stored in the water tank for further use.

V. CONCLUSION

As all the resources used to generate electricity are limited, the future poses a significant challenge in terms of energy resource availability. However, solar energy emerges as a promising solution that can address this limitation. Unlike coal and other fossil fuels, solar energy is a sustainable and renewable resource. By harnessing the power of the sun, we can overcome the challenges posed by finite energy resources.

One of the key advantages of solar energy is its applicability in various scenarios. In addition to being used as a primary source of electricity generation, solar energy can also be harnessed to power water purification systems. This becomes particularly relevant in rural areas and disaster-stricken regions where access to clean and safe drinking water may be limited.

Solar-powered water purifiers offer a sustainable and cost-effective alternative to traditional methods. By utilizing the inexhaustible natural source of solar energy, these purifiers can operate without relying on electricity grids or fuel-dependent systems. This not only makes them environmentally friendly but also significantly cheaper than other purification methods.

One effective technique employed in solar water purifiers is reverse osmosis. Reverse osmosis is a reliable disinfection process that can remove a wide range of contaminants from water, including bacteria, viruses, and impurities. By utilizing this process, solar purifiers can ensure access to clean and safe drinking water, promoting public health and well-being.

Furthermore, the implementation of solar water purifiers has significant economic advantages. While the initial installation may require a capital investment, the operational costs are minimal. Unlike conventional purifiers that rely on ongoing energy expenses or the purchase of purifying agents, solar-powered systems leverage the natural energy of the sun without any additional costs. This makes them highly affordable and accessible to all segments of society, including those with limited financial resources.

In conclusion, solar energy presents a sustainable and practical solution to the challenges posed by the limitation of energy resources. By harnessing the power of the sun, we can not only generate clean electricity but also provide access to safe drinking water through solar-powered purification systems.

The affordability, environmental friendliness, and effectiveness of solar purifiers, coupled with the reliable disinfection process of reverse osmosis, make this technology an asset for the near future.

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