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Automated Water Purification System Using Solar Energy

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Abstract: The increasing demand for clean and accessible water, combined with the need for sustainable energy solutions, has led to the development of an Automatic Water Purification System powered by solar energy. This system utilizes solar panels to harness renewable energy, driving a series of filtration and purification processes to ensure safe drinking water. The system incorporates a combination of physical, chemical, and biological treatment methods, including sediment filtration, activated carbon adsorption, and UV sterilization, all of which are controlled and monitored by an automated system. The automation aspect allows for real-time monitoring of water quality, flow rates, and energy consumption, ensuring optimal performance and efficiency. This system not only provides an eco-friendly solution to water purification but also offers a sustainable, off-grid option for rural or remote areas with limited access to electricity. By integrating solar energy and automation, the system aims to reduce dependency on traditional energy sources, lower operational costs, and improve access to clean water, contributing to public health.

I. INTRODUCTION

Access to clean and safe drinking water is a critical issue faced by many regions across the world, particularly in rural and remote areas where infrastructure for water treatment is limited or non-existent. Traditional water purification methods often rely on electricity and mechanical systems that can be costly, energy-intensive, and difficult to maintain in off-grid locations. In this context, there is a growing need for alternative, sustainable solutions that provide reliable and efficient water purification while minimizing the environmental impact.

Solar energy, a renewable and abundant resource, offers a promising solution to address both water purification and energy needs in remote areas. The use of solar power for water treatment systems presents several advantages, such as low operating costs, ease of maintenance, and reduced carbon footprint. Moreover, integrating automation into these systems enhances their efficiency, ensuring continuous monitoring, optimal performance, and minimal human intervention.

The Automatic Water Purification System powered by solar energy is designed to combine renewable energy with advanced filtration and purification technologies, offering a reliable and eco-friendly alternative for producing clean drinking water. This system utilizes solar panels to generate electricity, which powers a series of purification processes such as sediment filtration, activated carbon adsorption, and UV sterilization. By incorporating automation, the system ensures consistent water quality, real-time monitoring, and the ability to adapt to changing conditions. This innovative approach aims to address water scarcity, reduce reliance on conventional energy sources, and improve public health by providing a sustainable solution to water purification in underserved areas.

II. PROJECT AIM AND PLAN

The primary aim of this project is to design, develop, and implement an automatic water purification system that utilizes solar energy as a renewable power source. The system aims to provide a sustainable and eco-friendly solution to address water purification challenges, especially in areas with limited access to clean drinking water or unreliable power sources. By incorporating automation and solar energy, the project seeks to improve water quality, ensure safe drinking water, and contribute to environmental sustainability.

III. RENEWABLE ENERGY

Renewable energy is energy produced from sources that do not deplete or can be replenished within a human's life time, the most common examples include wind, solar geothermal, biomass and hydropower. This is in contrast to non-renewable sources such as

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fossil fuels. Renewable energy often provides energy in four important areas: electricity, generation air and water heating, transportation and rural (off-grid) energy services. Globally, there are an estimated 7.7 million jobs associated with the renewable energy industries with solar photovoltaic being the largest renewable employer. As of 2015 worldwide, more than half of new electricity capacity installed was renewable. Renewable energy sources exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation and economic benefits.

IV. RENEWABLE ENERGY SOURCES

1. Solar
2. Biogas
3. Wind
4. Tidal
5. Geothermal

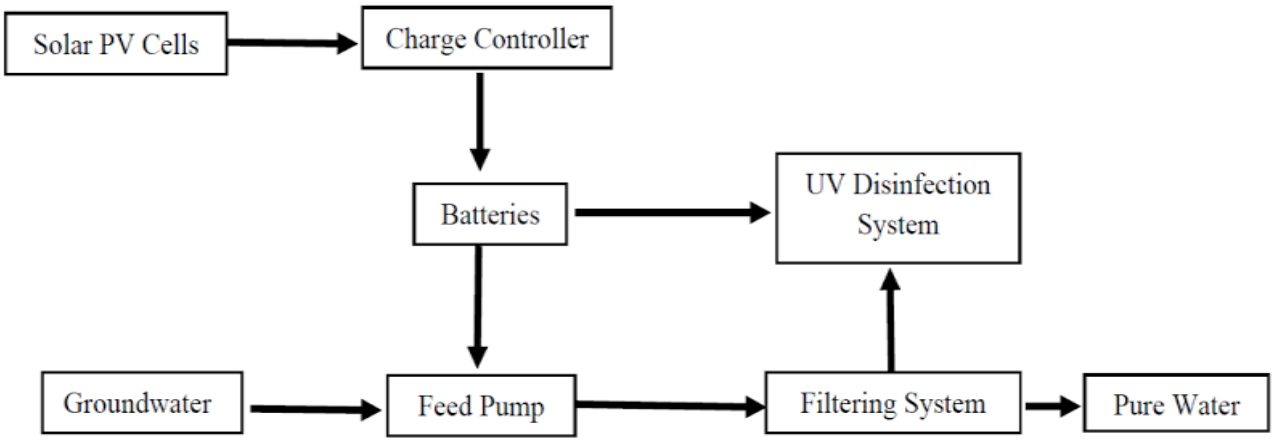
V. SOLAR ENERGY

The Sun is the source of heat and light. The produces heat by various nuclear fusion reactions. As the thermal energy radiated by the sun inexhaustible this energy is called as renewable source of energy. The diameter of the sun is 1.39 * 10 ^ 6 * km The diameter of the earth is about 12000km and the mean distance between the sun and the earth is 1.49 * 10 ^ 0 km. The sun subtends an angle of 32 minutes at the earth surface therefore earth receives the radiations with parallel rays.

VI. LITRETURE REVIEW

The need for clean drinking water remains one of the most pressing global challenges, particularly in areas with limited access to conventional water treatment infrastructure. The integration of renewable energy sources, such as solar power, into water purification systems has emerged as a promising solution to address this issue. This literature review examines existing research and technologies related to solar-powered water purification systems, focusing on the efficiency, sustainability, and advancements in automation and renewable energy applications.

VII. BLOCK DIAGRAM



Solar panel: A solar panel is a device that converts sunlight into electricity by using photovoltaic (PV) cells. PV cell are made of materials that produce excited electrons when exposed to light. These electrons flow through a circuit and produce direct current (DC) electricity, which can be used to power various devices or be stored in batteries. Solar panels are also known as solar cell panels, solar electric panels, or PV modules

Charge controller : A charge controller is a device that regulates the voltage and current that goes from a power source to a battery. it's also known as a charge regulator or battery regulator.

Battery : A battery is a device that stores chemical energy and converts it to electrical energy. Batteries are used many devices,
Inverter : An inverter can be defined as it is a compact and rectangular shaped electrical equipment used to convert direct current

(DC) voltage to alternating current (AC) voltage in common appliances. The applications of DC involves several small types of equipment like solar power systems.

Dirty tank : Unpolluted water means water of quality equal to or better than the effluent criteria in effect or water that would not cause violation of receiving water quality standards and would not be benefited by discharge to the sanitary sewers and wastewater treatment facilities provided.

RO (Reverse Osmosis) : The RO process, or Reverse Osmosis process, is a water purification method that uses pressure to remove contaminants from water. The process uses a semipermeable membrane that only allows water molecules to pass through.

UV lamp : Ultraviolet (UV) rays are part of the light that comes from the sun. The UV spectrum is higher in frequency than visible light and lower in frequency compared to x-rays. This also means that the UV spectrum has a longer wavelength than x-rays and a shorter wavelength than visible light; the order of energy, from low to high, is visible light, UV, than x-rays.

Pure water tank : Ultraviolet (UV) rays are part of the light that comes from the sun. The UV spectrum is higher in frequency than visible light and lower in frequency compared to x-rays. This also means that the UV spectrum has a longer wavelength than x-rays and a shorter wavelength than visible light; the order of energy, from low to high, is visible light, UV, than x-rays.

VIII. POTENTIAL ENERGY

The energy emitted by the Sun in space is 3.7 x 1025 watts. Out of which 5x10-19th part of the solar energy is received by the earth which is equivalent to the 107 x 1017 watts. The energy emitted by the Sun within 3 minutes is equivalent to the world energy consumption during a year. Thus the importance of the solar energy is justified and it would full fill the major requirement of demand of energy in next few years.

Most of the solar radiation reaches the earth as electromagnetic waves about 0.25 to 3 μ wave length. About half of these radiations are visible as light and the rest is infrared which accounts for heat. The intensity of the solar radiations is reduced by clouds, dust, etc. The intensity of solar energy in India is approximately 1.12 km/m² and the monthly average solar energy in India is 50 kJ/cm³/month (as per the metrological department of India).Solar energy has three attractive characteristics, first the Sun is essentially an infinite source of energy, second this energy is available to all nations and third this can be harnessed with minimum detrimental effects on the environment.

IX. SOLAR CONSTANT

TThe solar constant is the amount of solar radiation received per unit area at a distance of one astronomical unit (AU) from the Sun, which is approximately the average distance between the Earth and the Sun. It is a key value in understanding the Earth's climate and energy balance

X. CONCLUSION

solar-powered water purification systems present a highly promising and sustainable solution to address the global water scarcity issue, particularly in remote and off-grid areas. By leveraging renewable solar energy, these systems can efficiently purify water without relying on conventional power grids, providing a cost-effective and eco-friendly alternative. Various water purification technologies, such as reverse osmosis, UV disinfection, and activated carbon filtration, can be successfully integrated with solar power, offering flexibility in meeting different water treatment needs.

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