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SOLAR-POWERED WATER PURIFICATION: GREEN TECHNOLOGY FOR CLEAN DRINKING WATER

This research examines the application of solar energy for water purification in regions with limited resources and infrastructure. The work focuses on analyzing affordable and environmentally sustainable solar-powered water purification systems that can be implemented in rural communities facing water scarcity and contamination issues. The field has developed promising modular systems that combine several green technologies: solar photovoltaic panels, membrane filtration, ultraviolet disinfection, and solar thermal components.

A typical experimental setup uses a 100W solar panel array connected to a control system that optimizes energy distribution between the filtration pump, UV-C LED disinfection chamber, and monitoring equipment. The multi-stage filtration system includes sediment pre-filtration, activated carbon filtration, and a semi-permeable membrane for removing contaminants of various sizes. Water quality is evaluated before and after treatment using standard methods for measuring turbidity, microbial content, dissolved solids, heavy metals, and organic compounds.

According to research results, the most effective systems demonstrate removal of up to 99.5% of bacterial contaminants (including E. coli (Escherichia coli) and coliform bacteria), 95% of common chemical pollutants, and significant reduction of turbidity from an average of 25 NTU (Nephelometric Turbidity Units) to below 1 NTU. Purification productivity ranges from 5-7 liters per hour during optimal sunlight conditions, sufficient for a small family's daily drinking and cooking needs. During cloudy conditions, integrated battery storage provides approximately 60% of maximum capacity.

One significant advantage of such systems is their ability to function without chemical additives, eliminating the need for continuous supply chains that are often unavailable in remote areas. Cost analysis shows that modern designs are 60% less expensive than commercial alternatives, with an estimated production cost of approximately $120 USD per unit when manufactured using locally available materials. Modular designs allow for easy maintenance by users with minimal technical training, and component lifespan testing shows minimal performance degradation over the equivalent of three years of daily operation.

Environmental impact assessment indicates that solar water purification systems can prevent approximately 1.2 tons of CO_2 (Carbon Dioxide) emissions per year compared to equivalent water treatment using fossil fuel-powered equipment or the transportation of bottled water. Additionally, by eliminating the need for single-use plastic bottles, each unit potentially prevents over 7,300 plastic bottles from entering the waste stream annually.

Solar water purification technologies contribute to achieving UN (United Nations) Sustainable Development Goal 6 (Clean Water and Sanitation) through the application of green chemistry principles and renewable energy. Promising directions for further research include optimizing systems for specific contaminants common in different geographical regions and developing community-based manufacturing and distribution networks.

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