

Experimental Design of a Solar-Heated Water Displacement Pump

The goal of this master's graduation project is to perform an experimental design of a Shape Memory Alloy (SMA) driven solar-heated water displacement pump focused on its implementation in areas lacking access to safe drinking water, particularly in developing countries.

This is motivated by the identified opportunity of using Shape Memory Alloys as the working medium to transform low-grade heat energy into mechanical energy.

The research begins by examining the dire situation faced by the two billion people lacking safely managed drinking water (WHO/UNICEF JMP, 2023). This is done by looking closer at the factors influencing water supply, considering needs and the context in which these affected people live.

The contextual analysis examining the dire situation faced by the two billion people lacking safely managed drinking water motivated the need to develop a solar-powered water

pump system designed to effectively, reliably and sustainably bring safe drinking water from improved water sources to households in the most affected regions of the world.

To address this need, existing pumping systems that are currently used or have the potential to mitigate this problem were studied and evaluated.

By carefully examining the most recent advancements in relevant water pumping technologies for this contextual application, the opportunity to use Shape Memory Alloys for converting low-grade heat energy into mechanical energy was identified.

Having identified the problem and understood its context, analysed the existing solutions and identified a potentially disruptive hypothesis, an innovative system of an affordable, robust, and scalable solar-heated water displacement pump was designed.

In addition, the design was validated with a high-fidelity prototype with which experiments were done to

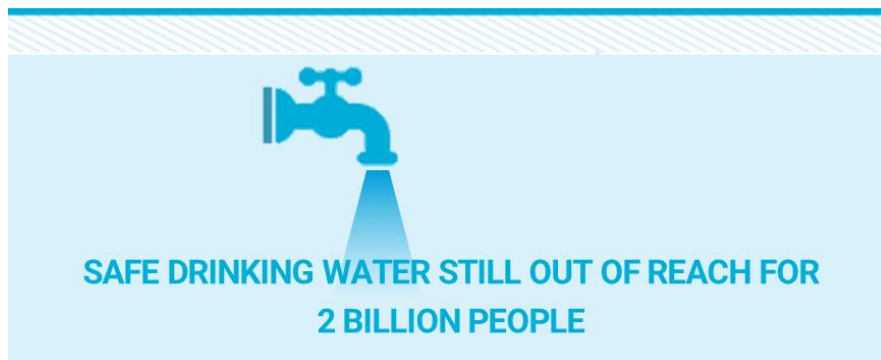
successfully prove the concept's working principle.

This prototype elegantly integrates a shape memory alloy in a solar collector using the absorbed heat to contract the wire. This elongation is associated with a force that is used to drive the piston of a displacement pump to pump water. To do this cycle repeatedly, a fraction of the pumped water is used to cool the Shape Memory Alloy, making it reversibly return to its initial state and restarting the cycle.

The successful proof of concept aligns with the established objectives of simplicity and affordability as its potential for scalable cost-effective manufacturing was demonstrated.

Thus, the present work lays the foundation for future research and developments on this innovative working principle, making it a valuable contribution to this life-changing field.

It is impressive how something so simple that pumps one small volume of water at a time can solve such a dire global issue.



6 CLEAN WATER AND SANITATION

ENSURE AVAILABILITY AND SUSTAINABLE MANAGEMENT OF WATER AND SANITATION FOR ALL

TARGET 6-1	TARGET 6-4	TARGET 6-5
SAFE AND AFFORDABLE DRINKING WATER	INCREASE WATER-USE EFFICIENCY AND ENSURE FRESHWATER SUPPLIES	IMPLEMENT INTEGRATED WATER RESOURCES MANAGEMENT



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