Regionalgruppe Darmstadt

Research Project
Solar Thermal Water Disinfection (SoWaDi) Unit

Project ID	DEU-IOG02
Location	Darmstadt, Deutschland Region Kilimanjaro, Tansania
Target Group	Families, schools and communities with access to microbiologically contaminated water
Partner	Kilimanjaro Childlight Foundation, Tansania
Details	www.sowadi.de/en/ https://www.ingenieure-ohne-grenzen.org/de/unsere-arbeit/projekte/forschungsprojekt-solarthermische-wasserdesinfektionsanlage-sowadi
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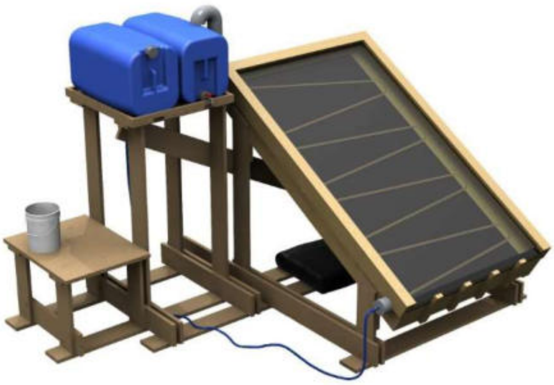

Virtual Model of the developed SoWaDi Unit.

Contaminated drinking water is a major problem for the health of the local population in many countries. Especially in large parts of Africa and Southeast Asia, many people do not have access to clean drinking water and are therefore dependent on water treatment measures. Boiling water is the most widespread method of destroying harmful germs and pathogens. However, boiling over a fire is often associated with high energy costs and environmental and health damage due to deforestation and smoke emissions.

Project Description

Our aim is to give people access to germ-free water and protect them from common diseases caused by microbiologically contaminated water by distributing the SoWaDi unit developed by us. For this purpose, a construction manual was published and is available free of charge. The unit developed by us sterilizes microbiologically contaminated water solely with the help of solar energy. In doing so, no electrical energy or chemical additives are used. The unit is designed in such a way that water to be boiled is continuously heated. Even in the event of a defect, only water that has been sufficiently heated can leave the system. All materials used are resource efficient, locally available and as cheap as possible. The construction of the unit is designed to be as simple as possible so that it can be carried out with a few simple tools using the construction manual. This means that the unit can be constructed by the workers themselves or with the support of local craftsmen.

In the first project phase from 2010 to 2014, three prototypes were initially designed, laid out and built in Germany. On the one hand, various design and production variants were tested and on the other hand, thermal and microbiological tests were carried out. In cooperation with the Darmstadt wastewater treatment plant, the functional principle of the plant was successfully validated in 2014. In the second project phase from 2015 to 2018, a construction manual was developed. Finally, a first practical test was carried out in Tanzania at the beginning of 2017. In cooperation with the Malage Vocational Training Centre, which is located in the Kilimanjaro region of Tanzania, two systems were set up by students with the help of the construction manual. The comprehensibility of the instructions was tested. Furthermore, our requirement to use only locally available materials was successfully tested. In June 2018, the changes made as a result of the practical test were tested in Darmstadt, with particular attention paid to the comprehensibility of the instructions.

Current Project Status

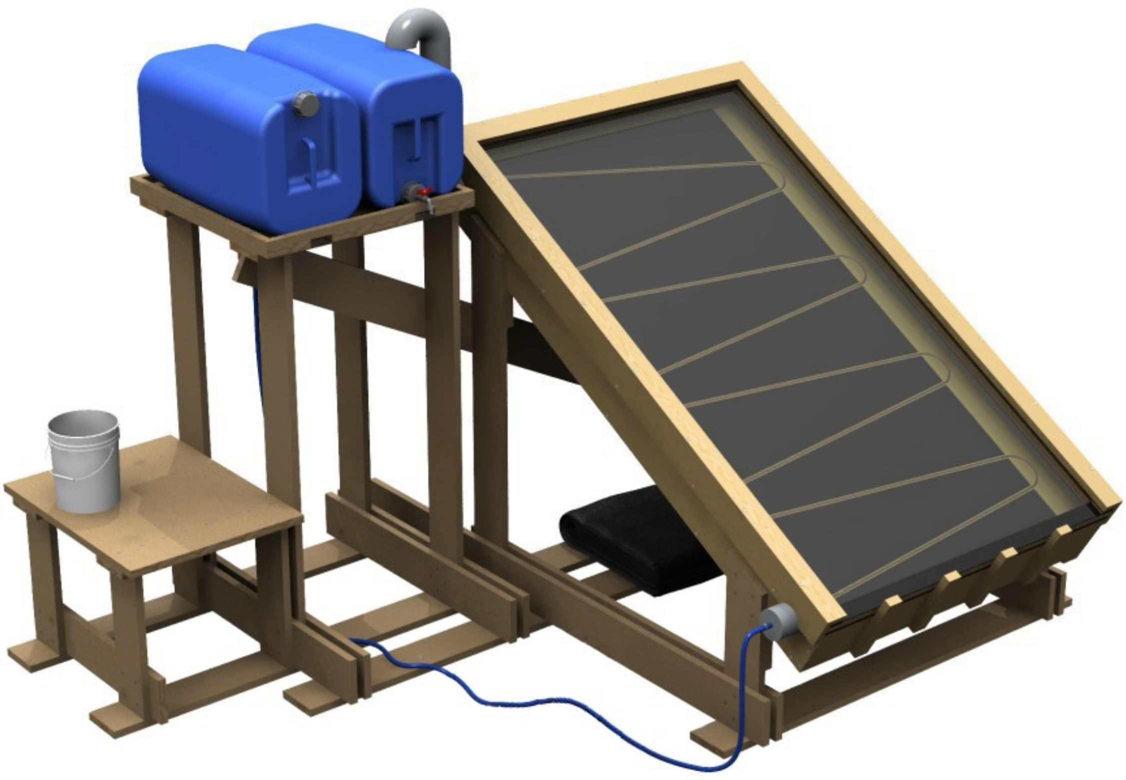
During the current project phase we want to ensure that the SoWaDi unit will work in the long term. For this purpose, two test facilities were set up on the experimental field of the TU Darmstadt in April 2021, whose parallel operation enables the direct comparison of design changes. The units will be characterized more precisely by means of a microcontroller-based monitoring system, which was developed in collaboration with the Technical University from spring to summer 2020. The test units in Darmstadt particularly support the acquisition and evaluation of long-term data. Furthermore, they serve the further technical development of the unit and support communication with project partners in Tanzania. Thus, technical improvements can be directly tested and quantified with regard to their efficiency.

Furthermore, at the beginning of 2020 four new units were built in Kidia, District Old-Moshi - Tanzania with the support of four members of our project team from Darmstadt. Two existing units at the Malage - Vocational Training Centre were adapted. A total of six test units are now being operated in Tanzania. In addition to the build of the units, a market analysis was carried out to gather information on possible distribution strategies for the technology. This will now be evaluated and will serve as a basis for the selection of a suitable distribution strategy in the 4th project phase.

The current test phase for long-term operation of the units will continue for several years. In the meantime, constant contact with the users on site will ensure that we receive information about the operation of the units and possible challenges. In cooperation with the state water supply and disposal company of Moshi and the surrounding area (MUWSA), regular checks are carried out on the quality of the water before and after treatment by the SoWaDi Units. The data collected in Tanzania is processed and analyzed. If problems arise, we work with the users and our local project partner, the Kilimanjaro Childlight Foundation, to find solutions together. If the test phase (current, 3rd project phase) is successfully completed, the SoWaDi project will be transferred to the distribution phase (4th project phase).

Solar thermal water disinfection system (SOWADI)

Product data sheet



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Status November 8, 2020

1 Application, liability

This is a product data sheet which summarizes the characteristics and general conditions of the solar thermal water disinfection system as it is built according to the associated instructions. The following information is intended for understanding and as a basis for planning. Due to the large number of unpredictable influences, the information is intended as a guide and not as guaranteed performance figures.
Due to the limitations described in the following chapters, the equipment does not ensure that the water is potable after it has flowed through the equipment. The author does not guarantee the function of the equipment and is not liable for damage to property or persons caused by equipment built according to the instructions or by the activities described in the construction manual.

2 Important applicable documents

The following documents can be obtained from the Darmstadt regional group of Engineers without Borders.
e.V. can be obtained. A way to contact the group is on the first page of this document.

- Construction drawings / CAD model
- Calculation documents, simulation results
- Test results of the microbiological tests
- Building instructions for the users
- Operating and maintenance instructions for users

3 Task

Starting from rainwater available in cisterns or in other ways, the plant shall reduce the microbiological load of the water by means of solar thermal heating. The plant developed for this purpose shall be producible with local materials and simple tools, supported by the published construction manual.

4 Technical realization

4.1 Principle sketch

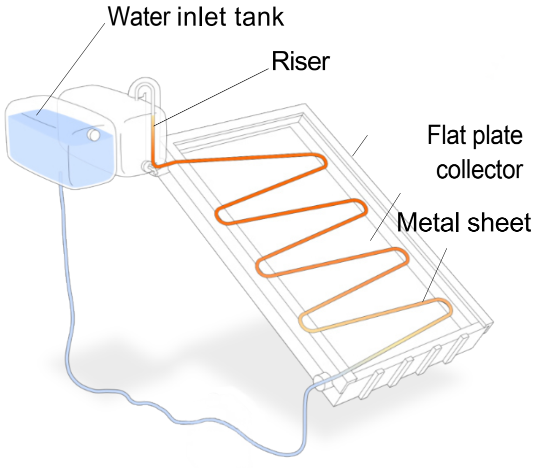

Figure 1: Schematic of the plant

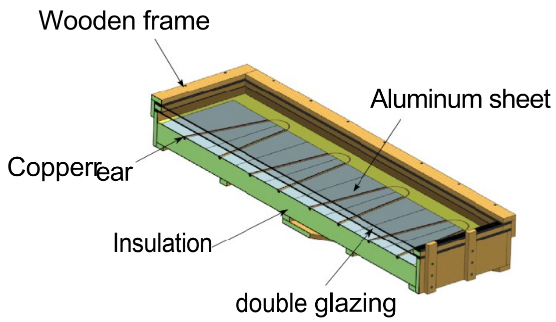

Figure 2: Longitudinal section through the system

4.2 Functional description

The thermal treatment of the water is done solely by solar radiation. A flat plate collector is used for heating. This technology is already established worldwide. For the control of the water output, a new concept was developed, the corresponding process of which is schematically shown in figure 3.

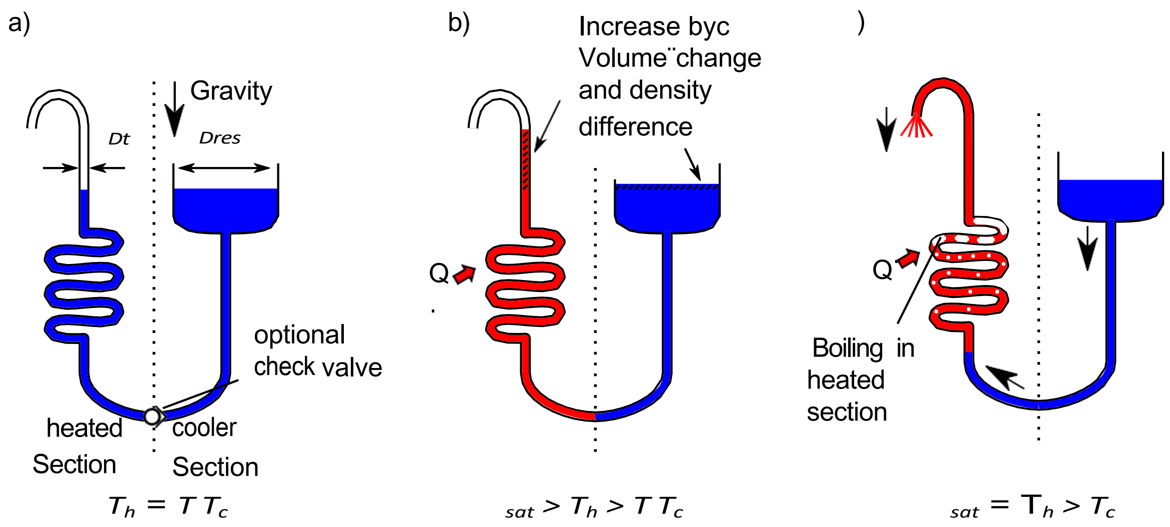

Figure 3: Concept for controlling the water discharge

The hydrodynamic system shown there can be divided into two areas. On the one hand, there is a cool area in which a reservoir with the water to be treated is located (Fig. 3, right side). On the other hand into a heated area, which is connected to the cool area and in which the water to be treated is heated. Figure 3a shows the initial condition. At homogeneous temperature, the water level is (approximately) the same according to the principle of communicating tubes. After a heating process (fig. 3b), a part of the water is evaporated in the hot section (fig. 3c). Since the pipes in this section have a sufficiently small diameter, the water vapor cannot leave the system prematurely by rising. Due to the difference in density between the cold and hot sections (including water vapor), hot water is forced out of the pipe system by gravity together with the water vapor (In Fig. 3c, shown by the black arrow in the upper left). Then cold water flows from the reservoir into the heated area and the process starts again (Fig. 3a).
The heated area is integrated into the flat absorber. A schematic representation is shown in figure 1 given. A more detailed description of the operating principle and the dimensioning of the system as well as of individual components can be found in the following publication, which is freely available online:

Dietl, Jochen ; Engelbart, Hendryk ; Sielaff, Axel (2015). *A Novel Type of Thermal Solar Water Disinfection Unit.* http://tuprints.ulb.tu-darmstadt.de/4460/.