# 5 Technical requirements

## 5.1 Environmental conditions

**Storage temperature** 0° C ... 70 C°
At temperatures below freezing point, the system must be drained. If the system is not used, it must be covered to prevent it from heating up excessively.

**Working (ambient) temperature** ≥ 5 C°

**Surface, angle of inclination, solar radiation**

- The angle of inclination of the plant with respect to the ground surface is 20° depending on the location. . . 30° (e.g. Germany).
- If the base construction from the appendix of the construction manual is used, a flat base is required
- During operation, free solar radiation must be guaranteed for as long as possible during the entire day.

**Resistance to pest infestation**
If there are any pests on site, the equipment must be protected against infestation of the wood and dam material (e.g. by treatment of the wood, construction of the metal base, or mounting on other objects on the property).

## 5.2 Neighboring systems

Further information is required in addition to the installation:

- 1 stand (construction suggestion is enclosed with the instructions)
- 2 canisters incl. closing tap, approx. 60 L. For the construction, canisters with the following dimensions were used (as shown on the cover picture) WxHxD: 30 cm x 45 cm x 60 cm.
- Container for filling the inlet tank with contaminated water
- Container with a narrow opening and/or tap for drawing off water. This collection tank should be completely drainable to avoid recontamination of stagnant water.
- Cover for the equipment so that it does not overheat after shutdown (e.g. an opaque tarpaulin).
- Means for cleaning the containers

## 5.3 Structure

**Partial procurement and assembly**
Parts procurement and assembly are carried out on site. If necessary, the water-transferring parts must be cleaned before initial start-up.

**Tool**

- Hammer
- S¨age
- Drill, for wood and metal (manual or electric)
- Screwdriver (manual or electric)
- Screwdriver or pliers (for building the tools)

In addition, tools are required for bending sheet metal and tubes. Many workshops have sufficient equipment at least for sheet metal bending. If no tools are available for these two purposes, the instructions include appendices for making your own tools using the tools listed above.
If the materials are not available in the specified state (size, shape), additional tools may be necessary.

### 5.3.1 People

**Quantity** ≥ 3
At least three persons are required for the assembly. If more than 3 people are working on the setup, sections can be worked on in parallel, which can shorten the time for the setup.

**Knowledge**

- no special training required
- extended basic technical understanding
- Ability to understand technical drawings
- certain manual aptitude
- routine handling of the listed tools

### 5.3.2 Area, duration, costs

**Area for construction** ≈ 20 $m^2$
**Duration of the construction** ≥ 2 days
If all materials are available, a skilled team can set up the system in about two days.

**Cost of materials** ≤ 200 € ... 300 €
The costs for the material depend strongly on the local prices.

# 6 Technical data

The technical data depend on the selected size of the unit. The following data refer to the dimensions selected in the manual.

## 6.1 Dimensions

**Weight** approx. 95 kg
The system weighs approx. 95 kg (empty, without neighboring systems). Of this, 40 to 45 kg falls on the glass panes alone.

**Size** (WxHxD)
without stand: 135 cm x 55 cm x 195 cm
with stand: 270 cm x 200 cm x 190 cm

## 6.2 Power

**Water volume** ≤ 30 L/d ... 40 L/d
The treated daily amount of water is strongly dependent on the ambient conditions. For orientation, Fig. 4 shows our record of the water output of a test facility in Darmstadt (top in blue). The weather was very changeable, which can be seen from the available solar energy per day (below in orange). The maximum throughput was about 25 L/d. Plants in Tanzania have reached a maximum throughput of about 37 L/d.

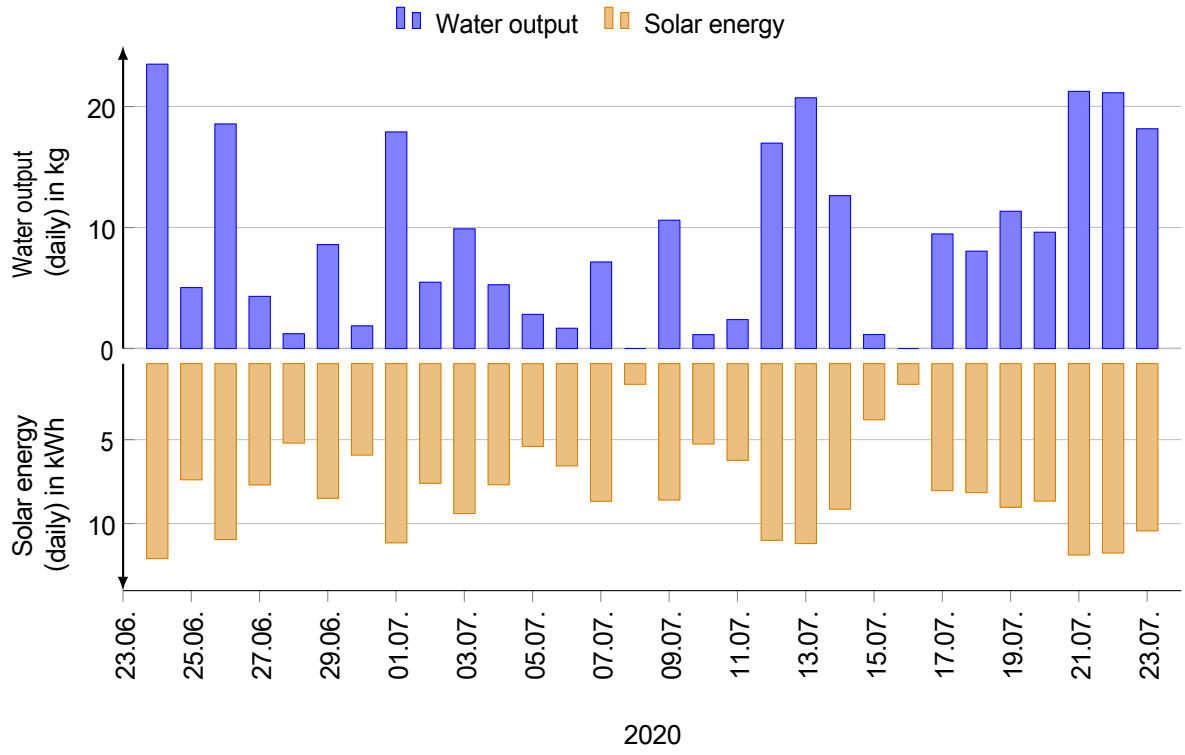


Figure 4: Daily water output (top) compared with the daily available solar energy (bottom) at the test facility in Darmstadt.

**Shelf life of the water** ≤ 1 day
Since boiling off is a selective treatment, depending on the storage conditions, the treated water may become reconaminated relatively quickly. Therefore, the discharged water should be consumed within one day.

## 6.3 Water quality

More detailed information about the investigated parameters, limit values and the reduction performance of the plant can be found in the following elaboration of a bachelor thesis:

> Thiemann, Fabian (2015). *Investigation of the operability of a small-scale and solar thermal drinking water treatment plant*. Technische Universit¨at Darmstadt.

If interested, please contact the email address on the first page of the document.

### 6.3.1 Water quality at the inlet (requirement)

**Bacterial load**

The maximum load of E. coli bacteria in the experiments was about 6, 6 - $10^6$ MPN/100 mL and of total coliforms about 2, 4 - $10^7$ MPN/100 mL. Fig. 5 shows the loading curve of the contaminated water. In the experiments, water with a very high concentration of pathogens was used to find out possible performance limits of the system. As a rule, the load of the water to be treated is lower.

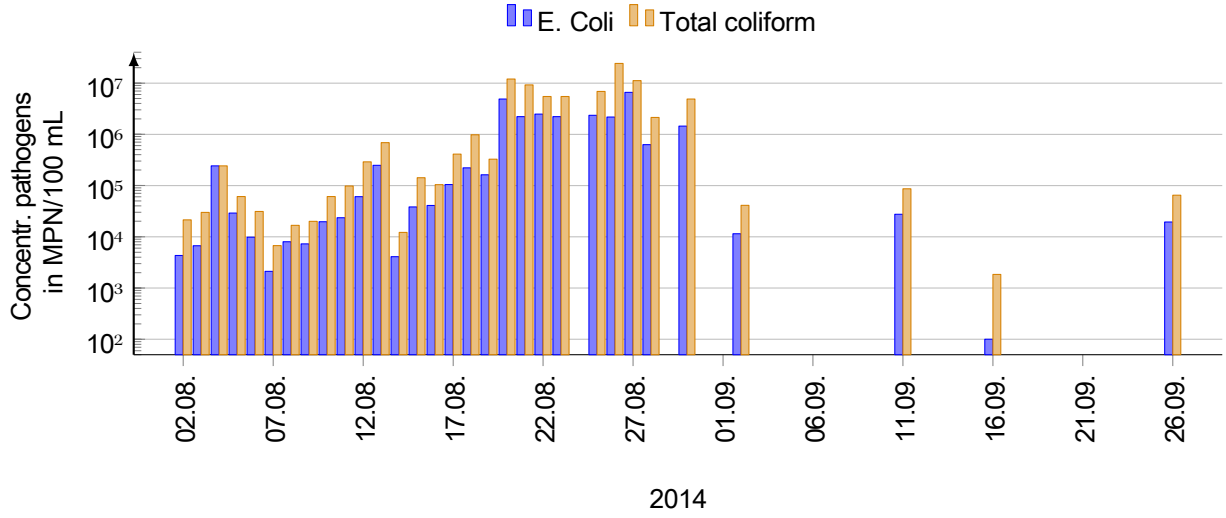


Figure 5: Load of added water on E. coli and total coliforms. (On days with both values equal to zero, the load measurement is missing).

**Chemical load** none

There must be no chemical contamination in the water, as this cannot be treated with this equipment.

**Tru¨bung** ≤ 5 NTU

The turbidity is not specifically influenced, therefore it should already be in the above mentioned acceptable range in the untreated water according to the recommendation of the World Health Organization (WHO). In the literature, values of up to 200 NTU are also described as suitable for thermal treatment. A lower turbidity usually means a lower microbiological concentration.

**Water hardness**

There are no fixed requirements for water hardness. The harder the water supplied, the more lime will precipitate in the heated areas of the plant.

**pH value** approx. 6.5 ... 8.5

The WHO requires a pH value of the water in the range between 6.5 and 8.5. When selecting the source of supply, it should be taken into account that on the one hand the pH value is slightly increased by the plant (see Fig. 6), on the other hand an acidic environment increases the dissolution of the copper in the water.

**Water temperature** ≥ 5 C°

### 6.3.2 Water quality at the output

**Bacterial load**

E. Coli and total coliforms of the added water with the concentration curve shown in Fig. 5 were reduced below the detection limit of 1 MPN/100 mL in each composite sample. This indicates a reduction efficiency of E. coli bacteria of at least lg 6.8 and of total coliforms of at least lg
7.4 For further information see the above mentioned Bachelor thesis.

**pH value**

The pH value increased by 0.84 on average during the experiments. The increase is attributed to the reduced $CO_2$ concentration in the water. Fig. 6 shows the course of the pH value at the inlet and outlet of the test plant.

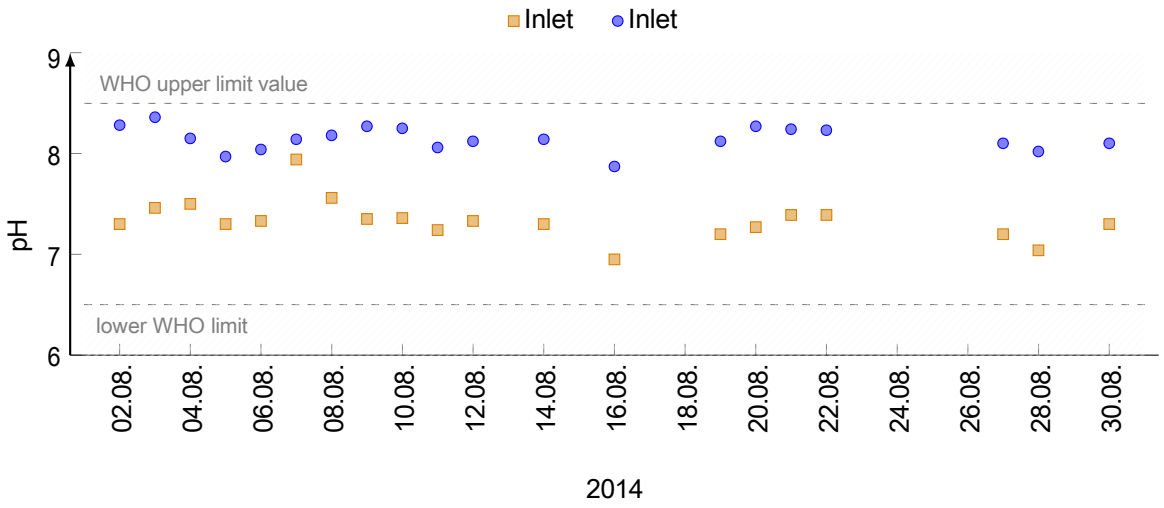


Figure 6: pH values of the composite samples from the inlet and outlet tanks.

**Water temperature** 90° C ... 100 C°

# 7 Security

- Water and material at the water outlet (riser pipe) have a temperature of up to 100 °C. There is a risk of burns here, which can be reduced by additional insulation, shielding, or the attachment of a warning notice. The collecting vessel should be located as close as possible to the water outlet, preferably firmly connected to it.
- The large glass pane can break. Care must be taken that no heavy objects are dropped or placed on it. If possible, install the equipment in a shielded place.
- If there are infants or small children among the users, the treated water should be examined with regard to possible elevated copper values and, in case of doubt, other supply channels should be sought for these persons.