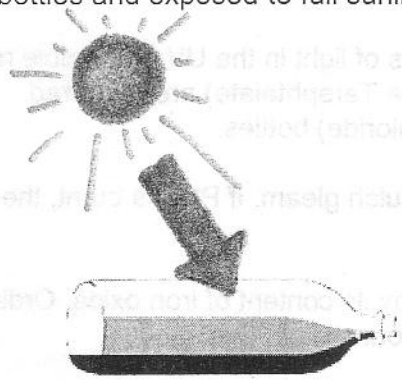
Solar Disinfection of Water

The Solar Water Disinfection (SODIS) process is a simple technology used to improve the microbiological quality of drinking water. SODIS uses solar radiation to destroy pathogenic microorganisms which cause water borne diseases.

SODIS is ideal to treat small quantities of water. Contaminated water is filled into transparent plastic bottles and exposed to full sunlight for six hours.

- Use bottles 2 litre size or less
- Leave 2.5cm space for air & shake up for 15 seconds



Inactivation of microorganisms by UV-A-radiation and thermal treatment

Sunlight is treating the contaminated water through two synergetic mechanisms: **Radiation** in the spectrum of **UV-A** (wavelength 320-400nm) and **increased water temperature**. If the water temperatures raises above 50°C, the disinfection process is three times faster.

Key factors of SODIS application

Weather and Climate

SODIS requires sun radiation and temperature:
=> the container needs to be exposed **to the sun** for **6 hours** if the sky is bright or up to 50% cloudy
=> the container needs to be exposed **to the sun** for **2 consecutive days** if the sky is 100% cloudy,
=> during days of continuous rainfall, SODIS does not perform satisfactorily. Rainwater harvesting is recommended during these days.
=> if a water temperature of at least **50°C (122° F)** is reached, an exposure time of **1 hour** is sufficient

The most favourable region for SODIS lies between latitudes 15°N and 35°N. These semi-arid regions are characterized by high solar radiation and limited cloud coverage and rainfall (3000 hours sunshine per year). The second most favourable region lies between the equator and latitude 15°N, the scattered radiation in this region is quite high (2500 hours sunshine per year).

If the weather conditions in a region are not optimal, the water temperature and therewith the efficiency of the disinfection process can be increased through:
=> using **half-blackened plastic bottles**, which achieve approximately 5°C higher water temperatures than fully transparent, non-painted bottles,
=> placing the plastic bottles on a **reflective surface,** such as for example CGI-sheets or aluminium foil.

Water Turbidity

Suspended particles in the water reduce the penetration of solar radiation into the water and protect microorganisms from being irradiated.
=> SODIS requires relatively **clear water** with a **turbidity less than 30 NTU**.

In water with higher turbidity than 30 NTU pathogens **will have to be inactivated by the temperature** rather than radiation (>50°C for at least an hour) or the water has to be filtered before being exposed to the sun.

Water Turbidity Test: place the bottle, full with water, on the SODIS logo on top of a table in the shade and look through the bottle from top to bottom. Water turbidity is less than 30 NTU, if you can read the letters of the SODIS logo through the water.

Material and Shape of the Containers
Various types of transparent plastic materials are good transmitters of light in the UV and visible range of the solar spectrum. Plastic bottles made from **PET** (PolyEthylene Terephtalate) are preferred because they contain less UV-stabilisators than PVC (PolyVinylChloride) bottles.

How to **distinguish PET and PVC**: Bottles of PVC often have a bluish gleam. If PVC is burnt, the smell of the smoke is pungent, whereas the smell of PET is sweet.

Glass: Transmission of UV radiation through glass is determined by its content of iron oxide. Ordinary window glass of 2mm thickness is practically opaque to UV-radiation.

Ageing of plastic bottles (due to mechanical scratches and due to photoproducts) leads to a reduction of UV transmittance which will reduce the efficiency of SODIS. Heavily scratched or old, blind bottles should be replaced.

Photoproducts: Sunlight does not only destroy pathogenic microorganisms found in the water but also transforms the plastic material into photoproducts. Laboratory and field tests showed that these photoproducts are generated at the outer surface of the bottles. No migration of photoproducts or additives (UV-stabilisators) into the water was observed.

Shape of Containers: UV radiation is reduced by increasing water depth. At a water depth of 10cm and moderate turbidity of 26 NTU, UV-A radiation is reduced to 50%. This means that PET bottles do not have the most efficient shape for SODIS as they have a small area for sunlight exposure and have a water depth of 6-10cm. Containers with a larger exposed area per water volume would be more efficient. However, PET soft drink bottles are often easily available and thus more practical for the SODIS application.

Oxygen
SODIS is more efficient in water containing high levels of **oxygen**: Sunlight produces highly reactive forms of oxygen (oxygen free radicals and hydrogen peroxides) in the water. These reactive forms of oxygen kill the microorganisms.
=> **Aeration of the water** can be achieved by **shaking** the 3/4 filled containers for about 20 secondes before they are filled completely.

Limitations of SODIS
- **SODIS does not change the chemical water quality**
- **SODIS requires relatively clear water (turbidity less than 30 NTU)**
- **SODIS requires suitable weather conditions**
- **SODIS is not useful to treat large volumes of water**

http://www.sodis.ch/Text2002/T-Howdoesitwork.htm