

Water sterilization in LEDCs

Introduction:

The lack of clean water in less economically developed countries is a severe global challenge and affects 13% of the world's population. 936 million people get illnesses like cholera or tuberculosis due to the missing access to safe drinking water.¹ Without clean water there is a continuous vicious circle, in which the people cannot be freed from diseases, caused by polluted water. The education does suffer, because students miss classes due to their need to gather water and a break-out of the circle is impossible without a good education, a good job and a source of income.

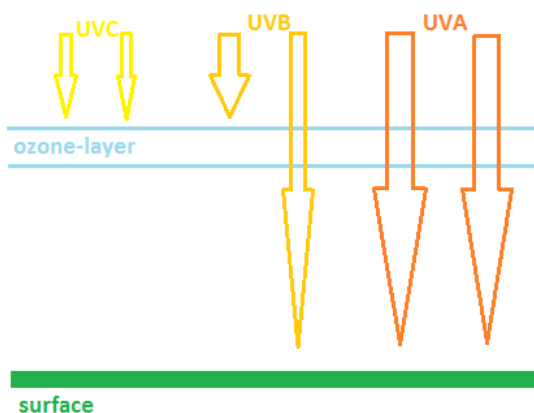
The process of sterilization:

The fundamental idea for our water cleaning system is the inactivation of bacteria and microorganism through UV-rays. The bacteria containing water can be inactivated by the destruction of their DNA. The DNA consists of four nucleobases, namely thymine, adenine, cytosine and guanine and the sugar and phosphate skeleton. The nucleobase thymine forms a base pair with adenine and cytosine forms another with guanine. The repetition and changing order of those base pairs define the DNA.

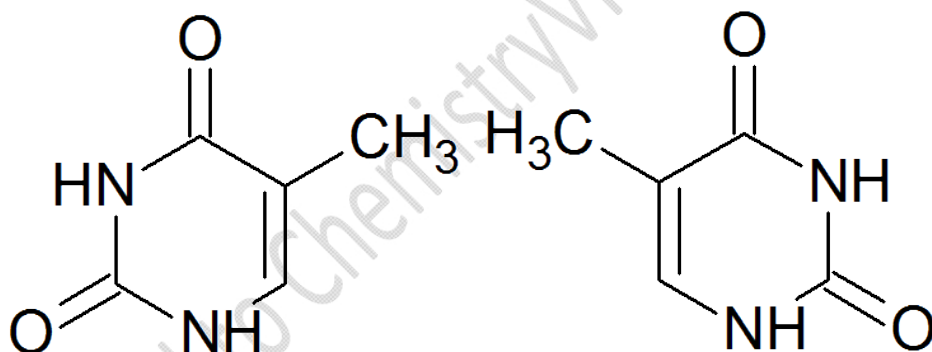
The sun emits three different types of UV-rays. The UVC-rays are the shortest with a length of 100nm to 290nm, but are totally absorbed and deflected by the ozone-layer. The second type is the UVB-rays, which have a wavelength of 290nm up to 320nm, so they can pass the ozone-layer partly and bring on the skin tanning. Guilty of inducing skin cancer and eye diseases are the UVA-rays, with a wavelength of 320nm to 400nm.

¹ Cornelsen Webcode Material Chapter3 „Living in the Global Village“

These can completely enter the atmosphere without being deflected or absorbed by the ozone-layer.²



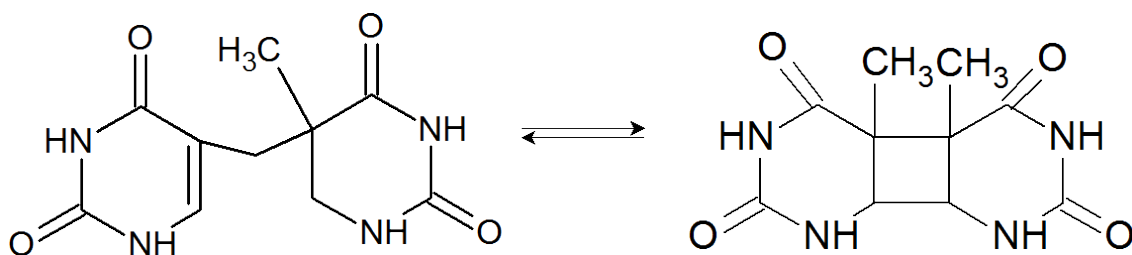
When two thymine nucleobases are arranged next to each other the UVA-rays deform the thymine, so that two thymine nucleobases bind with the other nucleobase and the bonds to adenine get resolved.



The deformation of thymine occurs in dependence on the change from the C=C double bond into the C-C single bond. The carbon atoms with the single bonds combine with the equivalent of the other thymine. Now exists a DNA mutation unable to be read by the ribosome. The genetic information is damaged so the bacteria cannot reproduce itself and the metabolism is paralyzed.³

² <http://www.physlink.com/Education/AskExperts/ae300.cfm>

³ https://en.wikipedia.org/wiki/Pyrimidine_dimer, "The Molecular Perspective: Ultraviolet Light and Pyrimidine Dimers" by David S. Goodsell



Necessary conditions for sterilizing process:

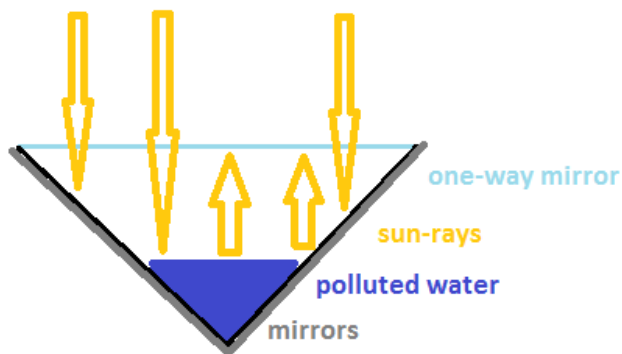
The most common solutions for water purifying at the moment are water filtration (e.g. with biosand), water sterilization with electricity induced UV-rays, chemical disinfection (for instance water purification tablets or activated charcoal absorption) and boiling the water. But the filtration has to last very long until the water is totally purified and the boiling can lead to a loose of water. Furthermore the chemicals are very expensive and the water sterilization with synthetic UV-radiation needs access to electricity, what causes more costs.⁴

But why generating UV-rays, when there is an average of 3254 hours of sunlight per year?⁵ For example in Southern Africa there is sufficient UV-light for cleaning water without electricity or synthetic UV-rays.

One could use a long trough, where polluted water can be filled in and flow through. On its top is a one-way mirror, that lets in sun radiation, but will not let it out. Mirrors on the inside reflect the UV-rays several times, which kills the bacteria like explained before. Depending on the length of the trough the amount of water varies, as well. This process will need about one or two hours before it is absolutely safe. There is no risk of losing water, because the possible steam cannot leave the closed system and it can be used more than once.

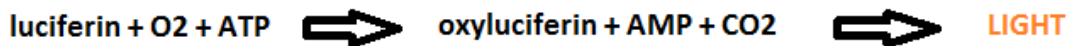
⁴ http://thewaterproject.org/biosand_water_filtration

⁵ <http://www.pretoria.climatemps.com/sunlight.php>



Testing the water:

Additionally the amount of bacteria in the water can be tested with a photometer. For that it will need to add firefly luciferase to a sample of the water. Organisms like bacteria produce adenosine triphosphate (ATP), which is the energy supply of all organisms. The luciferase reacts with the ATP and as product light will be emitted. The photometer can then measure the light emission by defining the wavelengths. If all bacteria are inactivated, there is no light emission.⁶



Conclusion:

This method for sterilization is much easier and cheaper to perform (due to the possibility of reusing it), while it is also effective, efficient and energy saving. So in conclusion it could be an appropriate alternative, which can be also introduced in less economically developed countries (LEDC's), which cannot afford expensive water cleaning systems, but also need safe drinking water.

⁶ <http://education.nationalgeographic.com/encyclopedia/bioluminescence/>, "Biologie Oberstufe – Gesamtband" by Cornelsen