self
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EMPA
Materials Science & Technology

eawag
aquatic research

The water concept in the independent house

Drinking roof water and showering with sewage water

Decentralized systems for drinking water processing could make a big contribution to development goals of the millennium. With the water concept in "self", Eawag demonstrates that membrane technology offers the chance to do just that.

Lack of drinking water hygiene is one of the main sources of the transmission of diseases worldwide, and centralised plants cannot be used in many situations because of the required infrastructure. Eawag therefore runs several research projects to examine the methods that enable sustainable processing for water of questionable quality or even sewage water into drinking and service water on the level of individual households or a quarter. The goal is a simple plant concept with sufficiently low investment and preferably low operating and maintenance expenses which can be implemented locally.

The independent house "self" is a joint project with Empa, the University of Applied Sciences Nordwestschweiz and the Zurich University of the Arts. Eawag has implemented a water concept in "self" that processes rainwater from the roof into drinking water with the help of a membrane and cleans the consumed water (grey water) with a membrane bioreactor until it can be used again for showering, washing dishes and to flush the toilet. Only heavily soiled waste water from the water-saving toilet (black water) is removed from the cycle. So two persons can live in "self" without compromising convenience for about two weeks before running out of fresh water – even without rain.

Using gravity instead of pumps

Ultrafiltration literally stands for the filtration of water through an extremely fine sieve. This "sieve" is a membrane made of plastic material. Its pores measure only fractions of a micrometer. They allow water and solute minerals to pass through while effectively holding back turbidity, germs, parasites and even viruses. The mechanical cleaning of the water thus simultaneously also takes on a disinfecting function without needing chemical aids like chlorine or ozone. Ultra filtration plants are used more and more in central drinking water processing. Three obstacles have so far prevented their use on a small scale. The water system in "self" now shows that these can be overcome:

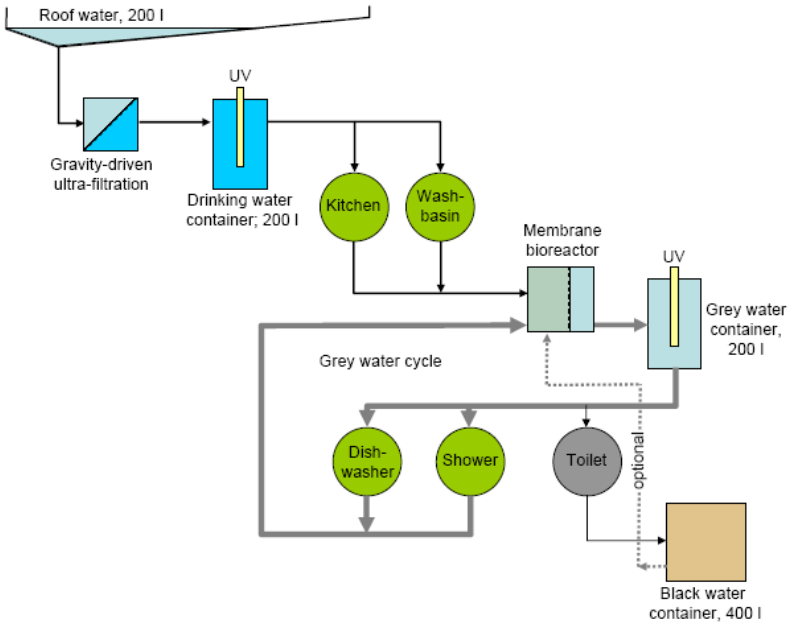
- Filtering sufficient amounts of water in a meaningful period of time in centralised systems requires either high pressure or very large membrane surfaces. To keep maintenance costs low and operational safety high, the system in "self" does without a pump. It uses only gravity without energy; because the pressure generated by the height difference of only one meter between the rainwater reservoir on the roof and the membrane is enough in this application, since only about 30 l have to be processed each day thanks to the economical handling of the drinking water. The filter area is 0.7 m^2, the corresponding membrane module is as big as a shoe box.
- The Eawag system is aware of the low filtration capacity of the membrane; because research has shown that the permeability of the membrane indeed drops in the beginning, but stays steadily on the lower level for months and does not fully collapse. This is ensured by biologically active growth (biofilm) that always leaves flow paths on the membrane. Backwashing and cleaning membrane is not necessary thus. No chemicals have to be used and the plant has very simply process engineering with two containers as well as the membrane module. Maintenance costs are practically nonexistent.

- The membranes have been very expensive until recently. There were narrow limits to their use in developing or emerging countries. Thanks to massively declining prices, today simple household systems can be designed that cost hardly more than $ 10 per family. Since no special technology is required even for somewhat larger plants, e.g. for a whole quarter, those directly affected can built and operate such plants themselves at a reasonable price.

Grey water cycle thanks to a micro sewage plant

When water runs down the shower drain or the vegetables have been rinsed clean, the sewage water is called grey water – unlike the more heavily soiled toilet sewage. In "self", Eawag wants to show that grey water can be processed with a micro sewage plant the size of a washing machine. It uses biological treatment of sewage and gravity driven membrane filtration that is operated analogous to the drinking water processing. In places with little or no fresh water, for living without losing comfort this water-reuse is as crucial as low consumption. "self" provides a full 100 l of water daily according to the calculations of Eawag. Practical use of "self" and accompanying research will have to prove its success though. Eawag has demonstrated that the "household without wastewater" is not a vision of the future in 2006 already during a test on a one-family house in Solothurn. The processed drinking and grey water in the two 200 l tanks is irradiated with a UV lamp at regular intervals to prevent microbial recontamination during longer storage of the processed water.

"self" is a living research project. A lot still has to be tested and optimised. In a later phase, it is conceivable to even separate urine and faeces to increase the recycling portion for water even more



eawag aquatic research

Eawag – part of the ETH Domain – is a national water research institute with international links. It promotes ecological, economical and socially responsible treatment of the life resource water and bodies of water. 400 employees are working at the locations Dübendorf (near Zurich) and Kastanienbaum (near Lucerne).

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