

# **A Self Sufficient Portable Set for the Production of Potable Water Using Photovoltaic and Cross Flow Filtration**

Dr. Klaus Brinkmann  
EnviPro Environmental Process Engineering  
Leckingser Str. 149  
D-58640 Iserlohn / Germany  
e-mail: klaus.brinkmann@envipro.de

Keywords: water supply, solar-aqua-box, cross flow, photovoltaic

## **Abstract**

In the last years extreme climatic balance-processes occurred increasingly. They are probably one of the consequences of the general global climate change because of the greenhouse-effect. These circumstances lead, for example, to thunderstorms with strong falls of rain, with flood disasters, whereby great areas are flood with muddy water. The pollution of this water implies a shortage of potable water for the affected people. This contribution presents the construction of an easy-handling, well operating portable set with an apparatus for the cleaning of water with the help of membrane cross flow filtration which has been applied for a patent. Presupposed for an unrestricted autonomous usage is a self-sufficient energy supply. For this reason, there are solar modules integrated. This allows an independence of a working electricity grid supply system.

## **Introduction**

It is a known fact, that water can be cleaned with the help of so-called cross flow-filtration techniques, like micro-filtration, nano-filtration or reverse osmosis. Existing technical realised plants of this kind for a water supply in disaster areas are often installed in container, which can be transported by heavy goods vehicles.

For the electricity supply of such plants many different variants are realised. These are for example the connection to the local electricity grid or a supply with independent units like diesel engines. But also wind energy and photovoltaic are already used to generate electricity for container-plants. Small systems, which are operated with emergency power units, are also available, among other things as used for military equipment.

Disadvantageous in the nowadays used processes is, that the water which has been cleaned with the help of the above mentioned plants is not directly available for the affected people. This is also not produced and distributed under the direct control of the affected people, who have the best special knowledge of their own situation and necessities, better than foreign helpers.

In these cases, the potable water is mostly put into barrels as well as bottles, which then have to be distributed with the help of vehicles. This kind of distribution is often very difficult to carry out, for the reason of impassable streets because of landslides.

The technical and the personal requirements are therefore large scale as well as expensive and a lot of time is needed.

This contribution presents the construction of an easy-handling, well operating portable set with an apparatus for the cleaning of water with the help of membrane cross flow filtration, which has been applied for a patent.

Presupposed for an unrestricted autonomous usage is a self-sufficient energy supply. For this reason, there are solar modules integrated. This allows an independence of

a working electricity grid supply system. The experimentally realised box is stainless, robust and can be stacked very close. Therefore available space for transportation could be optimally used. It is conceivable to take these boxes to the affected people by dropping them by parachute.

### **The Solar-Aqua-Box**

The increasing amounts of flood disasters, like for example actually in Mozambique, were the motivation to think about a method and a technical apparatus, in order to help the affected people more effectively and directly concerning the resulting lack of drinkable water [1].

Fundamental aspects for the development of the "solar-aqua-box" are the following circumstances.

- i) The flood water resulting from heavy rainfalls is first of all polluted with mud and increasing in time with bacteria.
- ii) The affected people are very often only reachable with the help of helicopters, because of the size of the area and of impassable streets.
- iii) The affected areas mostly belong to poor or underdeveloped countries, with no or bad working electricity supply. A probably existing electricity grid is in most cases also affected by the disaster and out of order.

Regarding these facts, i) supports the usage of micro-filtration, ii) recommends a smaller and lighter device and iii) shows the necessity of self-sufficient energy converter like solar cells.

With respect to these conditions, the idea was to develop a box, which could be easily handled and transported, basically equipped with a cross flow device and a photovoltaic which serves as energy supply.

It is obviously necessary to build up such a box only with water resistant materials. Advantageous would be also a light but robust construction and a sufficient ability for stacking, for an effective transportation. The experimental "pilot-box" as test-set-up is shown in (fig. 1).

The box is made of aluminium with the dimensions 78 cm x 38 cm x 38 cm and has a hinged cover on a rubber gasket and hinged handholds on each side. The screw connections for the water in- and outlets are mounted on the outer sides. There is one inlet for the dirty water on the left and two outlets on the right for the cleaned water (permeate) and the concentrated waste water.

All water-bearing parts of the cross-flow equipment, as far as possible made of plastic materials, were mounted on a steel plate, which lies rubber-buffer-mounted on the ground of the box. The storage battery, which supports the photovoltaic, together with the charge control are mounted on the upper inner wall to protect the electrical parts from water contact. There are also horizontal holders for the solar modules, to enable a safety transportation.

A funnel tube with filter cloths for a very first pre-filtration to fill a brackish water bag, which has to be connected to the inlet, the bag for the produced potable water together with all necessary connection tubes could be put loose into the box. Optionally, a chemical analysis set to test the water quality and a cleaning set for the cross flow module could be added. The operating construction is readable on the

inner side of the hinged cover. The process scheme (fig. 2) shows all important parts of the equipment and gives an impression of the working principle.

### Technical Data of the Test Equipment

Water pump to increase the filtration pressure:

centrifugal pump, 12V DC, 2.8 A (max. 3.2 A), max. 1200 l/h, 1 bar

Cross Flow Module:

capillary module, 40 capillaries, capillary diameter 1.8 mm, symmetrical polypropylene membrane, filtration area 0.1 m<sup>2</sup>, flow area 1.0 cm<sup>2</sup>, pore size 0.2 μm, rate of bacteria separation 99.99999%, max. working temperature 40°C, radial membrane pressure 1.6 bar / 25°C - 1.4 bar / 40°C

Photovoltaic:

water protected foil c-Si-Module 12 V / 9 Wp, max. electrical power 9 W, open circuit voltage 23.4 V, closed loop current 0.51 A, dimension 333 mm x 320 mm, (several modules could be connected parallel, approx. 40 Wp would be sufficient, other module dimensions are possible), dryfit solar battery 12 V / 6.6 Ah / 2.2 kg / 153 mm x 66 mm x 99 mm (18 Ah may be sufficient, heaviest part of the equipment)

Filtration output:

approximately 90 l/h – 150 l/h at 0.9 bar depending on the water fouling

### Working Principle

The box has to be placed on a dry place with sufficient solar insolation. The solar modules have to be directed to the sun and connected to the box. After the connection of the feed water and potable water bags to the box, the muddy water could be pre-filtered with the help of filter cloth and filled into the feed water bag. Then all valves could be opened, to fill the tubes. After the pump is filled with water it could be started and the throttle valve has to be closed until a sufficient filtration output is achieved. This valve must not be fully closed, because a steady cross flow is important to guarantee the filtration principle. It would be necessary to open this valve repeatedly in a period of time to increase this cross flow to get a stronger cleaning effect on the filtration area. At the end of the filtration process, the module could be cleaned by connecting the potable water bag (permeate) to the input and to rinse the module with opened throttle valve. This procedure serves as a kind of reset for the filtration modules. Additionally it is possible to blow permeate backward through the pores with the help of the lungs.

### Outlook

To get a real well functioning "Solar-Aqua-Box", which is able to serve as water supply equipment in flooded disaster areas, some things have to be optimised. Here some proposals are given. The size of the box could be minimised and it would be advantageous to make use of plastic materials instead of aluminium.

It is thinkable to construct the body of the box in such a way, that it is able to swim by itself, this would increase its flexibility.

The solar modules could be partly integrated in the surface of the box, foil-modules with amorphous silicon would be used. These modules are less effective than crystalline type modules, but they are cheaper and foldable.

The manually driven valves could be changed by automatic solenoid valves, which enables a controlled processing concerning the cross flow process, as described above as an aspect of the working principle.

Alternatively to the energy supply with the help of photovoltaic, a small decomposable wind energy converter could be used or added, in order to increase the availability of electrical energy.

### **Literature**

- [1] Klaus Brinkmann, Birgit Brinkmann, Inge Brinkmann  
"Ein Koffergerät zur Gewinnung von Trinkwasser mit Hilfe von Photovoltaik und Membrantechnik", 12. Internationales Sonnenforum, Juli 2000 Freiburg, DGS München, International Solar Energy Society – German Section.

### **Figure Captions**

Figure 1: Photography of the Solar-Aqua-Box

Figure 2: Process Scheme

Figure 1: Photography of the Solar-Aqua-Box

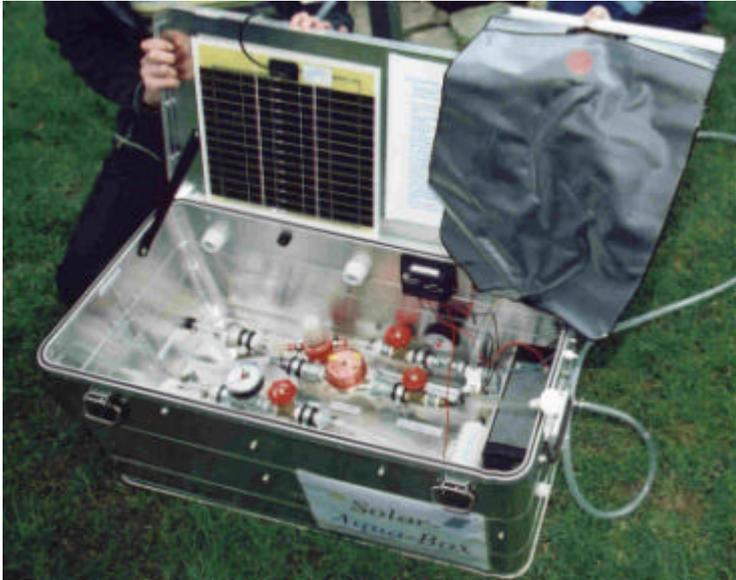


Figure 2: Process Scheme

