



Micro-filtration – a way to improve family health

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BESIDE THE FACT that a huge effort still is needed to provide safe drinking water at community and family level, there are many different ways to make safe drinking water available and affordable for family use in low-cost countries and emergencies. Chlorination is the most common practice both for providing safe water at large-scale schemes for villages or urban settlements by batch treatment and for families by disinfecting the collected water with tablets. This way of providing safe water has many advantages mainly because it makes the water safe also during carrying it home and handling it at family place. The provision of safe water relies on the proper dosing of chlorine and the availability of chlorine in the respective form, such as powder, tablets, liquid gas, etc. However, chlorination has also been difficult to introduce due to the changes in water taste, which has often made the population to go back to non-treated traditional sources. Usually, an effort is needed in health education to make a community to accept and to welcome chlorinated water as a safer drinking water supply. In conclusion from many water projects, it can be said that the taste change of the drinking water is an underestimated obstacle in improving the health of a population by providing treated water.

Water filtration practices have been introduced at the household level at many places with quite different results. Small household sand-filters were constructed and showed to reduce the water-related diseases (e.g. Mol 2001). There is still an enormous potential to spread this filter technology.

Filters with micro-pores, which do not allow harmful bacteria to pass, are based on a technology, which allow water to be made safe and guaranteed bacteria-free at any place. Such filters are mainly known as the ceramic filters used worldwide in expat-households. Until now, the price and the set-up have not made it possible to provide this water treatment at family level of low-income and poor settings.

An inexpensive micro-filter system working on gravity and producing safe water right where you need it is going to be introduced. Applications for this type of filter might be for a traveller, an individual working in emergencies and in the field, a family or smaller institution such as a health station, a school or community centre.

Water demand at family level

The daily drinking water demand for a family is in the range of 20 to 40 litres depending on the number of members. Although the total water demand might be substantially

higher, there is only a limited amount requested which has to fulfil the qualities of proper drinking water. Water production from such a single membrane domestic filter is in the range of 20 to 60 litres per day, depending on the fine material collected on the filter membrane. The membrane can be initially manually washed, but as with all membrane filters will clog more and more. Although less water is passing the filter, all water, which has passed is guaranteed safe water. A total of some 2500 litres is given as life production, although filters in use have produced much more. This quantity would easily represent the drinking water consumption of a family for half a year.

Water purification techniques

When working with water treatment in both emergency and development situations, it is important to establish an overview of the techniques available and the techniques appropriate for a given scenario. Based on many years experience from emergencies and development projects, Yme has tried to collect information about water treatment solutions and are continuously following up when new solutions are presented. The collected information is systematized in a way allowing us to better choose appropriate solutions.

The diagram shows the installations or the number of persons, which can be served with a given daily production. For a family ranging from 5 to 10 persons, 50 to 500 litres are needed to cover the daily consumption of both washing and drinking water, dependent on the situation. In emergencies, often water supply far below the Sphere standards of some 15 litres per person per day can be reached. In many situations, it is therefore advised to provide drinking water separated from washing water to reduce costs. This would also reduce the size of treatment equipment and related operation and maintenance. However, separation between drinking water and washing water needs a proper training campaign and good follow-up to establish it as a working solution.

The next step would be to have a look into existing technologies and already accepted water purification units in the work of humanitarian organizations. The different approaches can mainly be subdivided into technologies using chlorination as disinfection process and those using other solutions, such as UV-lamps, ozone, and ion-exchange based techniques. There are also filter technologies removing bacteria, in this report called “micro-filters”, which mainly consist of membranes with pore sizes smaller than pathogenic bacteria (in the range < 0.04 microns).

Many micro-filters of a type based on ceramic material are used by households in areas where water from the distribution network is not safe. "Candle" filters consist of a ceramic column with pore sizes in the range of 0.5 microns. A test of such filters in Nepal, however, showed that the results on improving the water quality were very disappointing (Maskey & Jackson 2001). The pore size and the distribution of pore sizes in such ceramic filters are usually not sufficient to remove all pathogens. In addition, the training on how to use the filters often was not extensive enough to achieve the improvements needed to make an effect on the health situation of the population.

Most technologies use several different processes to reach a satisfactory solution for different qualities of raw-water. Most processes need a filtration of the raw-water to remove inorganic and organic suspensions in the water. Some filtration technologies, especially those applying micro-filters, also remove pathogenic organisms. Depending on other components being present in the raw-water, such micro-filters also remove the heavy metals or pesticides, which are bound on to particles in organic or inorganic suspensions.

The processes mentioned above (see figure below) cover the range of subjects, which has to be in focus for humanitarian aid work both in emergencies and development. The critical part is always the filtration, because the raw-water is usually heavily loaded with suspension of both inorganic and organic material. As long as the turbidity as a measure for suspension is above 1 easily and micro-filtration is not possible due to clogging of any filter surface (filter membranes, ceramics, etc.). Sand-filters as a more 3-dimensional filter medium have a much greater potential to handle high-turbidity water. Also back-washing of sand-filters is more effective than back washing of membrane filters.

Disinfection, meaning guaranteed removal of any pathogenic organisms is usually a process only working with "clear" (<15 NTU) water. Chlorination, micro-filtration, UV lamps, ion-exchanger, oxidation, etc. are those most commonly used processes to achieve a proper and safe drinking water.

So in conclusion so far, it is suggested that the focus for any type of water purification system should be on treating highly turbid raw-water combined with a proper technology for disinfection.

Micro-filtration technology

The filter mainly consists of a membrane with a guaranteed pore size not allowing harmful bacteria and other organisms to pass. This is reached by preparing a specific polymeric film by etching to reach a high density of microscopic pores. The membrane features a high uniformity of pore size distribution, high strength and the possibility of regeneration by means of membrane cleaning.

The filter with its pore size of 0.4 micron can remove all faecal and total coliforms, giardia, cryptosporidium and

protozoa. As an advantage of such filtration, the water keeps its taste, which in many societies is an important aspect when introducing a new technology.

The membrane sits on both sides of a frame, which allows water to be collected and gravitationally sucked through the membrane into a pipe filling a lower-placed bucket (see sketch). This configuration of having the filter package in a bucket or water bag and a pipe filling a lower bucket is easy to set up in all kind of situations, including highly temporary settings as typical for emergencies. For more permanent situations, the gravity effect is applied by installing a smaller bucket into a larger one. The filter membrane is then fitted to an outlet in the bottom of the upper bucket, while usually the lower bucket is equipped with a tap to get proper access to the clean water (see figure below).

However, distribution of filters and replacement make a logistic structure necessary, which becomes the key issue. On the other side, assembling, packing, selling and replacing might also be the entry point to open up for business activities at small scale, especially suited for income generating activities. Such a project is initiated in a cholera prone area in eastern South Africa and shows good results. The price for a replacement filter is in the range of USD 18 resulting in a water price of far less than 1 cent per litre of safe drinking water.

Applications

There are many advantages using micro-filtration, mainly that it is also applicable where no chlorination is available, such as during emergencies where the population is widely spread. But micro-filtration is typically not a way to produce large quantities of water. The water has to be produced where it will be consumed because it does not contain any chemicals killing bacteria in containers and storage tanks.

Unlike usual development situations, during the first phase of a catastrophe or complex crisis, the approach to help people with water and sanitation has to be based on established routines and proper preparedness structures. Often, some highly sensitive issues cannot be taken into account as would be desirable, because of the shortage of time and the need for immediate action. Proper planning and a well established preparedness system including storage and established distribution systems, however, reduces the impact of neglecting the cultural understanding and sustainability perspectives from the beginning. Packages with both water containers and filters for providing proper drinking water have been distributed during the flooding in Mozambique. The reaction by the users was very positive and the filters were immediately used mainly at family level.

Combination of several filter membranes increases the total production per day. Filter membranes were combined to packages of three to ten units producing between 100 to 300 litres of safe water per day. Having installed such filters in practical buckets or small basins with taps and simple refill installations, made the filtration to become a simple

but effective solution for small health stations and field hospitals.

Such a micro-filter system at the level of a family costs in the range of 20 to 30 USD as an investment. A replacement of the membrane after having produced some 4-6000 litres (about the consumption of drinking water of a family during one year) is in the range of 15 USD. The resulting costs per litre of safe drinking water will be below 1 cent per litre. Of course, locally made sand and clay filters will give cheaper water, although the quality cannot be guaranteed. Ceramic filters as often used by expat-staff in tropical countries are much higher in price.

It is the aim for the near future to include this technology in preparedness stocks for any type of potential natural disaster. At the same time, the filter in different set-ups will be introduced into health-posts and schools in Angola and Sudan. The experience from KwaZulu Natal in South Africa, where this technology was introduced during a cholera outbreak in combination with sand-charcoal filter units, is an important basis for further introducing these micro-filters into similar settings. To supply safe drinking water to a very wide spread population and to health centres and schools this filter technology has a huge potential. However, the introduction and implementation of all filter technologies has to be initiated by a proper training phase and has to be based on a cooperation with a local NGO and the communities. By the excellent cooperation with a community based voluntary organisation in KwaZulu Natal, the different aspects of introducing new technologies for water treatment and the dissemination of informa-

tion about water related diseases and a general improvement of the health awareness helped to formulate new projects along the same line.

References

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- Maskey, A. & Jackson, D. 2001: Candle Filters. *Waterline* 20,2: 26-28.

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