December 7th 2010, Concepción/Chile

Short Course Program
Housing ● Manufacturing ● Water

Potable Water for small communities in cases of emergencies and natural disasters:
“The WaterBackpack”

Dr.-Ing. Wernfried Schier
Beginning of membrane technology at the DESEE

❖ Since 1999 DESEE operates pilot plants for research with membrane bioreactors
❖ Since then, it was questioned whether surface water can be filtered through a membrane even with very low transmembrane pressure
❖ Purpose: Treatment of surface water that is contaminated with Pathogens
❖ Use: in cases of emergencies and disasters
Basics of membrane separation

membrane

typical pore width 20 to 100 nm (0.020 to 0.100 µm)
Removal of bacteria, example cholera

cholera bacteria
diameter 300 to 500 nm, length 2 000 nm (2 µm)
membrane
typical pore width 20 to 100 nm (0.020 to 0.100 µm)
Drinking this surface water makes one ill

After disasters, usually no potable water is available
Drinking water in cases of disasters

- After disasters, usually no potable water is available
- Then, today mobile waterworks are necessary
  - Sand filters
  - Membrane units
    - Microfiltration (MF)
    - Ultrafiltration (UF)
    - Reverse osmosis (RO)
  - UV-Disinfection
  - Chlorination
- Those mobile Waterworks need
  - Energy/Diesel
  - Chemicals
  - Skilled operation personnel
The Challenge

- After disasters happen, mobile waterworks are employed where large numbers of people live (cities etc.)
- But victims living remote in small villages (e.g. <1,000 cap) have to walk long distances to obtain fresh drinking water at the centralized mobile waterworks
- This is only possible within certain distance and if infrastructure allows this – however, this often is not the case ....
- .... This makes it obvious that additional decentralized help is needed!
- At the DESEE, with financial aid by the DBU we therefore developed a prototype of a simple membrane filtration unit that is able to provide potable water for small numbers of people
Requirement profile and solution

- No energy demand
  - Usage of gravity

- No chemicals needed
  - Usage of membrane filtration for pathogens removal

- No skilled operation personnel needed
  - Utmost simple to use, extremely robust, no maintenance/cleaning required

- Self help possible even for illiterates
  - „Operation manual“ consists of four simple pictograms

- High time pressure
  - Can be stored ready to use

- Transport problems, destroyed infrastructure
  - Distribution from the air, e.g. helicopter drop, transportable on the back like a backpack (weight 20 kg)
The solution – prototype

✿ No moving parts, no **energy**, no **chemicals**, no **maintenance**, usable by **everyone** – even illiterates
The complete operation manual

⇒ No moving parts, no **energy**, no **chemicals**, no **maintenance**, usable by **everyone** – even illiterates

⇒ Here is the complete operation manual!
First project – realization of a prototype

☞ At the end of the first project, the prototype was formally handed over to the DBU
Long term tests concerning hydraulics and E. coli

- Long term flux 5 L/(m²*h), long term flow 1,200 L/d (800 bottles 1.5 Liter each)
- Sufficient for ≈ 200 people over months (≈ 500 people for 3 d)

![Graph showing E. coli levels and flux over days]

**Limit value „best bathing water“**
The question is:

drink this water?

or drink this?
The WaterBackpack in Chile (first use, since 03/2010)

WaterBackpack „PAUL“

Portable Aqua Unit for Lifesaving

2 in Chile:

- Alhuet
- Pelluhue
PAUL-provisional for Chile

The WaterBackpack
Concepción, 07.12.2010

Department of Sanitary and Environmental Engineering (DESEE)
Head: Univ.-Prof. Dr.-Ing. F.-B. Frechen

Fotos: FG SWW
PAUL-1 in Pelluhue: emergency camp for 100 people (12.03.2010)
PAUL-2 in Alhué; school in rural area for 50 scholars (11.03.2010)
The WaterBackpack in Pakistan & elsewhere

WaterBackpack „PAUL“

- 2 PAUL are in use in Chile since March 2010
- 53 PAUL are in use in Pakistan, 57 more will be shipped there within the next weeks
- 2 are in use in Vietnam since 8th October, 12 are on the way, 30 more ordered
- 2 are in use at St. Lucia (Caribbean)
- 1 is in field test in India
- 1 is in test in Taiwan
- 1 is on its way to Bolivia
- 1 is on its way to Kenya
- 60 are ordered for Haiti

Total population served: 50,000 capita
Technical specifications & details

- Outer dimensions 0.40 x 0.38 m, 1.10 m high
- 6 units fit on a standard Euro-palette
- Weight 20 kg
- Membrane surface 9.5 m², nominal pore width 40 nm (0.04 µm)
- Lifetime of the membranes ca. 8 to 10 years
- Flow rate from 3rd week ca. 1,200 Liter per day (operation without maintenance, cleaning etc.), sufficient for 200 people
- Permanent operation possible over months without cleaning, over years when removing settleable solids and flushing the membrane from time to time
- Price 999 Euro
  - 5 € per saved person when used only once
  - 0,50 €/person when used 10 times (note: 10 years membrane lifetime)
Shift of paradigm for remote areas: logistics/cost

✦ With PAUL:
  1 (air) transport on site, load 20 kg

✦ Alternative supply with bottled water:
  800 bottles à 1.5 Liter daily, i.e. 1.2 tons of water (airfreight?) per day
  Within e.g. 6 months, this sums up to 200 tons of water (144,000 bottles à 1.5 Liter) – transport cost / airfreight cost plus cost for water and bottles

✦ Using the transport capacity (e.g. helicopter) necessary for water supply of a village with 200 inhabitants for just one day (1.2 tons) would allow to distribute 60 PAULs just that one day:

✦ The next day, 12,000 more people would be able to prepare potable water on their own!

✦ Price per 1.5-Liter-bottle when using the WaterBackpack for 6 months: 0.7 €Ct, thus 0.007 €/bottle.
Shift of paradigm for remote areas: further aspects

Variant for the first time allows decentralized potable water supply in cases of disasters in the hinterland and avoids walking of large numbers of people to get their water (destroyed infrastructure).

The victims of disasters can concentrate on other things necessary for survival instead of wasting time and energy to walk to central waterworks.

Variant means to free victims from dependency on daily external supply („will someone bring water today? If not, what to do?“) and to empower people for sustainable self help.

Using Variant in cases of disasters makes a huge transport capacity available for transportation of other urgently needed first aid goods.
Impressions from Vietnam
Impressions from Vietnam
Impressions from Pakistan

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Recent impressions from Kassel:
Overview humanitarian use

Year 2010

- ordered
- delivered
- total

Number

- 0
- 50
- 100
- 150
- 200
- 250
- 300

Mar 10  Apr 10  May 10  Jun 10  Jul 10  Aug 10  Sep 10  Oct 10  Nov 10  Dec 10

- 2
- 2
- 2
- 2
- 2
- 2
- 31
- 44
- 134
- 248

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This (and many more) documents you will find on

www.uni-kassel.de\fb14\siwawi
www.waterbackpack.org