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Drinking water treatment with ceramic filters in Africa

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africaexpedition.de

Why is that topic so important?

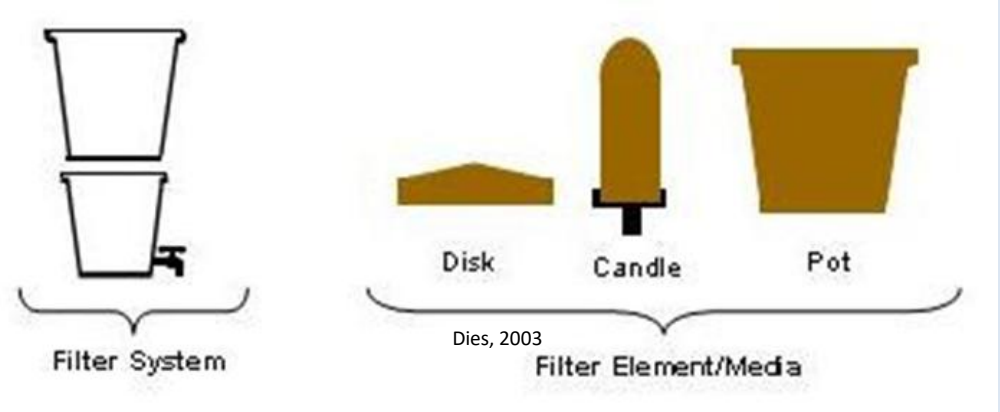
- 1.8 million people per year die because of diarrhea
  - 88% due to unclean water and poor hygiene
  - **344 million people in Africa** did not have access to improved drinking water sources in 2010
- **WHO: avoidability of 94% of deaths with the help of improved safe water supply and sanitation**
- Solution: „**point-of-use“- water treatment** → **e.g. ceramic filters**

http://www.believeinzero.at

http://www.water-for-africa.org

Manufacture of ceramic filters

1. Selection of materials:
   - clay, water, combustile materials (and possibly fire-resistant stones)
2. Mixing of materials:
   - Homogenous, not too moist mass
3. Forming the filter:
   - Disc filter
   - Pot filter
   - Candle filter
4. Drying and subsequent firing:
   - Burning temperature: 900-1000°C
     (possibly new stones for oven necessary)



Dies, 2003

Advantages and disadvantages of ceramic filters

Advantages:

- Economical and cheap in manufacturing and producing
- Materials are readily available (sand, clay, sawdust, rice husks…)
- In most countries ceramic trade is established
- Necessary know-how for the production is available
- High cleaning performance (with regard to microbial contamination and turbidity)

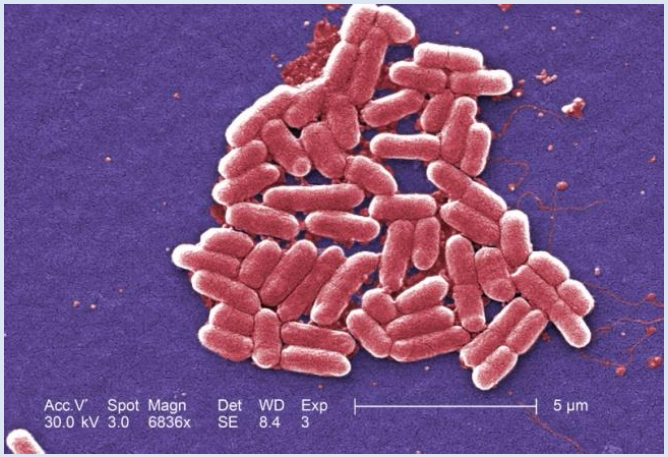
Disadvantages:

- Partially slow flow rates (Ø 1 - 3 l/h)
- Very fragile
- Service life and reliability are user-dependent

  → difficult to ensure the durability
- In poor countries there is often no high production rate

Guidelines and cleaning performance

- WHO Guideline: ***E. coli* should not be in drinking water**
  - *E. coli*: Indicator for fecal polluted water
- Two studies in Cambodia:



blogs.britannica.com

Table 1: Cleaning performance of ceramic filters compared to biosand filters

	Cleaning performance (%)	
	Ceramic filters	Biosand filters
Removal rate *E. coli*	98 (up to 99,99)	95
Reduction of diarrhea	46	47
Reduction of water turbidity	70	82

Guidelines and cleaning performance

- WHO guidelines for **risk groups**
  - Assessment of sanitary situations due to infection risks
  - ***E. coli*** as the indicator bacteria
  - Likelihood of keeping the guideline at least is higher for ceramic filters compared to biosand filter

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Table 2: Exceedance propability of the WHO guidelines

WHO risk groups by *E. coli* in drinking water	Exceedance propability (%)	
	Ceramic filters	Biosand filters
Low risk: >0CFU*/100ml	30-40	56-67
Average risk: >10CFU*/100ml	15	37
High risk: >100CFU*/100ml	6	14

*CFU = colony-forming unit

Guidelines and cleaning performance

- WHO: **required reduction values** for pathogens (dependent on DALY*)
- Summary of **average reduction values** of sand and ceramic filters by the WHO

Table 3: required and average reduction values of household water treatment in LRV** (log_{10} reduction value)

Patogens	Required LRV		Average LRV	
	Protective (≤10^{-4} DALY per person per year)	**Highly Protective** (≤10^{-6} DALY per person per year)	**Ceramic filters**	**Slow sand filters**
Bacteria	≥2	≥4		
Viruses	≥3	≥5		
Protozoa	≥2	≥4		

*DALY: Disability-adjusted life-years, measure for the health of a population or the burden of disease

**LRV = Log_{10} (Pathogenic concentration before treatment) - Log_{10} (Pathogenic concentration after treatment)
LRV = 1 = 10^1 = 90%, LRV = 2 = 10^2 = 99%, LRV = 3 = 10^3 = 99,9% reduced pathogens.

Guidelines and cleaning performance

- **ceramic filters** have **better reduction performance** of all pathogens
- **ceramic filters** more likely attain the **„Highly Protective“** reduction values

Table 3: required and average reduction values of household water treatment in LRV** (log_{10} reduction value)

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	Protective (≤10^{-4} DALY per person per year)	**Highly Protective** (≤10^{-6} DALY per person per year)	**Ceramic filters**	**Slow sand filters**
Bacteria	≥2	≥4	2-6	1-3
Viruses	≥3	≥5	1-4	0,5-2
Protozoa	≥2	≥4	4-6	2-4

*DALY: Disability-adjusted life-years, measure for the health of a population or the burden of disease

**LRV = Log_{10} (Pathogenic concentration before treatment) - Log_{10} (Pathogenic concentration after treatment)
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Ensuring drinking water demand

- WHO statement: **20 liters of water per day and person** for a minimum of health and hygiene

charitywater.org

- **Ceramic filters**: flow rate 1-3 l/h
  → 10 hours for 20 liters
  - Sand filters flow rate 15-60 l/h
  - Flow rate depending on filter thickness, the used material and the thereof accompanying pore size of the filter

- Connection between change in performance and service life not known
  → General: **4 years of use period**, in which filter cleans smoothly
  - Filter cleaning by user is obligatory (due to particulate material)

Summary

- Africa: more than 30% of the population don‘t have access to improved drinking water → death by diarrhea is often the case

Potential solution: **water cleaning at the point of use**

→ **Ceramic filters**

- Production possible on-site, cost-effective
- High cleaning performance
- WHO guidelines are more likely kept than with sand filters
- **Problem**: slow provision of purified water, cleaning required by users

But: Many lives could be saved by this simple gadget.

The end

Thank you for your attention!

globalnaturalresources.wordpress.com