TOT 2

Small-scale Water Treatment

1. Introduction to Household Level Water Treatment

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Introduction

- **Access to sufficient amount of safe water is important to ensure good public health.**
- **Water sources may contain some contaminants which may have adverse health effect on the users.**
  - **Hence some form of water treatment is often required.**
- **Water treatment systems should**
  - **meet the drinking water quality objectives and regulations with reasonable ease and cost**
  - **be flexible in dealing with seasonal as well as long-term changes in water quality**

Water Quality Parameters

Quality of the water is defined by "Water Quality Parameters"

- **Microbiological parameters**
  - **bacteria (e.g. total coliform, *E-coli),* virus, protozoa**
- **General Physical Parameters**
  - **color, turbidity, taste and odour, temperature, pH, conductivity, total dissolved & suspended solids**
- **Chemical Parameters (inorganic)**
  - **cations, anions, gases, total hardness, alkalinity**
- **Chemical Parameters (organic)**
  - **dissolved organic carbon, total organic nitrogen, organic micropollutants (e.g. pesticides, pharmaceuticals)**
- **Radioactive Elements (α, β or γ-radiations)**

Water Quality Criteria

A safe and potable drinking water should confirm to the following water quality criteria:

Health-based criteria

- **Free from pathogenic organisms**
- **Low in concentration of compounds that are acutely toxic or that have serious long-term health effects**

Aesthetic criteria

- **Clear**
- **Not saline (salty)**
- **Free from compounds that cause an offensive taste and odour**

Operational criteria

- **Non-corrosive, not causing scales on piping or staining of clothes and appliances**

Drinking Water Quality Guidelines and Standards

Different National and International Agencies have set standards and guidelines for drinking water quality to protect public health.

- **Some of the standards are enforceable while other are guidelines.**
- **WHO (2017) gives guideline values for parameters that have health consequences.**
- **For other parameters (which are more of aesthetic concerns) WHO recommended that each country should set their own guidelines based on local circumstances (water quality, availability, quantity used and treatment costs).**

Water Treatment

- **The aim of water treatment is to remove objectionable constituents to raise water quality to highest possible level for long-term use.**
- **Treatment processes to be used depend on the raw water quality and drinking water quality standards.**
- **Water treatment processes can be broadly classified into three main types:**
  - **Physical treatment process**
  - **Chemical treatment process**
  - **Biochemical treatment process**
- **In water treatment, contaminants present are removed by the combination of above processes**

Water Treatment Processes

- **Some common drinking water treatment processes:**
  - ♦ pretreatment
  - ♦ coagulation
  - ♦ softening
  - ♦ adsorption
  - ♦ ion exchange
  - ♦ disinfection
  - ♦ ozonation/advanced oxidation
  - ♦ aeration
  - ♦ sedimentation
  - ♦ (granular media) filtration
  - ♦ membrane filtration
  - ♦ stabilization

Selection of treatment processes

Primary factors influencing selection of treatment processes

- **Treated water specification (water quality requirements and applicable standards)**
- **Raw water quality and its variation**
- **Local constraints (in developing countries)**
  - **Availability of skilled and unskilled labour, equipment, construction materials, water treatment chemicals**
  - **Influence of local traditions, customs, and culture**
- **Relative costs of different treatment options (Capital and O&M Costs)**

Criteria for small-scale water treatment system

- The lowest possible level of complexity
- Construction and operations with the maximum use of the locally available materials and labour
- Minimal usage of mechanical and automated equipment and chemicals (that need to be imported)
- Simple operation and maintenance
- Low capital and O&M costs
- Minimal energy use; Optimal employment of primary energy sources

Groundwater Treatment

- **Groundwater - a major source of drinking water worldwide**
  - extensively in rural areas (developing countries)

- **Groundwater quality problems:**

Iron and Manganese	**- taste, colour, stain**
Fluoride, Arsenic	**- health consequences**
Methane, Ammonium	**- smell, biological growth**

- **People may reject groundwater for its taste and colour and go back to traditional sources.**

- **Treatment at**
  household level, handpump level or community level

Surface Water Treatment

- **Surface water - generally needs treatment due to natural and manmade pollution**

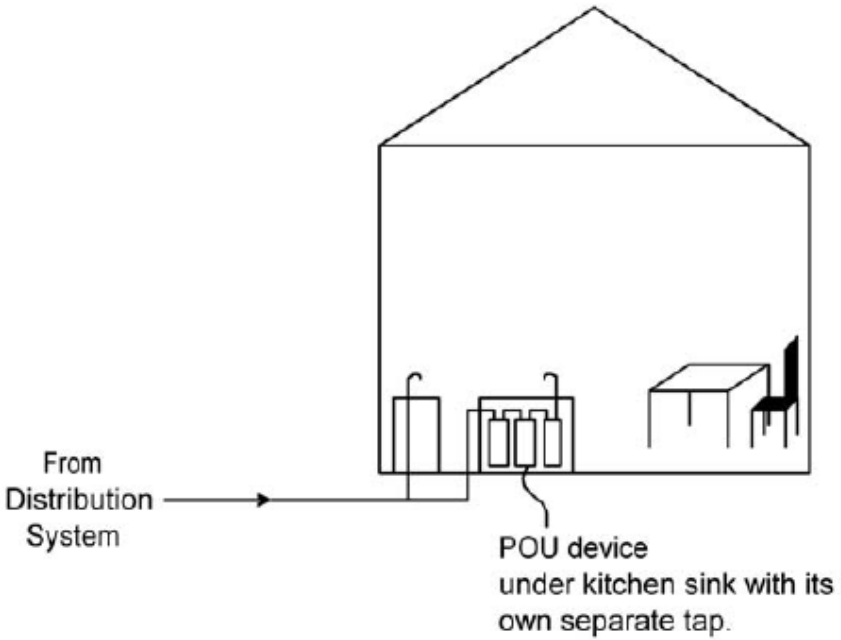
- **Design of treatment system mainly depends on following water quality parameters:**
  - **turbidity, colour, suspended solid concentration**
  - **degree of faecal pollution/microbial contamination**

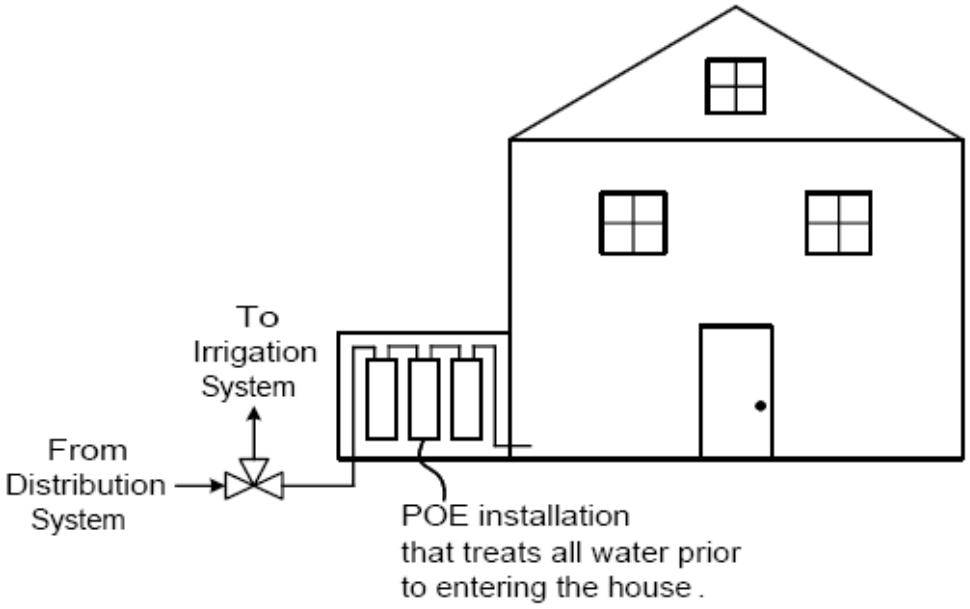
- **For small-scale treatment systems, the main surface water treatment objective are:**
  (i) to improve bacteriological quality (*disinfection*)
  and
  (ii) to improve aesthetic quality (*filtration and removal of specific impurities, if any*)

Types of Water Treatment Systems

- **Household level**
  - **Point of Use (POU) treatment system**
  - **Point of Entry (POE) treatment system**
- **Handpump/source level treatment system**
- **Centralised treatment system**
  (at community level, for piped water supply)

POU and POE Water Treatment Systems





Source: (USEPA, 2006)

Point-of-use (POU) water treatment systems are designed to treat water at a single location in a building (with or without piped water supply)

Point-of-entry (POE) treatment systems are designed to treat all of the water entering a building

Household level treatment - Suitability

- Small amount of water is being supplied from a well or spring, and particularly water is collected and transported by hand
- Source is contaminated and simple protective measures can neither improve water quality nor stop contamination
- Community resources are inadequate to meet the cost of a simple community treatment system
- Community uses several water sources or homes are widely separated making it difficult to develop a centralised treatment system
- An emergency situation causing disruption of the service and contamination of the water supply

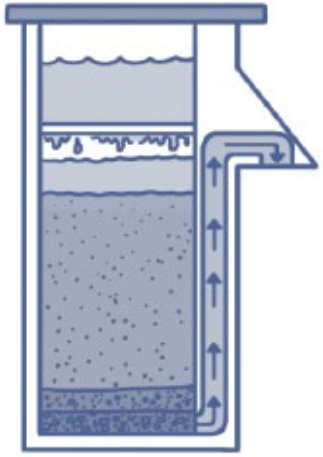
Types of Household Level Treatment Systems

- **Many promising technologies for household level (POU) treatment systems are available**

Most Common Methods:

- **Disinfection**
  - **Boiling,**
  - **UV**
  - **Chlorine compounds**
  - **Solar disinfection**
- **Filtration**
  - **Sand,**
  - **Activated carbon**
  - **Ceramic filters**
  - **Adsorptive media to remove specific impurities (As, F, Mn^{-})**
  - **Membrane filtration (UF, RO)**
- **Coagulation**
- **Ion-exchange**

- **"Middle-market Water Treatment System"**
  (combining different methods in one or more units)

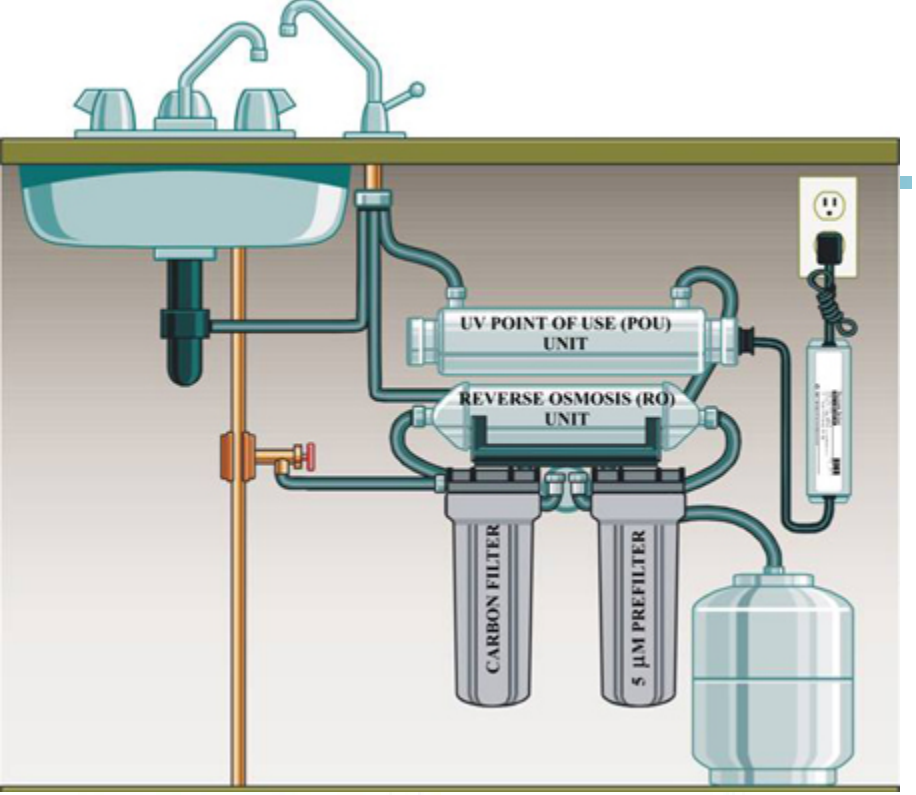


Filtration (ceramic, porous;
membrane filtration not pictured)

Chemical disinfection

Heat; including boiling, pasteurization and UV radiation

Flocculant/disinfectant

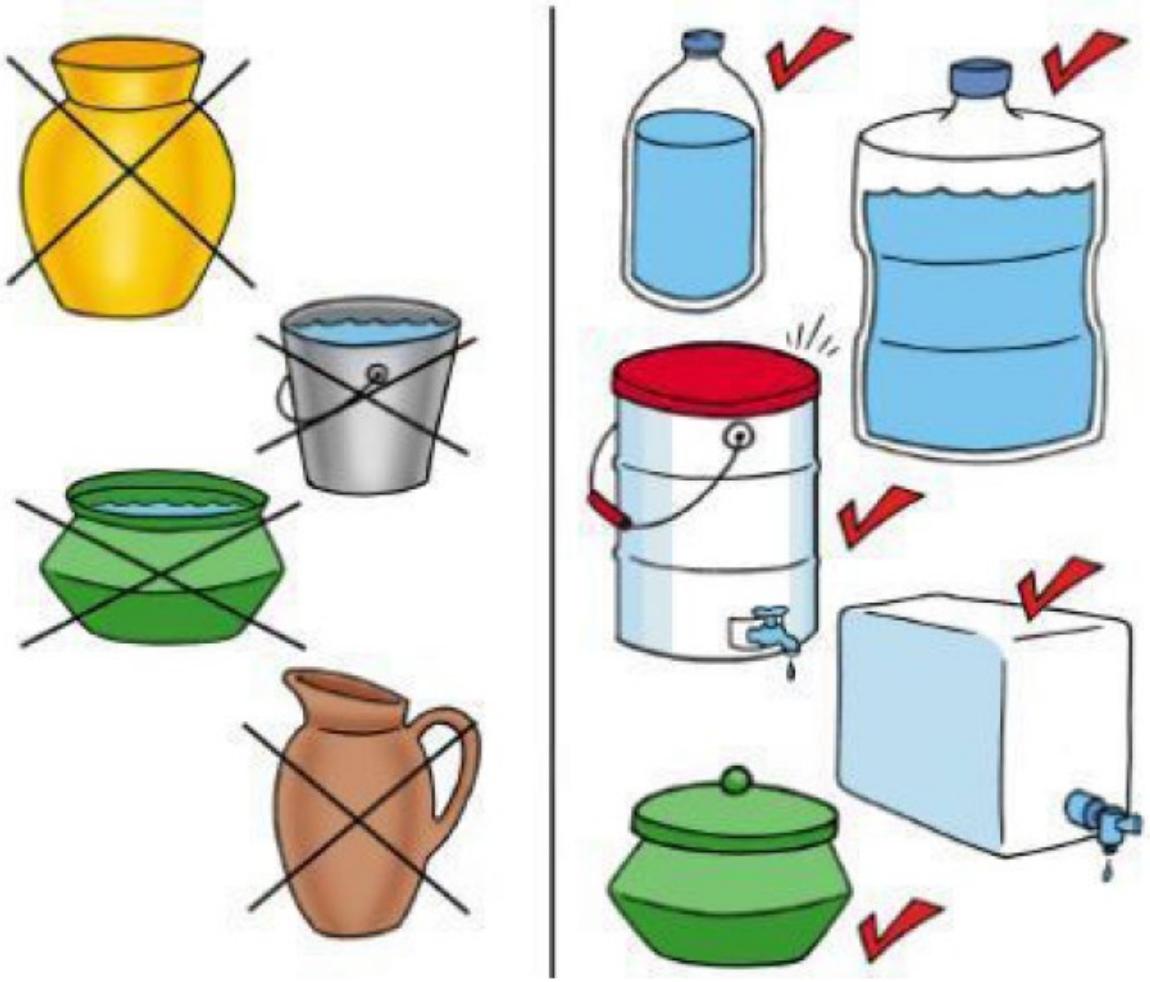

UV POINT OF USE (POU) UNIT
REVERSE OSMOSIS (RO) UNIT
CARBON FILTER
5 µM PREFILTER


Filtrao


Filtrao

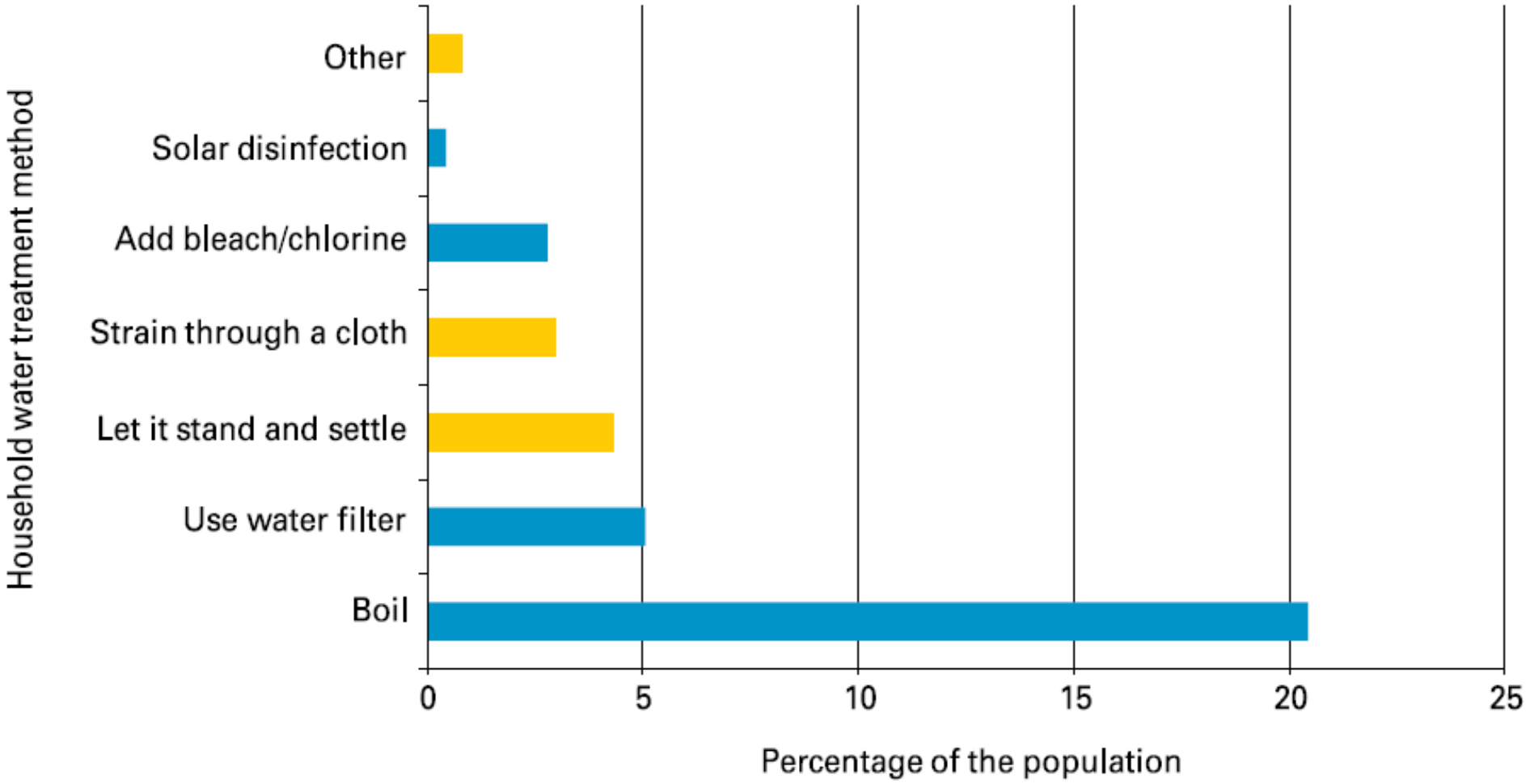
Safe Storage and Handling of Treated Water

Examples of good and bad water storage containers



Source: CAWST (2009)

Prevalence of household water treatment methods



Source: UNICEF and WHO (2011)

Household Water Treatment and Safe Storage

Advantages	Limitations
• Can be implemented faster than a community system • Relies on individual motivation rather than community consensus • Relatively inexpensive & cost effective • Provides an entry point for hygiene and sanitation education • Wide range of simple technologies are available based on suitability and affordability for the household • Reduces the contamination risk between source, treatment and use	• Requires households to be knowledgeable about O&M • Most technologies are designed to remove pathogens rather than chemicals • Treated water may be lower quality than that offered by a well designed, operated and maintained community water supply system

Source: CAWST – Training Manual (2009)

Multi-barrier approach to safe water supply

- **Simply relying on treatment processes in not adequate**
- **Multi-barrier approach is essential**
  - **An integral system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water *from source to tap* to reduce risks to public health**
- **Key elements of multi-barrier approach in HHWT:**
  - **Source protection**
  - **Optimal treatment system (with multiple barriers)**
  - **Management of water quality at homes**

    (*Safe storage/handling; hygienic practices)*
  - **Regular *m*onitoring and testing**

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Thank you for your attention