

## 2.1 Plastic bottle for water purification

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| <p><b>Basic information and collecting ideas</b></p>  | <p>This model experiment demonstrates the natural purification process for contaminated water. Many cities drain polluted water from rivers into the soil and recycle it as purified water from deep wells for further use as drinking water.</p> <p>When water contains toxic substances such as fluorides, charcoal can be used as a cleansing agent. Due to its porosity, charcoal has a large surface area that adsorbs unwanted substances and the filtered water can be used as drinking water. This process is carried out in many African countries, as charcoal is a cheap filter material.</p> |
| <p><b>Setting up and conducting experiments</b></p>   | <p>Provide washed materials such as sand and gravel and drill a hole in the cap of the bottle so that the filtered water can flow out. Depending on the materials and pore size, the filtered water is clear or mostly clear.</p> <p>In some regions with a high fluoride concentration, people use the ash from burned bones because the phosphate of the bones is able to absorb the fluoride.</p>   |
| <p><b>Observing and documenting</b></p>             | <p>Students should compare different solutions in tubes of the same diameter. Different diameters distort the results.</p>   |
| <p><b>Analysing and reflecting</b></p>              |  |
| <p><b>Doing further research</b></p>                | <p>Dissolved salts are not filtered out of the water by this process because they flow through the existing pores. Inform the students about the different pore sizes of the materials:</p> <ul style="list-style-type: none"> <li>▪ Sand in the millimetre range</li> <li>▪ Ceramic container in the micrometre range</li> </ul> <p>Only special plastic material with pores in the nanometre range will be able to filter out the salt.</p>  |

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| <p><b>Technical and vocational application</b></p>  | <ul style="list-style-type: none"> <li>▪ Ceramic vessels are used in many countries to purify unclean water.</li> <li>▪ In some regions with a high fluoride concentration, people use the ash from bones of slaughtered animals because the phosphate of the bones is able to absorb the fluoride.</li> <li>▪ The students should be supported in developing a cleaning system to produce drinking water from river water for outdoor activities (filter material: clean sand).</li> <li>▪ Collected rainwater should also be cleaned using charcoal filters to filter out any organic matter. As a result, the purified water is better preserved.</li> </ul> |
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## Filtration methods with different pore sizes for different applications

### Overview of membrane filters

| Process                      | Microfiltration (MF)  | Ultrafiltration (UF)   | Nanofiltration (NF)  | Reverse osmosis (RO)  |
|------------------------------|---|--|--|---|
| Filter material              | Organic material or ceramic   | Polyamides, polysulfanes, cellulose acetates, PVdF (polyvinylidene fluoride) | Homogeneous polymer layers   | Homogeneous polymer layers  |
| Pore size                    | In the micrometer range<br>0,05 – 10 µm   | Hundredths of micrometers<br>0.005 – 0.15 µm                                 | In the nanometer range<br>0.7 – 10 nm                                    | < 1 nm<br>"No pores"  |
| Separable substances         | Plankton, algae, turbidity, bacteria, suspended particles, fibers, poss. proteins and large microorganisms (amoeba) | Macromolecules, viruses, colloids, bacteria                                  | Organic compounds, ions (bivalent), dyes, pesticides and also herbicides | Molecules and ions: alkali and earth alkali salts but also heavy metal ions and alcohols as well as sugar |
| Required pressure difference | 0.1 – 2 bar   | 0.1 – 5 bar  | 3 – 20 bar   | 10 – 100 bar  |
| Example                      | Aftertreatment of purified wastewater   | Drinking water treatment (e.g. SkyHydrant)                                   | Pure water treatment, water softening                                    | Ultra-pure water treatment, seawater desalination   |