B4 We produce drinking water – Methods of purifying water

Note: This answer sheet will go into the analyses for the individual subexperiments only if experience shows that there could be particular difficulties.

1 Rough purification of contaminated water with silica sand, activated carbon, and filter paper

1.5 Analysis

b) Were you able to remove the dissolved table salt using the sand/paper filter and activated carbon?

Note: No. The salt ions cannot be removed through normal filtration or adsorption.

2 Fine purification of water with membrane filter

2.5 Analysis

b) Were you able to remove the dissolved table salt using the membrane filter?

Note: No. The salt ions can be removed only by reverse osmosis with filter pores in the subnanometer range.

3 Fine purification of water with hollow fiber membrane filter

3.5 Analysis

a) Which of the filtration methods used was most effective? Please explain.

Note: The filtration methods using a membrane filter or a hollow fiber membrane tube are the most effective.

b) Explain the degree to which the pore size of the filter or the particle size of the contaminants affects the use and the result of the different filtration methods.

Note: Filtration is based on the relative sizes of the particles to be filtered out and the pore openings of the filter. If the openings are smaller than the particles to be filtered out, the particles will be kept back. Since the membrane filter and the hollow fiber membrane tube have approximately the same pore diameter, their effectiveness as a filter is approximately the same.

c) Ask yourself whether all contaminants can be removed from the water using mechanical filtration.

Note: No. See above!

d) Describe how the conductivity of the filtrate changed after the individual separation methods and explain the result.

Note: The conductivity remains high throughout all purification stages, because the table salt ions cannot be removed with the applied methods.

e) Suggest an additional separation method that you could use to turn salt water into drinking water.

Note: Pure water can be obtained from salt water only by means of reverse osmosis or distillation (vaporization of the water).

4 Questions (summary for all subexperiments)

a) Why is clean drinking water so important for humans? How many people do not have access to clean drinking water?

Answer: Clean drinking water is necessary for human life. A person normally cannot survive longer than three days without water. Although a person's water requirement can be met with contaminated water, the consequence is that the person will perish due to the toxins or pathogens in the water. In wealthier countries, some people meet their water requirement through beverages other than water. You might therefore think that these beverages could serve as a substitute for clean drinking water. However, that is not the case, because clean water is necessary for the production of all beverages that can meet the water requirement.
Around the world, almost one billion people do not have access to clean drinking water.

b) The quality of drinking water is deteriorating around the world. How can you explain that?

Answer: Among other things, the inadequate supply of water can be traced to the Earth's growing population, regional water shortages caused by climatic conditions, and the deforestation of water-retaining forests. In many areas, though, the main reason is the contamination of natural water reserves (rivers, lakes, and ground water) by households, industry, and agriculture.

If you have Internet access:

Note: You will find further media on the following questions on the media portal of Siemens Stiftung in the media packages “Experimento | 10+: B4 We produce drinking water,” “Waste water and sewage plant,” and “Humanitarian aid – drinking water filters in use.” Teachers can download these media and provide them to the students for offline investigation. On the media portal, you will also find a link list for this experiment that refers to additional information.

c) Which filtration methods are best suited for different sizes of contaminant particles? What are these methods called? What technology do they require?

Answer: For links for searching, see the link list for the experiment.

d) What other options are available for the purification of drinking water?

Answer: The methods investigated in the subexperiments are indeed the standard, on an industrial scale as well. The standard method for obtaining drinking water from ground water and river water is filtration with sand filters. For contamination with organic substances, adsorption methods may also be used (usually with activated carbon). Other contaminants such as nitrate and nitrites are often removed today using hollow fiber membrane filters with especially small pores. In addition, the water must be sterilized, for example, with ozone and/or UV light or with chlorine.

e) How does reverse osmosis work? What it is used for? Are there any advantages or disadvantages of the process?

Answer: For links for searching, see the link list for the experiment.

f) What is meant by “biodegradable” contaminants? Can you name some examples? How does biodegradation work?

Answer: Simple organic substances can be broken down by microbes occurring in nature. If the process takes place in the presence of air (aerobic), the substances are primarily broken down into water and oxygen. In the absence of air, anaerobic microbes convert the substances into products such as methane (biogas). This purification method may meet the requirements of waste water treatment in a sewage plant. It is not sufficient for drinking water. In that case, the water must be purified further and sterilized to a great extent.

g) How does the government of your country regulate the protection of drinking water? What institutions oversee compliance with those laws?

Answer: For links for searching, see the link list for the experiment.