Drinking water treatment (Item No.: P7187900)

Curricular Relevance

Area of Expertise: Chemie
Education Level: Klasse 10-13
Topic: Organische Chemie
Subtopic: Lebensmittelchemie: Fette, Kohlenhydrate, Aminosäuren/Proteine, Vitamine, Gewürze
Experiment: Trinkwasseraufbereitur

Difficulty	Preparation Time	Execution Time	Recommended Group Size
Intermediate	10 Minutes	20 Minutes	2 Students

Additional Requirements:

Experiment Variations:

Keywords:

water treatment

Task and equipment

Information for teachers

Additional Information

Shortage of drinking water! This message is sent out many times each year.
In Germany the consumption of water per head is 122 liters / day, while in the U.S. or in Italy the consumption per head is about 260 liters per day per person.

Notes on content and learning objectives

- Drinking water must frequently be prepared by iron removal, sterilization and deacidification.
- Organic compounds can be removed from water by treatment with activated carbon.

Notes on the method

The significance of water as the most important food should be explained on the basis of various examples.
Limiting values are set for various contamination parameters for drinking water.

Fundamentals and remarks

Drinking water is mainly won from ground water, surface waters such as from rivers and dams, spring water, rain water or sea water.
The water must frequently be treated to remove spoiling substances. The most important treatment processes are sterilization, deacidification, iron removal, demanganization and softening.
For the chemical deacidification, magnesite ($MgCO_3$) and dolomite ($CaCO_3 \cdot MgCO_3$) are also used, alongside marble ($CaCO_3$).

Hints on going deeper

- Further drinking water parameters can be determined with quick test methods (for example TESS Biology Set Biological water analysis, Order-No. 30834-88).

Notes on set-up and procedure

Preparation:
Manganese(II) salts can be used in place of iron salts, the process is then called demanganization.
Organic solvents such as petrol or mineral oil, as organic contamination, can also be removed with activated carbon.

Notes on the students experiment:
Should a magnetic stirrer be available, it can be used to stir the solution in beaker 1.
Ensure that the hydrochloric acid solution is only slowly poured over the marble. The pH of the water before and after the reaction with marble can be determined with universal indicator paper or a pH meter.





Hazard and Precautionary statements

Iron-III chloride:

H302:	Harmful if swallowed.
H315:	Causes skin irritation.
H317:	May cause an allergic skin reaction.
H318:	Causes serious eye damage.
P280:	Wear protective gloves/protective clothing/eye protection/face protection.
P301+P312:	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P302+P352:	IF ON SKIN: Wash with soap and water.
P305+P351+P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P310:	Immediately call a POISON CENTER or doctor/physician.

Ethanol:

H225:	Highly flammable liquid and vapour.
P210:	Keep away from heat/sparks/open flames/hot surfaces – No smoking.

Hydrochloric acid:

H290:	May be corrosive to metals.
H314:	Causes severe skin burns and eye damage.
H335:	May cause respiratory irritation.
P234:	Keep only in original container.
P260:	Do not breathe dust/fume/gas/mist/vapours/spray.
P303+P361+P353:	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340:	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338:	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do – continue rinsing.
P309+P311:	IF exposed or you feel unwell: Call a POISON CENTER or doctor/physician.

Hazards

- Hydrochloric acid and iron-III chloride can cause damage to health when ingested. Ensure complete avoidance of skin-contact with the chemicals.
- Wear protective gloves and protective glasses.
- Ethanol is highly inflammable. Extinguish all open flames before handling it.

Waste disposal

Pour the solutions to drain. Put solid material in the normal waste bin.

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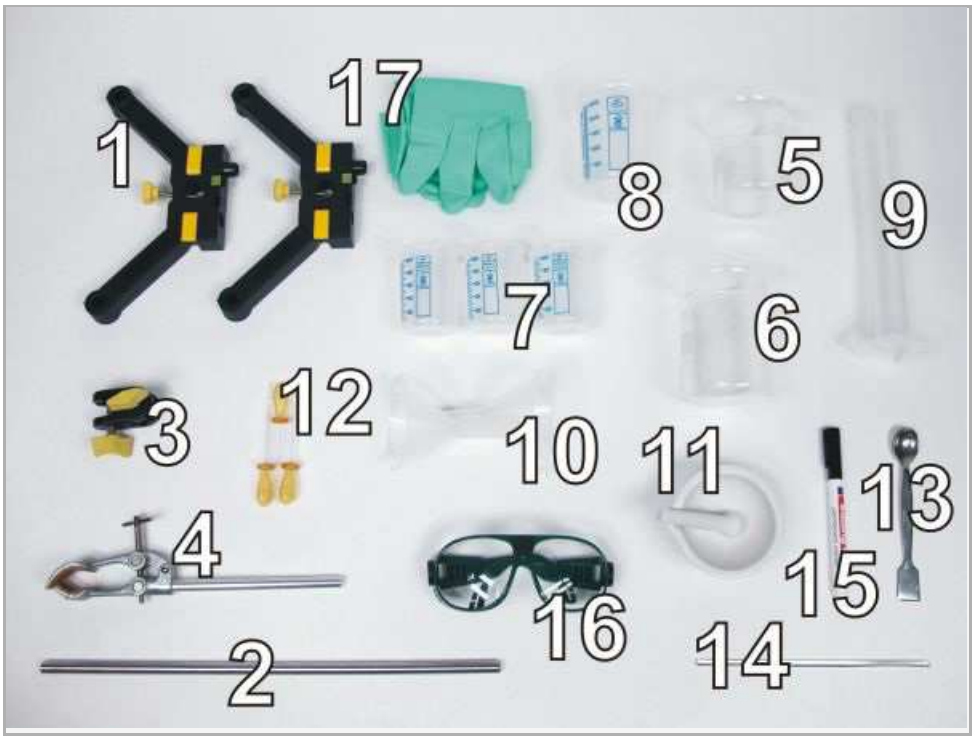
Task and equipment

Task

How can drinking water be prepared?

Remove unwanted substances from samples of water.

Equipment



Position No.	Material	Order No.	Quantity
1	Support base, variable	02001-00	1
2	Support rod, stainless steel, l=370 mm, d=10 mm	02059-00	1
3	Boss head	02043-00	1
4	Universal clamp	37715-00	1
5	Glass beaker DURAN®, short, 250 ml	36013-00	1
6	Glass beaker DURAN®, short, 400 ml	36014-00	1
7	Beaker, 100 ml, low form, stackable, plastic	36081-00	3
8	Beaker, 250 ml, low form, stackable, plastic	36082-00	1
9	Graduated cylinder 100 ml, PP transparent	36629-01	1
10	Filter funnel, d = 75 mm, PP	46895-00	2
11	Mortar w. pestle, 70ml, porcelain	32603-00	1
12	Pipette with rubber bulb	64701-00	3
13	Spoon, special steel	33398-00	1
14	Glass rod, boro 3.3, l=200mm, d=6mm	40485-04	3
15	Labor pencil, waterproof	38711-00	1
16	Protecting glasses, clear glass	39316-00	1
17	Rubber gloves, size S (7)	39325-00	1
	Activated carbon, granular 500 g	30011-50	1
	Iron-III chloride 6-hydr. 500 g	30069-50	1
	Marble, pieces 1000 g	30140-70	1
	Methyl red solution (alc.) 50 ml	30145-05	1
	Hydrochloric acid 25% 1000 ml	31822-70	1
	folded filter,qual.,150 mm,100pcs	47580-04	3
Additional material			
	Vegetable oil (sunflower oil, olive oil,...)		
	Drinking water		

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Set-up and procedure

Set-up

Hazards

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Setup

Number three 100 ml lab beakers 1, 2 and 3 (Fig. 1).

Fig. 1

Pour 50 ml of tap water into a 400 ml glass beaker, a 250 ml glass beaker and a 250 ml lab beaker (Fig. 2).

Fig. 2

Put a few pieces of marble in the mortar and crush them with the pestle (Fig. 3).

Fig. 3

Assemble the stand as shown in figures 4 to 7.

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Procedure

Add a spatula tip of iron-III chloride to the water in the 400 ml glass beaker. When the salt has dissolved, stir the solution vigorously with a glass rod for about 10 minutes. Place the beaker to one side for at least 30 minutes.
Attach a cleanly rinsed funnel with the universal clamp. so that it hangs vertically above lab beaker 1 and put a fluted filter into the funnel.Filter the mixture through a fluted filter. Note the colour of the filtrate and of the precipitate on the filter.

Fig. 8

Fig. 9

Fig. 10

Pipette a few drops of methyl red into the 250 ml glass beaker. Add three drops of hydrochloric acid to the solution.
Attach a cleanly rinsed funnel with the universal clamp. so that it hangs vertically above lab beaker 2 and put a fluted filter into the funnel. Transfer the crushed marble to the fluted filter. Slowly pour the hydrochloric acid solution from the glass beaker over the marble. Check the filtrate.

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Fig. 11

Fig. 12

Pipette a few drops of vegetable oil onto the water in the 250 ml lab beaker. Add a spatula tip of activated carbon. Stir the solution vigorously with a glass rod.

Attach a cleanly rinsed funnel with the universal clamp. so that it hangs vertically above lab beaker 3 and put a fluted filter into the funnel. Subsequently filter the mixture through the fluted filter into lab beaker 3. Check the filtrate.

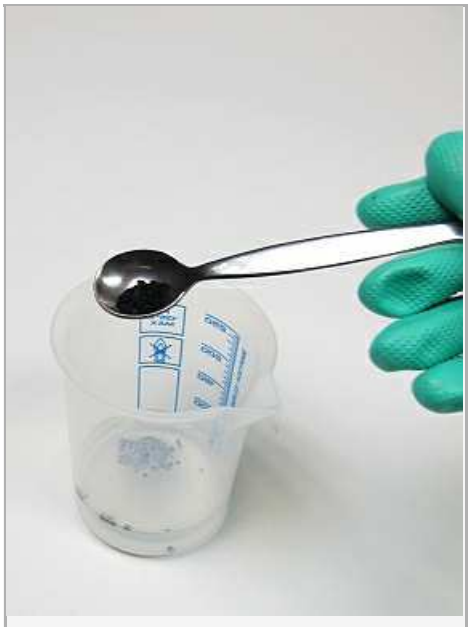

Fig. 13

Waste disposal

Pour the solutions to drain. Put solid material in the normal waste bin.

Report: Drinking water treatment

Result - Observations

Describe your observations.

a) Water with iron salts

b) Water with acid

c) Water with organic substance

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Evaluation - Question 1

Draw conclusions from your observations.

a) Water with iron salts

b) Water with acid

c) Water with organic substances

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Evaluation - Question 2

How can water be sterilized?

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Evaluation - Question 3

Which basis requirements must be fulfilled by drinking water?

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Evaluation - Question 4

Complete the following statements.

1. Iron is removed by ..... or ...... Iron salts react to insoluble .....
2. Acidified water is filtered over ....., so increasing the .....
3. Organic substances and suspended matter are removed by ..... filters.
4. Bacteria are killed by ..... or .....