

Tento projekt je financován Evropskou unií v rámci Národního plánu obnovy.

Tool: Water treatment plant

As part of the project From the faucet to the toilet, we have prepared an illustrative aid that will allow you and your children to explore the technological processes at the water treatment plant, thanks to which drinking water flows from the tap.

I) WATER TREATMENT PLANT MODEL

Time:	Environment:
about 60 minutes	anywhere, ideally a larger table

Thanks to the water treatment plant and its technology, drinking water flows from the tap at home. But what chemistry and what processes prepare such drinking water for us? This tool shows a simplified technology of modern water treatment typical for Central Europe.

The described tool (water treatment plant model) is designed in a modular way, so you can rearrange the individual technological units so that a specific water treatment plant can be demonstrated. For a professional description of individual technological units and processes, we refer to the methodology for conducting a tour of the water treatment plant created as part of the same project.

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Equipment and materials needed:

You can find the necessary equipment in the two supplied plastic boxes, or you can get them yourself; the tool is prepared in such a way that nothing is used that cannot be found in a normal school laboratory and workshop.

The assembly consists of a small and a large plastic box; the entire model is located in the small one, the large one functions as a handy store of support and supplementary material. Everything you need for the experiment is shown in the picture and described below.

A1 – reservoir representing the source of raw water, i.e. reservoir, river or well; at the point of connection of the tube there is a fabric mesh representing combs on the inflow to the treatment plant technology

A2 – mixing tank (aggregation) and dosing of chemicals (coagulant, pH change)

A3 – sand filtration, a fabric net is placed at the point where the water drains away, preventing the further flow of sand

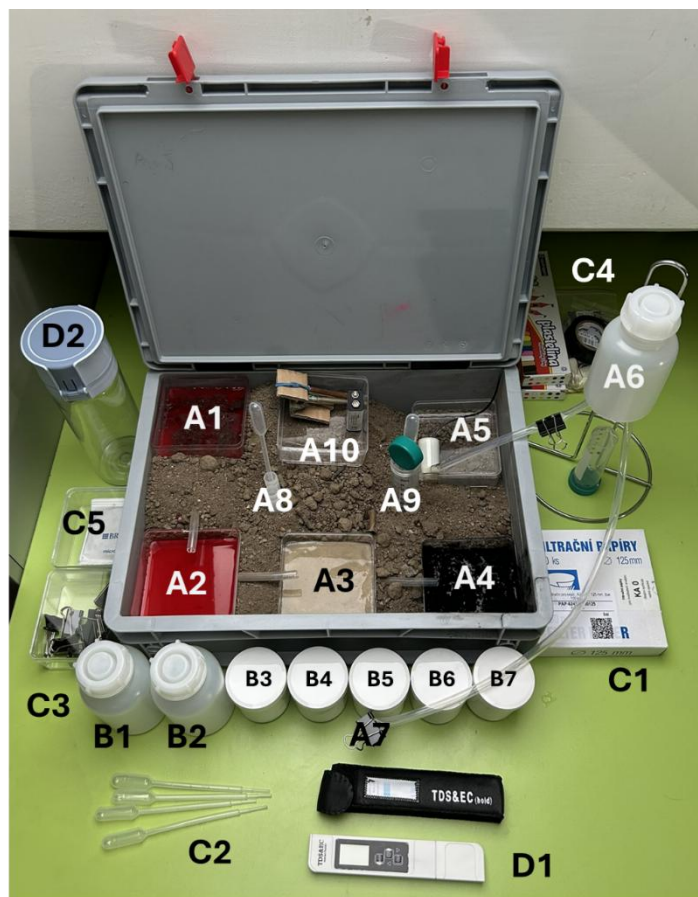
A4 – filtration through activated carbon, a fabric net is placed at the point of outflow to prevent the outflow of activated carbon into the accumulation

A5 – accumulation of treated water with hygienic hypochlorite protection and a submersible pump (representing the automatic pressure station ATS) pumping water into the reservoir; the pump is connected to the battery reservoir (batteries are included in the package)

A6 – above-ground water tank with a volume of 100 mL, possibility of secondary hygienic water security

A7 – a gravity-fed consumer closed by a flap; by raising the outlet from the tube to different heights, it is possible to simulate the pressure conditions in the gravity-fed consumer (alternatively, the pressure ratio can also be used in the case of simultaneously opening the consumer flap and switching on the submersible pump)

A8 – two chemical dosing tanks (pH adjustment and coagulant)



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A9 – chemical dosing tank for the sanitation of supplied water (typically sodium hypochlorite)

A10 – dual-use tank – possibility of use as sludge management for filter tanks in technology / electrocoagulation tank for an alternative demonstration of coagulation without chemicals

B1 – bottle with a volume of 100 mL for the preparation of raw water (you can mix dyes, add tonic or other unwanted colloidal substances in the water)

B2 – tank for chemicals (in case of dilution, for example SAVA)

B3 – dye container for raw water pollution preparation (one color; other colors in a large plastic box); it is a food coloring and corn starch, i.e. harmless to health (even so, we do not recommend consuming raw or model-treated water)

B4 – tank for filter sand for refilling the tank in technology (another supply in a large plastic box)

B5 - activated carbon tank for refilling the tank in technology (another supply in a large plastic box)

B6 – clay tank for preparing raw water

B7 – tank for kitchen salt for preparing raw water

C1 – filter paper for the option of demonstrating membrane filtration (as an alternative to the sand filtration shown in the basic model)

C2 – reusable dropper (also called Pasteur pipettes) for dispensing chemicals, dyes, or other substances

C3 – caps and flaps for pipe connections within the model

C4 – technical accessories for preparation, modifications and possible repairs of the sample technology (adhesive tapes, plasticine for sealing, tubes, spare submersible pump)

C5 – accessories for the Brita filter bottle (replacement filter rings and cartridges, instructions and more)

D1 – analyzer for pH and conductivity with instructions for use, alternatively universal indicator papers or ISE electrode probes can be used to determine the removal of a specific pollutant

D2 - Brita filter bottle as an example of the compactness of the modification in field conditions (compared to the model on display), spare filter rings are part of item C5

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Procedure:

- 1) First, it is necessary to create a model of the water treatment plant. It is possible to use the delivered and ready-made version described above; however, in the case of a model of a specific treatment plant (which will require a subsequent excursion), it is possible to modify the technology of the model (for example, remove the stage of filtration through activated carbon or, conversely, add another reaction tank).
- 2) The second step is the preparation of raw water. The basis can be tap water with added ingredients (food coloring, sand, leaves, tonic (the treatment will then be displayed with UV light), mud, clay, dust particles and so on), or you can use water from nature (water from standing water with clearly grown biomass is ideal, when the treatment can then be visually seen). In any case, we recommend preparing/collecting the raw water in the presence of the children, or even better, let them complete this step.
- 3) By pouring the prepared raw water into the first tank (marked as A1 in the plan), the treatment process begins, because in the basic model the entire technology is conceived as gravity flow.
- 4) Grab the dropper with the appropriate chemicals (hydroxide, coagulant, or other) and slowly drip into the reaction tank (marked as A2 on the map). As a result, chemical reactions (including so-called coagulation) begin to occur, on the basis of which unwanted substances on the sand filter are removed. It is good not only to drip the chemicals into the tank, but also to mix them afterwards - mixing these tanks is in reality a complex process requiring many calculations, but in this case a simple spoon or spatula will do.¹
- 5) The water from the sand filters overflows into the activated carbon filters and then into the storage tank. In real operation, both types of filters are washed regularly, i.e. they get rid of dirt. The used water, the so-called washing water, is then continued for further processing in the sludge management. Unfortunately, automatic washing is not addressed in this model, but you can at least partially simulate it by thoroughly mixing the sand once in a while and collecting the draining water and pouring it into the tank intended for this (marked as A10 in the plan).

¹You can also perform coagulation without the addition of chemicals. In the dual-use tank (marked as A10 in the plan) you have an electrocoagulation kit ready; all you have to do is connect the battery to the electrodes and put it in a tank with treated water. Almost immediately, oxygen begins to evolve and dirt flakes begin to collect at the electrodes.

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- 6) Pay attention to the level of treated water in the storage tank! At the right time, turn on the submersible pump and open the faucet towards the above-ground water reservoir so that the water can drain from the technology. When there is enough water in the reservoir, turn off the pump and close the faucet. However, you must not forget the hygienic security of the supplied water, typically with sodium hypochlorite (commercial name SAVO). Use the dropper to keep the chlorine level in the water at the required level (in tap water, the ratio is approx. 1 mL of hypochlorite per 2 liters of water, you are not able to achieve such precision here; therefore, take it only as an example, not as an exact dosage).
- 7) You can now start supplying your appliance by releasing the tap on the outlet of the reservoir. Note that the pressure of the water coming out (and the related velocity) depends on the height at which you hold the spout of the tube, until at some height the water stops coming out completely (even if you have water in the reservoir, of course). It is a classic principle of connected containers, and city and village reservoirs work on the same principle.
- 8) Even if all technological steps are thoroughly calculated and modeled, you cannot rely on them alone. In real operation, all technological steps are monitored – samples from the operation are continuously taken and analyzed. Therefore, this model also includes a pH and conductivity analyzer, thanks to which you can measure changes in these parameters along the technology (in the case of using salt water, you will measure high conductivity at the beginning, at the end it should be significantly lower; alternatively, of course, the color change due to food coloring or the reaction to UV radiation when using tonic). In addition to the supplied measuring device, you can of course also use classic universal indicator papers or ISE electrodes to measure a specific analyte (for example chlorides).

What we observe:

During the experiment, we can observe the modification of water properties during the technology.