



INTEGRATED DRINKING WATER PURIFICATION TECHNOLOGY FOR OUTDOOR SPORTS EVENTS

Oleksiy KURYLIUK¹, Igor POLOVNIKOV²

*¹National University of Water and
Environmental Engineering, Rivne, Ukraine*

*²Ukrainian Technological Academy,
a member of UNESCO, Kyiv, Ukraine*

Field conditions during outdoor sports competitions, especially multi-day events, require the organization of stable and safe drinking water supply for participants. Water is needed for drinking, preparation of hot beverages and food, as well as for hygiene purposes, including the arrangement of field showers. When the water supply comes from catchments and open natural sources – such as streams, canals, or springs – there is a high probability of contamination with nitrites, organic substances, petroleum residues, and microbiological impurities. This makes direct use of such water impossible without prior treatment.

To address this issue, an autonomous deep water purification system has been developed and tested, combining electrochemical and sorption-filtration methods. The core of the technology is a block-modular flow/non-flow type diaphragm electrolyzer with an inert membrane, equipped with a packed ampholyte cathode for the electrolysis of sodium chlorite (NaClO_2) solution. During electrolysis, environmentally safe chlorine

dioxide (ClO_2) and oxygen are generated in the anode zone, providing intensive oxidation of toxic impurities, particularly converting nitrites to less toxic nitrates, as well as degrading petroleum residues, organic compounds, and microbial contaminants without forming toxic intermediate by-products (such as trihalomethanes, organochlorine compounds, or toxic chloramines).

Additional purification is carried out using a filter filled with floating filter plates made of activated polystyrene (type PSVS) and a granular layer of clinoptilolite (zeolite from the Sokyryany quarry, Carpathians). Final purification is achieved through ultrafiltration and integrated disinfection of the filtrate using chlorine dioxide and electroionized silver (Ag 99.99), ensuring a high level of microbiological safety and excellent organoleptic properties of the treated water (odor, taste, color, transparency, etc.).

Power supply for the unit in field conditions is provided by an autonomous electric generator with the option to connect modular solar panels. Continuous low-voltage direct current supply to the electrolyzer is ensured by a portable charging station (type HBM Machines), allowing the equipment to be operated independently of centralized grids and recharged from the autonomous generator.

Field tests of the system were conducted during summer using water collected from a canal near Sloviansk and a lake near Rivne. According to the analysis, the concentration of nitrites in the raw water exceeded the maximum allowable limits by 12–15 times; color intensity exceeded permissible limits by 8–12 times; and odor intensity corresponded to an excess of 4–6 points on the odor scale. Water quality control was performed using an autonomous photometer (Pool Lab 1.0), as well as in field express analysis and laboratory settings.

During operation, water was supplied to the anode chamber of the diaphragm electrolyzer-activator designed by Pylypchuk, where oxidation of pollutants occurred with the participation of gases generated at the graphite anode. These gases (chlorine dioxide and oxygen) were extracted from the electrode space using a vacuum-ejector method and mixed with the water flow in a special column (ejector), hydraulically connected to the pump and pneumatically to the anode chamber. The concentration of gases was regulated by adjusting the

electrolysis parameters (current-voltage) and by dosing the NaClO_2 solution and water supplied to the anode zone.

The anodes were made of high-purity graphite connected to the positive terminal of the power source. Oxidation processes were intensified by the continuous generation of chlorine dioxide and oxygen directly on the anode surface. The cathode consisted of a stainless-steel mesh electrode (grade X18H9T) and ampholyte filler based on aluminum shavings (silumin), positioned between the cathode and the inert diaphragm made of chlorine-containing fabric (Chlorine type) fixed on an electrically neutral frame.

The anode chamber of the electrolyzer operated in flow mode, while the cathode chamber functioned in non-flow mode. Flotation sludge with aggregated contaminants formed during electrolysis was discharged into a separate collector.

The trials confirmed that electrolysis of NaClO_2 solution in the described configuration of the diaphragm electrolyzer-activator with a combined ampholyte cathode contributes to deep purification of water from trace petroleum residues, mercaptans, skatole, and other common impurities found in surface water bodies. The treated water achieved consistently high organoleptic parameters and can be safely used by athletes and eco-tourists for both drinking and household needs while staying in nature.

The autonomous block-modular unit for obtaining potable-quality water for athletes and green tourism enthusiasts enables safe and comfortable outdoor sports and recreation. The unit is transportable by a passenger car or trailer.



Photo: Preparation for transportation of the autonomous block-modular unit for obtaining potable-quality water under field conditions using water from open sources (canal, lake, river, or catchments).

List of references

1. Mikhaleva M.S., Svitlyk I.V. Possibilities of using electrochemical technologies for modifying the properties and controlling the quality of water. / Technology audit and production reserves - No. 3/1(17), 2014. - P. 31-33.
2. Patent for KM No. 119008. Diaphragm electrolyser by Filipchuk for water activation. Published 11.09.2017, bulletin No. 17
3. Patent for KM No. 158685. Sulyma-Kuryliuk complex water purification filter. Published 05.03.2025, bulletin No. 10