Technical Solutions and Technological Schemes for the Engineering Protection of the Water and Energy Supply of Small Recreational Facilities on the Black Sea Coast of the Krasnodar Region

Tehnička rješenja i tehnološke sheme struktura za očuvanje opskrbe vode i energije u malim prostorima za rekreaciju na obali Crnog mora u Krasnodarskom kraju

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Summary

This article deals with issues on the design of seasonal-active water-power supply systems for small recreational facilities on the Black Sea coast. Modular prefabricated shell facilities are proposed for water and energy supply (MPSFWE) that meet the ecological infrastructure requirements in specially protected areas and provide the least negative impact on the environment by making maximum use of local building materials and ensure energy conservation through energy recovery. The first part of the article gives the rationale for the development of recreational facilities on the Black Sea coast of the Krasnodar region. The second part of the article gives the characteristics of natural and climatic conditions, water resources and the Black Sea coast, defining the basic requirements for their engineering protection and the water and energy supply systems. The third part of the article justifies the choice of new technical solutions and technologies for erecting engineering protection structures from composite materials. The fourth part of the article justifies the technological schemes of water treatment using membrane technologies and energy recovery for the water and energy supply of seasonally operating recreation facilities, as well as berthing facilities and yacht berths. It considers the technological schemes of water supply.

KEY WORDS

Black Sea
recreation
water and energy supply
engineering protection
shell structures
reverse osmosis

Sažetak

Članak se bavi pitanjima projektiranja sezonski aktivnih sustava vodoopskrbe u malim prostorima za rekreaciju na obali Crnog mora. Predložene su modularne montažne oplate za vodoopskrbu i opskrbu energijom (MPSFWE) koje zadovoljavaju zahtjeve ekološke infrastrukture u posebno zaštićenim područjima i pružaju najmanje negativan utjecaj na okoliš maksimalnom uporabom lokalnih građevinskih materijala te osiguravaju očuvanje energije kroz uporabu energije. U prvom dijelu članka govori se o razvoju rekreativnih sadržaja na crnomorskoj obali Krasnodarskog kraja. Drugi dio članka daje značajke prirodnih i klimatskih uvjeta, vodnih resursa i obale Crnog mora, definirajući osnovne zahtjeve vezane uz inženjersku zaštitu i sustave opskrbe vodom i energijom. U trećem dijelu članka analizira se izbor novih tehničkih rješenja i tehnologija za podizanje inženjerskih zaštitnih struktura od kompozitnih materijala. U četvrtom dijelu članka opisuju se tehnološke sheme pročišćavanja voda uz pomoć membranskih tehnologija i uporabe energije za opskrbu vodom i energijom sezonskih rekreacijskih objekata, kao i standardnih vezova i vezova za jahte. Razmatraju se tehnološke sheme opskrbe vodom.

KLJUČNE RIJEČI

Crno more
rekreacija
opskrba vodom i energijom
zaštitne konstrukcije
školjkaste strukture
postrojenja za dovod vode
reverzna osmoza

1. PROSPECTS FOR THE DEVELOPMENT OF THE RECREATIONAL SECTOR ON THE BLACK SEA COAST OF KRASNODAR REGION / *Budućnost razvoja rekreativnog sektora na crnomorskoj obali Krasnodarskog kraja*

The Black Sea coast within the Krasnodar region of the Russian Federation extends to 475 km, mostly with fully developed beach areas near towns and municipalities, the most extensive of which is Anapa, extending up to about 60 km and Bolshoi Sochi - 118 km. Also, the most organized beach areas of the resorts of Durso, Kabardinka, Gelendzhik, Divnomorsk, Nebug, Lazarevskoe, between which are located the so-called "wild beaches", bays and rocky areas (Fig. 1) [1, 2].

Taking into account the increase in tourist flow along the coast (in 2016 estimated at more than 14.1 million people) in summer, the recreational capacity of the existing beach areas will be insufficient.

One of the most promising areas is the simultaneous development and streamlining of "wild beaches", bays and rocky areas in the first and second zone belts of sanitary protection, taking into account the environmental requirements.

Furthermore, attention should be mostly focused on small seasonally-active recreation facilities, which in terms of nature protection territories are justified by the following reasons: reduce capital costs for the engineering protection of water supply systems; ensure the possibility of modernization and mobility; reduce negative impact on the environment [4, 5].

Small recreational objects arranged in cramped bays and rocky areas include camping sites, floating camps and boat camps [5].

The construction of the last two types of recreational facilities can contribute to the development of water tourism and yachting in the Russian Federation. Currently, the main attention in the development of yachting is given to the elite 2-4 categories of international classification by type of service to yacht clubs that are inaccessible to most holidaymakers and which require a developed infrastructure and significant transformations to the environment upon implementation. Meanwhile, the use of seasonally active float and boat camps with a capacity of 25 to 50 people assumes that yachts of the first category (economy class) are available, accommodating small boats and yachts of mini ton and quarter ton class [5].

The development of these small recreational facilities on territorially disparate sections of the Black Sea coast with underdeveloped infrastructure and difficult terrain conditions is possible if engineering protection structures are built, making maximum use of local building materials and creating decentralized water and energy supply systems either using local surface and underground runoff water or sea water. We shall consider the natural and climatic conditions prevailing along the Black Sea coast when justifying technical and technological solutions for engineering protection and water-energy supply facilities [2].

2. NATURAL-CLIMATIC CONDITIONS AND CHARACTERISTICS OF WATER SUPPLY SOURCES / *Prirodni i klimatski uvjeti i značajke izvora vode*

2.1. The natural and climatic conditions of the Black Sea coast / *Prirodni i klimatski uvjeti na obali Crnog mora*

The climate is temperate continental. On a nice summer day, the average sea surface temperature rises (8.9 °C). In winter, the average surface water temperature in the open sea is 6-8 °C.

Unfavorable physical and geological processes, which have developed in the area under consideration, include the presence of a number of factors that significantly complicate

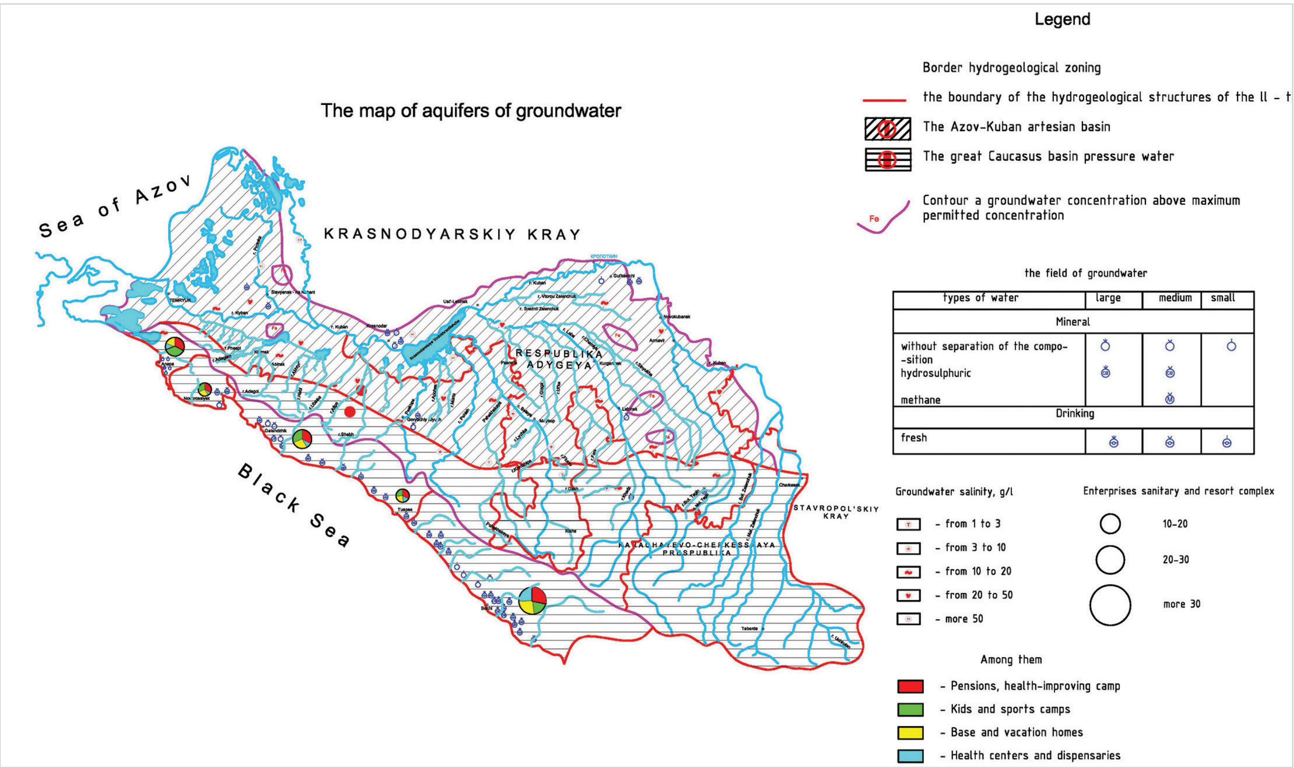


Figure 1 Characteristics of water resources and location of recreational facilities along the Black Sea coast of the Russian Federation

Slika 1. Značajke vodnih resursa i lokacija rekreativnih sadržaja na obali Crnog mora Ruske Federacije the development of the territory and adversely affect its normal life activity. The following are very frequent: landslides and landslips – collapsing land on the slopes of sea and river valleys; weathering, slope washout, active abrasion of the sea shore;• bottom and side erosion of watercourses; flooding in floodplain areas; development of mudflows; groundwater flooding; Karst processes; formation and development of snow avalanches.

The high seismicity of the territory under consideration poses a great threat. This is facilitated by the geological structure, tectonic and hydrogeological processes, intensive abrasion of the sea, the erosive impact of water currents and wind activity.

The most relevant is the use of landslide and bank protection structures and seasonal use.

2.2 Characteristics of water supply sources / *Značajke izvora vode*

2.2.1 Characteristics of river runoff within the Tuapse-Sochi area of the Black sea / *Značajke otjecanja rijeke u regiji Tuapse-Sočina Crnom moru*

Surface river runoff, groundwater and seawater can be considered as potential water supply sources.

The source of water along the rivers of the Black Sea coast are mixed in nature, predominantly from rain. Since precipitation on the coast occurs throughout the year, the hydrographs of the rivers are saw-shaped due to frequent and short floods, overlapping the smooth line, which limit the hydrograph to ground and mountain-snow sources.

The average annual runoff of the rivers of the Black Sea basin, located on the territory of the Russian Federation, is 6.8 km^3. The distribution of runoff on rivers during the year is uneven. For the Middle-altitudinal mountains of the Black Sea chain of the Caucasus (Tuapse, Sochi), the prevalence of spring runoff is typical, which is due to the melting of small snow caps on the upper parts of the basins at that time. The rivers of the foothills and midlands of the North-west Caucasus (Anapa, Novorossiysk, Gelendzhik) have a winter peak flow, coinciding with the rain maximum. Their water regime is typically Mediterranean in nature.

For this reason, it is necessary to ensure seasonal accumulation of surface runoff during the summer period for channel and sub-channel water intake without interfering with the transport of sediments.

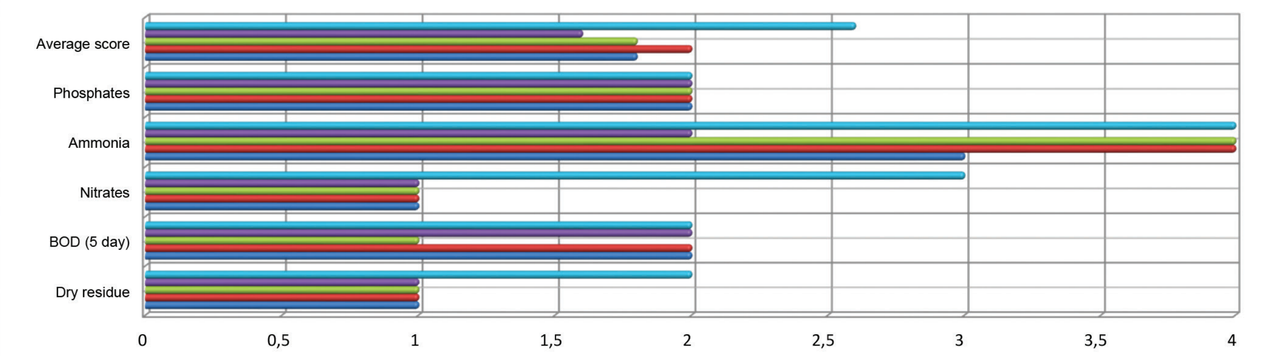
Hydrochemical characteristics of rivers according to the complex use schemes of the Black Sea basin rivers are shown in Figure 2 [2].

According to hydrochemical indicators, compact installations may be used for water conditioning.

2.2.2 Characteristics of the coastal sea waters of Krasnodar region / *Značajke priobalja Krasnodarskog kraja*

In summer, surface water is heated up to 25 °C or more to a depth of 15-30 m over the entire sea water area. Deeper than the seasonal thermocline, the temperature decreases to approximately 75-100 m, where cold intermediate waters are located with a constant temperature of 7-8 °C throughout the year. Deeper, the temperature rises slowly with depth due to geothermal heat inflow from the bottom and reaches 9.2 °C at a depth of 2 km. The sea is almost always free of ice. Only in some cold winters the coastal waters in the northwestern shallow part of the sea are covered with ice. Ice formation begins in mid-December. The ice thickness reaches 14-15 cm, and in severe winters - 50-55 cm. By the end of March, the ice disappears completely [6].

The seasonal course of salinity of the surface layer of coastal waters is determined by a change in the ratio of river runoff and general circulation. The annual river runoff of the small Caucasus rivers is approximately 7.17 km. Coastal waters from Anapa to Sochi belong to the area with a relatively low salinity in all seasons of the year. Especially noticeable is the local decrease in salinity in the south of the region, at the point where the Mzymta and Sochi rivers flow into the sea. From this site towards the north, salinity rises. The minimum for the seasonal process is in March-April in all areas of the region



	Dry residue	BOD (5 day)	Nitrates	Ammonia	Phosphates	Average score
r. Agoy	2	2	3	4	2	2,6
r. Tuapse	1	2	1	2	2	1,6
r. Shahe	1	1	1	4	2	1,8
r. Psezuapse	1	2	1	4	2	2
r. Ashe	1	2	1	3	2	1,8

Figure 2 Classes of water quality in the Black Sea basin from an ecological point of view
1 class - "conditionally clean"; 2 class – "slightly contaminated"; 3 class grade - "polluted"; 4 class -" dirty "

Slika 2 Ekološki aspect ocjene kvalitete vode u Crnomorskom bazenu
1 klasa – "uvjetno čisto"; 2 klasa – "malo onečišćeno"; 3 klasa – onečišćeno; 4 klasa – "prljavo"

and varies between 16.39‰ (Sochi) and 17.99 ‰ (Anapa). In the summer, there is a slight increase in salinity of the coastal waters, whereby the maximum is usually observed in October-November ranging from 16.92‰ (Sochi) to 18.26‰ (Anapa). The averaged hydrochemical characteristics are given in Table 1.

Table 1 Average characteristics of the chemical composition of the Black Sea waters [2, 6]

Tablica 1 Prosječne vrijednosti kemijskog sastava Crnog mora [2, 6]

Name	Concentration	TLV
The hydrogen index	7,36-8,56 pH	6,0-9,0 pH
Mineralization, mg/l	18600	no more than 1000,0 mg/l
$Ж_o$, mg·equ/l	68,00	no more than7,0 mg·equ/l
HCO_3^-, mg/l	170	-
Na^+, mg/l	6200	-
K^+, mg/l	190	-
Ca^{2+}, mg/l	200	-
Mg^{2+}, mg/l	700	-
Cl^-, mg/l	10000	no more than 350,0 mg/l
SO_4^{2-}, mg/l	1400	no more than 500,0 mg/l
Iron total, mg/l	0,245	0,5 mg/l
Pb, mg/l	0,0111	0,03 mg/l

2.2.3. Characteristics of underground runoffs of the Black sea coast / *Značajke podzemnih otjecanjana obali Crnog mora*

The underground runoff at almost all deposits is formed in alluvial deposits of the deepest river valleys, which is characteristic of the Black Sea coast. The alluvial aquifer is mainly supplied through surface water infiltration and, to a lesser extent, through the infiltration of atmospheric precipitation and the discharge of groundwater from the Jurassic, Cretaceous and Quaternary sediment slopes. The movement of groundwater occurs within the band of alluvial deposits and its flow is directed to the mouth of rivers, whereby it is discharged into the sea. According to their chemical composition, groundwaters are mainly bicarbonate calcium, moderately fresh, slightly alkaline, moderately hard, odorless and colorless. The water content of the main chemical components is within the limits of the permissible standards stipulated in GOST 2874 and SanPiN 2.14.1074-01. Slightly elevated Fe and Mn concentrations are detected in the valleys of the Mezyb and Sochi rivers (Fig 1) [2].

3. SUBSTANTIATION OF NEW TECHNICAL SOLUTIONS AND TECHNOLOGIES FOR THE ERECTION OF ENGINEERING PROTECTION STRUCTURES FROM COMPOSITE MATERIALS / *Utvrđivanje novih tehničkih rješenja i tehnologija zapostavljanje zaštitnih struktura od kompozitnih materijala*

3.1 Soil-reinforced retaining wall structures of engineering protection structures / *Potporni zidovi ojačani u tlu u sklopu zaštitnih struktura*

For the erection of engineering protection structures in cramped conditions, it is necessary to ensure the maximum use of local building materials without heavy construction equipment and to ensure a minimum laying of retaining wall slopes. These requirements correspond to soil-reinforced structures.

Soil-reinforced structures with flexible tapes (Fig. 3, a) can be used as anti-erosion structures with a terrace height of up to 6 m. Their use makes it possible to simplify the construction technology and use local soil due to its reinforcement with flexible tapes of composite materials. In the case of a significant level of groundwater, a soil-reinforced retaining structure is used (Figure 3, b), consisting of a single face wall fixed with anchor blocks in its upper and lower parts. Its body is packed with horizontal armored-tape shells, filled depending on deformation and draft deposits, as well as inclined, flat or corrugated armored tape, ending with a drain shell, having openings filled with a sorbent and connected to drainage systems. The upper anchorage unit is connected to the

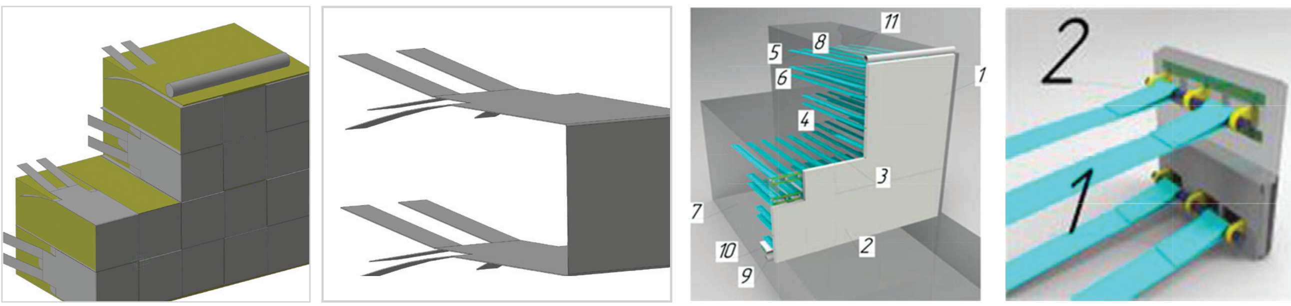


Figure 3 Ways to create soil-reinforced structures for anti-erosion measures and shore reinforcement in cramped conditions: a - method of creating soil reinforced structures from flexible belts and a device for its implementation (Patent RF 2181407): 1 - soil; 1- reinforcing tapes; 2 - flexible tapes; 3 - front wall; 6 - Method of creating a soil-reinforced sub-retaining structure and a device for its implementation (Pat. RF 2352713) 1 - front wall; 2 - bulk ground; 3 - flexible connections; 4- tape-shell; 5 - corrugated and flat armored tape; 6 - drain shell; 7 - special holes; 8 - drainage system; 9 - anchor blocks; в - shore protection soil-reinforced structure: 1 - front wall; 2 - front elements of composite materials resistant to abrasion; 3, 4 - horizontal and vertical sections of the frontal elements in 2; 5.6 - inclined lower and upper armored tape respectively; 7 - soil massif (for example, man-made soil); 8, 9 - soil-filled multi-lobed lower and upper anchors; 10 - drainage; 11 - polymeric material with seeds

Slika 3. Metode izgradnje struktura učvršćenih u tlu kako bi se spriječila erozija i učvrstila obala u skučenim zonama: a – metode izgradnje struktura od savitljivih traka učvršćenih u tlu i uređaj za njihovu primjenu (Patent RF 2181407): 1 – tlo; 1 – pojačavajuće trake; 2 – savitljive trake; 3 – prednji zid; 6 Metode izgradnje potpornih struktura učvršćenih u tlu i uređaj za njihovu primjenu (Patent RF 2181407) 1 – prednji zid; 2 – rasuti teren; 3 – savitljivi spojevi; 4 – ljuskasta traka; 5 –valovita i ravna armirana traka; 6 - drenažna školjka; 7 – posebne rupe; 8 – sustav odvodnje; 9 – sidreni blokovi; B – strukture zaštite obale učvršćene u tlu: 1 – prednji zid; 2 - prednji elementi napravljeni od kompozitnih materijala otpornih na abraziju; 3, 4 - horizontalni i vertikalni odjeljci frontalnih elemenata u 2; 5.6 - nagnuta donja i gornja armirana traka; 7 - masiv tla (na primjer, umjetno tlo); 8, 9 – donja i gornja sidra s izbočinama punjena tlom ; 10 - drenaža; 11 - polimerni materijali drainage device. The front wall and armored tape are made of composite materials. A retaining wall is used in case of abrasive effect. It contains a front wall, horizontal and inclined armored tape, soil-reinforced anchor shells. The front wall consists of elements made of composite materials with memory, including horizontal and vertical sections thereof, cut from them or attached horizontal, lower, upper, lateral rectilinear and inclined armored tape perforated in staggered order, introduced into a soil massif [7, 8].

To select the material of the reinforced tape, the linear tension for each pair of reinforced tape is determined from the following relationship:

$$N_0 = N_1 + N_2 = \int_0^{l_1} 2b_1 \cdot m_1 \cdot f_1 \cdot \gamma \cdot z \cdot dl + \int_0^{l_2} 2b_2 \cdot m_2 \cdot f_2 \cdot \gamma \cdot z \cdot dl = \\ = 2\gamma \cdot h \cdot (b_1 m_1 \cdot f_1 \cdot l_{a1} + b_2 m_2 \cdot f_2 \cdot l_{a2}),$$

where N_0 – total tensile force in all layers of reinforcement corresponding to the collapse surface; N_1, N_2 – stretching forces in armored tapes with different slopes; b_1, b_2 – width of straight and inclined armored tapes with different slope; m_1, m_2 – tilt coefficients of armored tapes; z – height of the layer under consideration above the armored tapes; f_1, f_2 – coefficient of soil friction on the valve; $l_{\text{à}1}$, $l_{\text{à}2}$ – reinforced tape lengths; γ – bulk weight of mound.

The following invariant MM can be represented for soil-reinforced retaining walls [9]:

$$\begin{cases} 1-\left[H_{\text{гр}} \Big/ \left(\sum l_{\text{а}} + L_{\text{ст}}\right) \right] \to \min; \\ C_{\text{р}} = f\left(N; \sum l_{\text{а}} + L_{\text{ст}}\right) \to \min; \\ N \big/ N_{\text{ст}} = f\left(l_{\text{зд}}; H_{\text{гр}}\right) \to \min, \end{cases}$$

where $H_{\text{ãð}}$ - height of a soil-reinforced mound; $l_{\text{à}}$ - length of armored tapes; $L_{\text{ñò}}$ - length of the front wall; $l_{\text{çä}}$ - length of reinforced tape embedding in the first approximation.

3.2 Technical solutions of modular prefabricated shell structures for surface water intake / *Tehnička rješenja modularnih montažnih konstrukcija ljuske za dovod površinske vode*

Modular prefabricated shell structures for water-energy supply (MPSFWE), which include: regulating structures for surface water supply; water intake devices; water supply facilities; hydroelectric units (turbines and pumps); water treatment plants with a recurrent or circulating water supply system, energy recovery, recycling and processing technology for recovered products in an autonomous mode, the design of which is based on the modular principle [8] (fig. 4).

When regulating water levels of surface water sources within the territory of natural protection zones, it is most rational to use seasonally-functioning water intake facilities (fig.4) with membrane-cable dams and to lay temporary water conduits made of composite materials on water-filled or soil-reinforced bases.

These facilities can be used to provide the necessary level and volume of regulation and power generation for water and energy supply. The characteristics are given in table 1.

Table 2 Technical characteristics of micro HPP

Tablica 2. Tehničke značajke mikro HPPa

Parameters	Energy supply, kW					
	5	10	15	25	50	100
Created water pressure, m	1-2	1-2	1-4	1-4	1-4	1-4
Flow intensity, m²/s	0,03-0,06	0,04-0,07	0,03-0,08	0,04-0,09	0,08-0,14	0,15-0,30
Span in the water-way, m	5-10	5-20	10-20	10-30	10-40	10-40

When justifying the parameters of the membrane-cable dam for water intake structures, the results are used to simulate and optimize the parameters of the linear tension and the perimeter of the shell

If underground runoff is used, traditional radiation intakes may be envisaged, and for sea waters, floating structures may be considered.

4. TECHNOLOGICAL SCHEMES TO CONDITION WATER FROM SURFACE, UNDERGROUND AND SEA WATER SOURCES / *Tehnološke sheme za omekšavanje površinske, podzemne i morske vode*

To provide campgrounds, boat and floating campsites with drinking water that meets the quality set by SanPiN 2.1.4 1074-01 "Drinking water from centralized water supply sources. Quality control", it is preferable to use membrane technologies. When using underground water sources, a water treatment

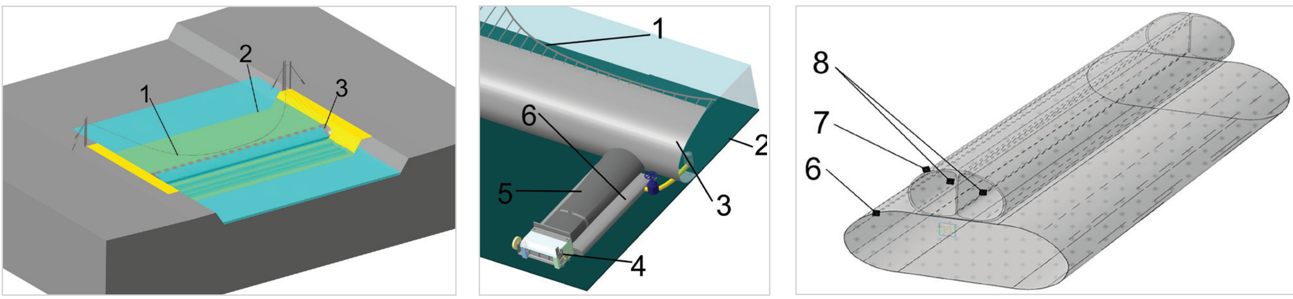


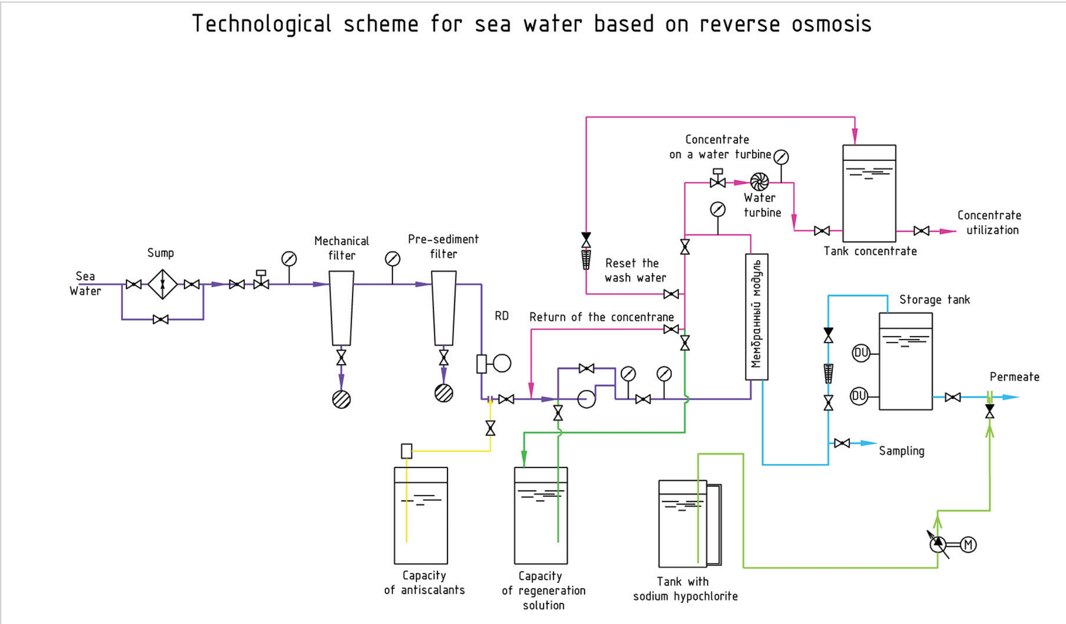
Figure 4 Water-air-filled flexible shell conduits on a filled base: 1 – cable system; 2 – flexible slute; 3 – water retaining shell; 4 – hydraulic unit; 4 – flexible sleeve; 5 - tapered sleeve; 6 - filling shell; 7 - the inner shell of the water conduit; 8 - outer sheath of the water conduit

Slika 4. Vodonepropusni fleksibilni kabelski kanali na ispunjenoj podlozi: 1- kabelski sustav; 2 - fleksibilne slute; 3 - školjka za zadržavanje vode; 4 - hidraulička jedinica; 4 - fleksibilni rukav; 5 - konusni rukav; 6 - ljuska za punjenje; 7 - unutarnja školjka vodovoda; 8 - donji omot vodovodnih cijevi

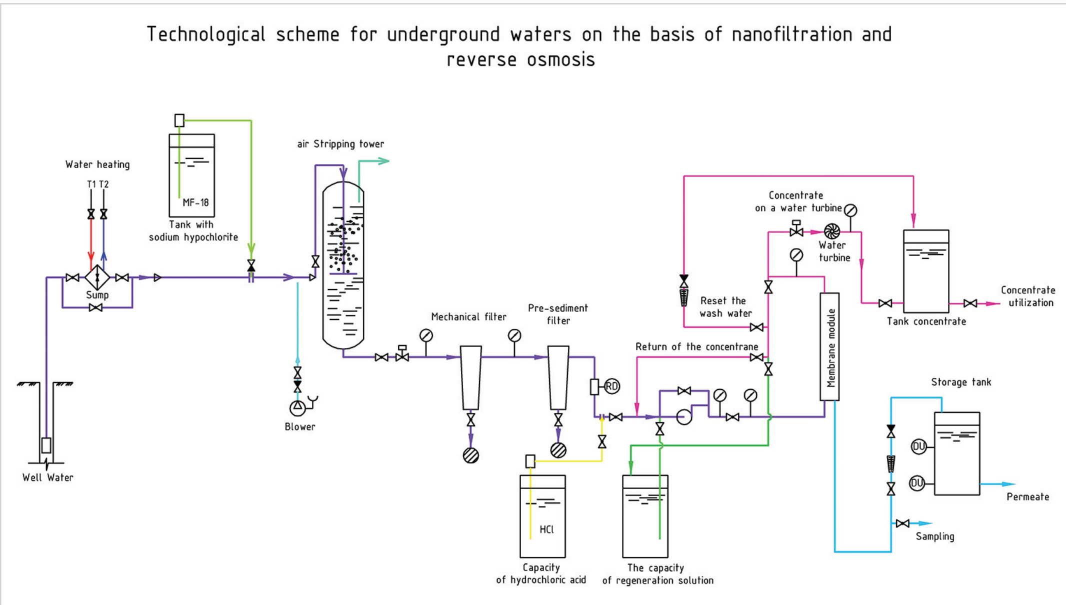
Table3 Initial data for the calculation of flow diagrams

Tablica 3. Inicijalni podaci za izračun dijagrama toka

Characteristics	Name of the source					
	Surface		Underground		Black sea water	
	min	max	min	max	min	max
Hardness, °H	*10*	*20*	*15*	*25*	*15*	*60*
Salt content, мg/l	*1200*	*3000*	*1200*	*3500*	*11000*	*19000*
Iron total мg/l	*0,1*	*1,5*	*0,1*	*0,8*	*0,1*	*0,1*
Manganese, mg/l	*0,1*	*1,5*	*0,1*	*0,5*	*0,1*	*0,1*
Color, degree.	*3*	*5*	*5*	*10*	*3*	*5*
Turbidity, mg/l	*0,6*	*2*	*0,6*	*3*	*0,6*	*2*
Colloidal index (SDI)	*1*	*5*	*1*	*5*	*1*	*5*
Temperature, ° C	*10*	*20*	*5*	*10*	*20*	*25*
Hydrogen index, units PH	*7*	*9*	*6*	*9*	*7,5*	*8,3*



a



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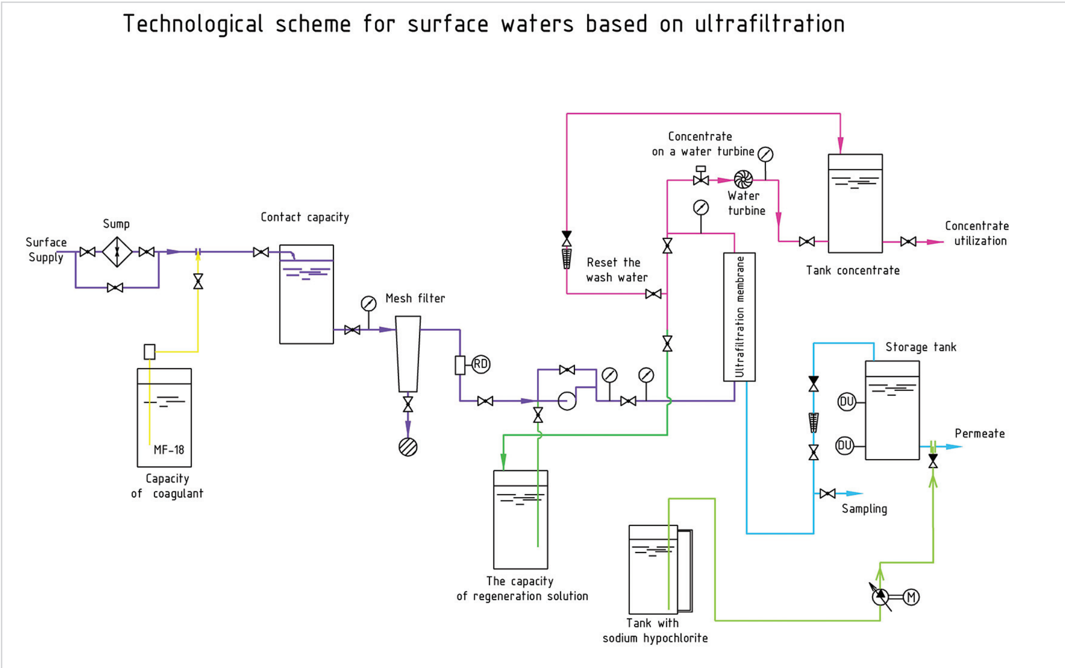

c

Figure 5 Technological schemes of treatment plants for the purification of: a – surface waters based on ultrafiltration; в – underground waters of nanofiltretion and revers osmosis; c – sea water

Slika 5. Tehnološke sheme postrojenja za pročišćavanje sljedećeg: a – površinskih voda ultra filtracijom; b - podzemnih voda na nofiltracijom i reverznom osmozom; c – morske vode

method based on nanofiltration and reverse osmosis is used. Nanofiltration, like reverse osmosis, will make it possible to purify water to the required values, but at the same time, energy costs are lower and this purifying method allows to preserve salts and microelements necessary for the human body in a liquid medium.

We compare the purification of surface, groundwater runoff and sea water with the average concentrations and physical parameters given in Table 3 to provide 50 people with drinking water consumption needs of up to 10 m³/day and ensure the possibility of recovering the concentrate energy (fig.5) [10-17].

Comparative characteristics of membrane purification methods with relative energy recovery, actual service life (maximum period of 5 years) and the ratio of concentrate flow to the output flow.

An important problem is the utilization of the concentrate, the following options are available: brine is preconcentrated with multistage osmosis, which allows to reduce the volume of the concentrate, however, the problem of dumping and saline utilization requires further solution; The reverse osmosis concentrate is subjected to evaporation with the transfer of brine to the solid phase of easily utilizable salts; Reagent treatment by precipitation with the separation of insoluble salts from the solution into a precipitate in the form of $BaSO_4$, $CaCO_3$, Mg $(OH)_2$, etc.

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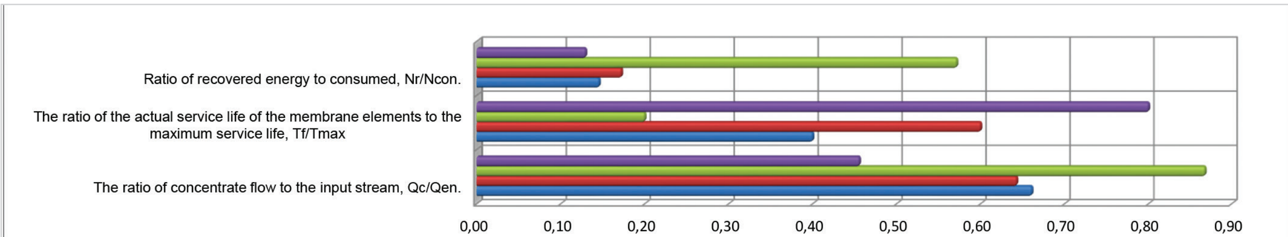

	The ratio of concentrate flow to the input stream, Qc/Qen.	The ratio of the actual service life of the membrane elements to the maximum service life, Tf/Tmax	Ratio of recovered energy to consumed, Nr/Ncon.
Desalination of surface water using ultrafiltration	0,46	0,8	0,13
Desalting of sea water using reverse osmosis	0,87	0,2	0,57
Desalination of groundwater with nanofiltration	0,64	0,6	0,17
Desalination of groundwater using reverse osmosis	0,66	0,4	0,15

Figure 6 Relative characteristics of water conditioning from three main sources: surface, groundwater and seawater

Slika 6. Relativne značajke omekšavanja vode iz tri glavna izvora: površinska, podzemna i morska voda

5. CONCLUSION / *Zaključak*

1. The necessity to develop floating and boat camps to increase the recreational capacity of the Black Sea coast of Krasnodar region was justified.

2. During the course of the analysis of natural climatic conditions, a rationale was given for the use of soil-reinforced structures as anti-erosive and bank protection structures in rocky areas and bays of the Black Sea coast

3. For conditions of surface water intake it is recommended to use mobile prefabricated water and power supply structures (MPSFWE) with a membrane-cable dam as base, intended for regulation.

4. The use of membrane technologies as a technological scheme was justified for the treatment of water from sea, surface and underground runoffs, allowing the non-reagent purification of water to supply floating and boat camps with drinking water.

5. Methods for the utilization of the concentrate were proposed.

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