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Study of water treatment technologies

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Abstract: Purification of sea water is difficult because the amount and diversity of microorganisms it contains are much higher than in fresh water, however scientists are creating new and improved cleaning and desalinization methods. We have examined purification methods that make no changes in general in the water: Mechanical – reservoir pollution: suspended solids, acidity (pH); Chemical - chlorination and ionization; and the process of osmosis. Samples included the Batumi Dolphinarium, the Batumi Aquarium, the training pool of the Georgian Maritime Academy, Lake Nurigel, the vessel Cadet (BSMA) training vessel and the Batumi Yacht Club waters. Using a bathometer, we took samples of water at various depths to analyze their chemical composition, physical properties and the amount of inorganic or organic impurities. Measurements were made by photometer. In previous studies we addressed the issues of water pollution near the coastal zone of Adjara. Present research will contribute to the improvement of our training course "Marine Pollution Prevention and Control Methods" at the Georgian Maritime Academy. The participation of students in the study will contribute to their research skills and allow us to establish information on the key sources of pollution and apply appropriate pollution prevention policy.

Keywords: water purification, pollution prevention training and policies, comparative pollution analysis.

1. Introduction

Salt water makes up 97% of our planet's water resources. Transforming this resource into potable water has been one of mankind's great achievements, yet one in ten people still suffers from a lack of drinking water. In dry regions it is difficult to get the required amount of water, while in other areas large amounts of water are available but unsuitable for drinking. Water purification is crucial where no other source is available than salt water, for example in the Middle East and Africa. The transformation of seawater is also needed for long-distance navigation vessels (Figure 1), space stations, polar stations, and other particular cases [3].

River confluences and salt marshes near the ocean can also be transformed into drinking water. Sea water is analyzed for the following chemical and physical properties and characteristics: salinity, density, compressibility, the speed sound is carried, the light absorption coefficient, electrical conductivity, specific heat capacity and other factors. Technology to convert brackish sea water, or other brackish water into clean, drinkable water could change the lives of millions of people, and research technologies are improving. However, installing the tools and equipment is often a lengthy process and costly, although progress is being made to simplify and shorten the installation time, creating technologies that are more accessible to regions that need them most.

A key issue is keeping treatment methods and means both suitable and safe to use[i] [4]. From a technological point of view for water treatment, these resources can be divided into two types: 1) brackish water (containing 30 to 45 grams of salt per liter) such as ocean waters and most sea waters; and 2) saline water (0,5 to 30 grams of salt per liter, which includes some continental bodies of water, for example, the Black Sea and the Sea of Azov. Both types of water contain many components, but the main one is sodium chloride (which is the same as table salt).

Considering the results of studies on water treatment works (there are up to 20,000 water treatment plants worldwide) we can conclude that ≈50% of consumable water is produced in North Africa and the Middle East; up to 20% in East Asia; 13% in North America; and 10% in Europe, of which 6% is produced in Spain. As for the consumption of distilled water, up to 65% is used for urban areas; 35% in industry; 6% in the energy sector and 4% in agriculture.

Technologies for obtaining clean water include condensation (obtaining water from the air), transforming salt water to freshwater, and other methods such as using purification microchips that can be used at home. Billions of gallons of clean water are produced through these methods today.

Figure 1. Water treatment plant on seagoing vessel

Figure 2. Carnegie Perth's Wave Energy Project

For example - especially interesting projects include the use of water waves. The "Carnegie Perth's Wave Energy Project" (Figure 2) has a dual function: 1) generating energy through waves and 2) purifying sea water using the generated energy, thus making it suitable for drinking. After water treatment, the remaining electricity is sent to a shore control station and stored. Similar types of installations are currently operating off the coast of Western Australia.

2. Study Methodology

The working environment of our graduates is the sea and the waters of the world ocean, where there is knowledge about water treatment technologies and their application are important for the job. We decided to find out the level of knowledge of students in this area using a qualitative research method (a survey of students). The first step was a short online survey, with 5 questions:

1. Suppose you are on an excursion. What should you do if you run out of drinking water on the way?

2. Suppose you encounter a swamp, a lake, a river, a river confluence or the sea. Which reservoir water is unsuitable for drinking?

3. Why is it necessary to clean river / sea water?

4. What method / methods of sea water purification do you know?

5. Name the types of sea water pollution and the main sources of pollution?

Three hundred, mostly third-year students, answered the survey. After processing and analyzing the data, we realized that 75% of the interviewees did not understand the importance of water purification, 85% were not familiar with water purification methods and 55% could not name sources of water pollution. The results of the survey were alarming.

In the second stage of the study we formed student work groups to explore types of pollution in different settings, the sources of pollution and the means for treatment. The following sites were selected: I - The Batumi Dolphinarium (Figure 1-1, 1-2, 1-3), the Batumi Aquarium (Figure 2), the Marine Academy Training Pool [6] (Figure 3-1, 3-2). II - Nuri Lake (also Pioneer Lake**,** natural lake in Adjara, Batumi **(F**igure 4), Ballast Waters from the Training ship Cadet ship (Figure 5) and Batumi Yacht Club Water Area (Figure 6).

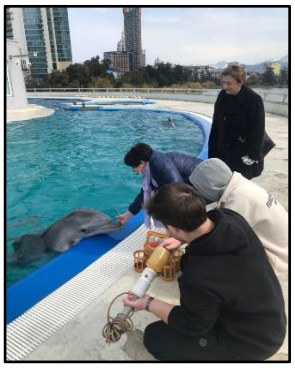

Figure 1-1. Dolphinarium

Figure 1-2. Ozon treatment plant

Figure 1-3. Seal pool

Figure 2. Aquarium

Figure 3 - 1. Marine Academy Pool

Figure 3 - 2. Marine Academy Pool

Then we made a schedule – we started take water analyses at the first three facilities (Table 1) on 15.12.2021, we finished on 25.12.2021. We planned to take water analysis at the second three facilities (Table 2) in the period 5.01.22.-25.01.22. We inspected each facility, got acquainted with the water treatment facilities, took samples, checked the water quality on various parameters by express-analysis and laboratory methods, analyzed the results and made the appropriate conclusions.

Sample taken in the above reservoirs were studied in the laboratory. The results of the study are given in table 1. Appropriate cleaning methods were applied for each object.

Table 1. Water analysis of the first three facilities

№	Type of sample	Temp	suspended solids	Ph	$ozone\ O_3$	NO_2	NO_3	NH_3
		℃	mg/l		mg/l	mg/l	mg/l	mg/l
1	**Dolphinarium**							
	Sample before cleaning							
	Seal Pool	18	< 2	< 5,1	0	0,01	0,05	0,03
	Dolphin Pool	18	0,02	6,5	0	0,01	0,02	0,02
	Sample after cleansing (osmosis, ozonation)							
	Seal Pool	18	0	< 5,1	< 0,02	0,37	0	0
	Dolphin Pool	18	0	< 5,1	< 0,01	0,39	0	0
2	**Aquarium**							
		Sample before cleaning						
		19	< 4	< 5, 5	0	0	-	-
		Sample after cleaning (filtering)						
		19	< 1	< 5,1	0	0	-	-
3	**MaritimeAcademy Pool**							
		Sample before cleaning						
		0	-	6,5	-	-	-	-
		Sample after cleaning (chlorination)						
		17	-	7,2	-	-	-	-

Figure 4. Nurigel Lake

Figure 5. Cadet ballast sample

Figure 6. Yacht Club water area

Sample taken in the above reservoirs were studied in the laboratory. The results of the study are given in table 2. Appropriate cleaning methods were applied for each object.

Table 2. Water analysis at the second three facilities

№	Type of sample	Temp.	suspended solids	Ph	$Cont.\ Fe$	COD	BOD	Dissolve oxygen
		℃	mg/l		mg/l	mg/l	mg/l	mg/l
1	**Lake Nurigel**	Water sample (near the shore)						
		12	34	-	0,001	25	4,3	6.0
		Water near artificial aeration (fountain)						
		12	19	6			6	6,5
2	**Training ship Cadet**	16 ℃	109,5	7	8,5	-	-	3,8
3	**Yacht Club water area**	13 ℃	2	5	0,9	-	-	-

3. Final Conclusions and Recommendations

As a result of the research, various types of water treatment facilities were studied, including the latest, most modern and most effective means – ozonation which is used in the Batumi Dolphinarium. Water purification in the Batumi Aquarium is carried out by a mechanical method (filtration). The chlorination method is used to purify the water in the Maritime Academy training pool. Oxygen saturation is used to improve the water quality of Lake Nurigel (aeration method) [1].

Analysis of the results of laboratory studies (Table1- light-colored, slightly turbid, with a small amount of precipitation. Table 2 – Sample was muddy, with precipitation. There were floating compounds, sometimes with a specific odor, that appeared before treatment. These disappeared after treatment showing how water quality improved as a result of treatment.

The Black Sea and its basin are important parts of the Georgian ecosystem and play a major role in the country's economy. Georgia's Black Sea coastline is 320 km long, and more than 75% of the country's rivers flow in the Black Sea basin. Thus, it is highly important to ensure that untreated water does not pollute key reservoirs [3] which can cause contamination from impurities and chemicals, thus affecting the flora and fauna of the reservoirs. Pollution would seriously harm tourism, which is a major economic factor for the region. This is why awareness of the populations living in these areas is important [5].

Our project is a methodology "to identify types of pollution in the Black Sea region of Georgia, using a collaborative research method with Maritime Academy students, and to select the most adapted solutions to different types of water pollution. To raise public awareness of specific types of water pollution and provide information within the local education system that will impact behavior of the populations living along the Black Sea coastal areas [2].

The program will develop adapted presentation materials based on our findings, for information on the protection of the region's unique environment. Local administrations should take a greater responsibility for

the prevention of coastal pollution, to avoid tragic consequences [7]. Our study revealed the need for more local awareness, and the importance of including these subjects in the education curricula.

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