Investigation of the water of Aydarkul Lake into components and the scope of their application

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Abstract. To assess the suitability of Aydarkul Lake's water for various purposes such as industrial, agricultural, domestic, or drinking usage, a comprehensive analysis was conducted encompassing all pertinent physico-chemical parameters of the water. The study aimed to ascertain whether the water met the requisite standards for safe utilization. The results of the analysis demonstrated that the water in Aydarkul Lake exhibited basic physico-chemical characteristics that exceeded the permissible concentrations for drinking water, as defined by the state standards. These findings underscore a significant deviation from the criteria established for safe drinking water consumption. These conclusions illuminate the need for thorough consideration when contemplating the utilization of Aydarkul Lake's water for various purposes. The data generated from this analysis serves as an important resource for decision-makers and stakeholders, guiding informed choices regarding the potential applications of the lake's water while also highlighting the importance of maintaining water quality standards for public health and environmental sustainability.
Keywords. Aydarkul, Kizilkum, Kili, Akbulak Tuzkan, drinking water, salty, hard, sulfate, nitrate, carbonate, bicarbonate, pH.

1 Introduction

Aydarkul Lake is a kind of ecological antipode of the Aral Sea, a huge drainless reservoir [1]. A large artificial reservoir in the Kyzylkum desert, located in the northeast of Uzbekistan [2]. The reservoir is located at an altitude of 247 meters above sea level of the Baltic system and is part of the Arnasai system of lakes, which occupies a huge salt basin [3]. Aydarkul contains 44.3 km^3 of slightly salted water [4]. The mineralization of the reservoir in the east is only 1.5-2%, and in the western part – 8%. The lake stretches for 160 km and is about 34.8 km wide. Its average depth reaches 12.5 m, and the maximum reaches 33.6 m [5].

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More than 100 species of flora and fauna have found shelter here, some of which are listed in the Red Book [6-9]. On the reservoir you can meet rare birds – pink pelicans, swans, dives, white herons, curly pelican, white-tailed and red barracks. Of the fish, carp, asp, carp, walleye, bream, catfish, snakehead, chehon, etc. live here. On the southern shore of the reservoir there is the Nuratau-Qyzylkum Biosphere Reserve, created to preserve endangered and endemic species of flora and fauna [10-15].

Lake Aydarkul is characterized by the absence of undercurrents, resulting in relatively tranquil water conditions [16]. A distinct pattern emerges as one moves westward across the lake: the water's salinity progressively increases. In the western regions, mineralization levels exceed 8 grams per liter, signifying a higher concentration of dissolved salts [17]. In contrast, the estuaries situated in the eastern parts of the lake exhibit mineralization levels ranging from 3 to 5 grams per liter [18]. This variance in mineral content contributes to the creation of favorable environmental conditions that support biological life [19].

The decreasing salinity from east to west within Lake Aydarkul's expanse influences the suitability of the water for various forms of aquatic life [20]. The relatively lower mineralization levels in the eastern estuaries provide a hospitable environment that fosters diverse biological activity. This ecological distinction underscores the intricate interplay between geographical factors, mineral composition, and the nurturing of life forms within the lake's ecosystem.

2 Research methods

Calcium (Ca^{2+}) and magnesium (Mg^{2+}) were determined by titric method with trilon "B". Chlorides (Cl^-) were determined by the argentometric method. Sulfate ions (SO_4^{2-}) were determined by the weight method [21], precipitating by passing through a filter and burning 1:50 hours at a temperature of 800 ^{0}C, the remaining ash was weighed on a scale and counted [22]. The pH was determined on a pH meter device, and nitrate (NO_3^-) on a nitratomer device. HCO_3^-, that is, bicarbonate was determined by titration, titrimetric method with a solution of HCl 0.05 N. Determination of iron, (Fe^{3+}, Fe^{2+}), ammonium ions (NH_4^+) and nitrites (NO_2^-) was carried out in a refractometer. Sodium (Na^+) and potassium (K^+) were determined in a flame apparatus. CO_2 free mg/l by titration. The oxidability was determined by the permanganate titration method [23]. The general severity and aggressiveness can be found by the formula by calculations. Silicon (Si) was determined by the comparison method.

3 Results and discussion

The results of the study. By comparing the results of samples from three different points of the Aidar-Arnasoy lake system with the established state standard standards of Uzbekistan for drinking water, the data obtained are given in detail in Tables 1 and 2.

According to Tables 1 and 2, the following conclusions can be drawn:

- from the point of view of the total content of trace elements, the water at point 1 (≈10,000 mg/l) can be classified as saltier water, and the water at points 2 and 3 (≈5,000 mg/l) can be classified as brackish;
- at all points of the content of nitrate anions (NO_3^-), the indicator is within the normal range, the level is below 45 mg/l;
- at all points of the content of nitrite anions (NO_2^-), the indicator is within the normal range, the level is below 3 mg/l;
- the chlorine anion content (Cl^-) (250 mg/l) is 2-8 times higher than normal at all points;
- the content of sulfate (SO_4^{2-}) is 10-15 times higher than the norm (400 mg/l) by 10-15 times at each point;

- amonium (NH_4^+) cations are within the normal range, the level is below 1 mg/l;
- the indicator for iron cations (Fe^{2+} and Fe^{3+}) at all points, the indicator is within the normal range, the level is below 0.3 mg/l;

The water hardness level is high at all points and, according to the standard, belongs to the class of very hard water.

Table 1. Analysis results for all physico – chemical parameters of water (Qizilkum 4-Collector).

#	Name	Normative indicators in a liter of drinking water	Qizilkum 4-Collector		
			Content in liter		
			mg/l	mg-eq/l	%- eq/l
Anions					
1	Na^+		2182	94.86	49
2	NH_4^+	1 mg/l	0.4	0.02	-
3	Ca^{2+}		661	33.00	17
4	Mg^{2+}		790	65.00	34
5	Fe^{2+}	0,3 mg/l	< 0.3	-	-
6	Fe^{3+}	0,3 mg/l	< 0.3	-	-
Total				192.88	100
Cations					
7	Cl^-	250 mg/l	2127	60.00	31
8	SO_4^{2-}	400 mg/l	6189	128.94	67
9	NO_2^-	3 mg/l	< 0.01	-	-
10	NO_3^-	45 mg/l	15	0.24	-
11	CO_3^-		no	-	-
12	HCO_3^-		226	3.70	2
Total				192.88	100
Formula of the salt composition of water			$12{,}6\frac{SO_4^{67}\ Cl^{31}}{(Na+K)^{49}Mg^{34}Ca^{17}}$		

Table 2. Analysis results for all physico – chemical parameters of water (Qili Collector and Akbulak Collector).

#	Name	Normative indicators in a liter of drinking water	Qili Collector			Akbulak Collector		
			Content in liter			Content in liter		
			mg/l	mg-eq/l	%- eq/l	mg/l	mg-eq/l	%- eq/l
Anions								
1	Na^+		988	42.97	50	594	24.54	30

2	NH_4^+	1 mg/l	0.4	0.02	-	2.1	0.12	-
3	Ca^{2+}		341	17.00	20	301	15.00	19
4	Mg^{2+}		316	26.00	30	492	40.50	51
5	Fe^{2+}	0.3 mg/l	< 0.3	-	-	< 0.3	-	-
6	Fe^{3+}	0.3 mg/l	< 0.3	-	-	0.3	0.01	-
Total				85,99	100		80.17	100
Cations								
7	Cl^-	250 mg/l	576	16.25	19	401	20,00	25
8	SO_4^{2-}	400 mg/l	3094	64.47	75	2806	58,47	73
9	NO_2^-	3 mg/l	0.5	0.01	-	< 0.01	-	-
10	NO_3^-	45 mg/l	10	0.16	-	6	0,10	-
11	CO_3^-		no	-	-	no	-	-
12	HCO_3^-		311	5.10	6	98	1,60	2
Total				85,99	100		80.17	100
Formula of the salt composition of water			$5{,}7\frac{SO_4^{75}\ Cl^{19}}{(Na+K)^{50}Mg^{30}Ca^{20}}$			$4{,}7\frac{SO_4^{73}\ Cl^{25}}{(Na+K)^{30}Mg^{51}Ca^{19}}$		

We have proposed ways to solve the problem: for each case of water use, it is necessary to approach individually, that is why it is advisable to apply a set of measures to purify the waters of the Aydarkul lakes.

For example, to use the waters of Aydarkul for drinking purposes, deep purification is necessary. After the initial mechanical cleaning with coarse dispersed filters, it is necessary to continue cleaning the water with a sand filter, an aerator, a degreasing filter and a carbon filter (adsorption). Each cleaning process is an equipment (cylinder) with a special filler, since there are electronic and mechanical devices on each filter.

In water treatment plants, quartz sand for water filtration is poured into a durable housing that is resistant to corrosion and the action of chemically aggressive media. The water is supplied by a pump and, at excessive pressure, passes through a sand backfill with a grain size of 0.4-0.8 mm (Table 3).

Modern aerators easily remove gases dissolved in water, thereby improving its properties. In addition, they contribute to the oxidation of iron present in the water, prevent the reproduction of bacteria.

The aerator is capable of purifying water from any dissolved metals — whether it is manganese or iron. Organic compounds are no exception. To do this, the impurities are first oxidized. The most affordable and environmentally friendly oxidizer is air oxygen. Therefore, the use of aerators is very effective.

Aerators for water purification pump air into the pressure pipeline. This is done by means of a compressor, the interfering ions are oxidized and remain in the form of a precipitate on the filter material. An important advantage of aerators used in water treatment systems is minimal operating costs. At the same time, the load on water treatment equipment is significantly reduced. As a result, water purification is dramatically accelerated, and without the use of complex, expensive equipment.

The oxygen-enriched water enters a filter based on a catalytically active granular filter material catalytic material. The use of a catalytically active granular filter material is an effective and inexpensive way to remove dissolved iron and manganese from the source water. The catalytically active granular filter material acts as a catalyst that accelerates the reaction between oxygen dissolved in water and divalent iron contained in water. Divalent

iron is present in our test water in a dissolved state and therefore does not lend itself to mechanical filtration. The catalytically active granular filter media, acting as a catalyst, promotes the oxidation of divalent iron to trivalent. As a result, insoluble particles of iron hydroxide (rust) are formed, which are quite easily retained in the layer of the filter medium.

The activated carbon filter cleans the water from harmful impurities, primarily chlorine, as well as from unpleasant odor, taste, bacteria and organic substances in small quantities by adsorption into the water.

Table 3. Analysis results for other water indicators.

#	Other definitions	Qizilkum 4-Collector	Qili Collector	Akbulak Collector
Hardness mg-eq/l				
1	Total water hardness	98.00	43.00	55.50
2	Carbonate	3.70	5.10	1.60
3	Non - carbonate	94.30	37.90	53.90
4	pH	7.70	7.00	7.00
5	CO_2 is free. mg/l	35	44	15
6	CO_3 unit mg/l	no	no	9
7	Oxidizability mg O_2/l	3.1	2.9	3.04
8	SiO_2 mg	6	20	8
9	H_2S mg/l	no	no	no
10	Dry residue experiment mg/l	12600	5700	4760
11	Dry residue calculated mg/l	12083	5501	4621
Physical properties				
12	Transparency	Transparent	Transparent	Transparent
13	Taste	Bitterly salty	Very salty	Brackish
14	Colour	Without color	Without color	Without color
15	Smell	Without smell	Without smell	Without smell
16	Sediment	Without sediment	Slight sediment	Without sediment

But in addition to these purification processes, in order to achieve the goal, it is necessary to soften and remove salts from the water. To do this, you must first soften the water by the ion exchange method. The ion-exchange method of water purification refers to the complex of water treatment. It is used to remove hardness salts and is called softening. In the process, calcium, magnesium, manganese salts, as well as heavy metals, radionuclides, organic pollutants are removed.

The new polycondensation anionite obtained by us is called: ANDM, which is effective for sorption and ions of copper, nickel, molybdenum and other elements, the degree of dissociation of ionogenic functional groups from the chemical composition, sorption and physico-chemical properties of the initial monomers suitable for use.

And last of all, you can put reverse osmosis for desalination of water. A process in which, at a certain pressure, water passes through a semipermeable membrane from a more concentrated to a less concentrated solution, that is, in the reverse direction for osmosis. The waters purified after reverse osmosis are very clean and their use for drinking purposes has a beneficial effect on the human body.

It is possible to continue water purification by adding distiller and water deionizer equipment. Distilled water is considered sterile and is used mainly for pharmaceutical, laboratory and other needs for the preparation of injection solutions. Deionized waters of types 1 and 2 are especially pure liquids obtained by filtration. The raw material of the process is distilled water, the output is deionized water (demineralized, desalinated). Very sensitive laboratory equipment, such as gas and liquid chromatographs and other devices requiring especially pure waters use deionized waters of types 1 and 2. The purity of the water affects the results of the tests.

The sequence of application of these devices for purification will allow obtaining clean and high-quality drinking water, distilled water and water of the first and second types, while the phasing of water purification will allow the equipment to be used for a long time in a continuous cycle. The right approach to research will allow you to solve the tasks without extra effort and without wasting time and money.

4 Conclusions

The conclusion was made on the physico-chemical composition and properties of the samples obtained, based on the results of the obtained analyses of the water systems of the Aidar-Arnasay lakes. It was found that the water is very hard, has a very high level of salinity, the level of minerals is higher than the permissible concentrations for drinking water according to GOST.

These conclusions do not apply to the biological-bacteriological and sanitary-epidemiological conditions for the conclusion on fisheries, resort recreation areas, tourist recreation areas and therapeutic properties of the waters of the Aidar-Arnasay lake system.

The right approach to research will allow you to solve the tasks without extra effort and without wasting time and money. The waters of the Aidar-Arnasay lake systems can be used in the above directions, but only first they need to be cleaned before use.

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