

QUALITY INDEXES OF GROUND WATER AT ZMIEV DISTRICT OF KHARKIV REGION

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ABSTRACT

This study investigates the ground water quality at Zmiev district of Kharkiv Region. The result shows that 97% of cases the water in wells doesn't meet the requirements of the quality standards for sanitary and chemical indices. The most actual indices of non-correspondence of quality are: hardness, solid residual, iron, manganese, sulfates, chlorides, nitrates, and oxidation characteristic. The necessity of use of more strict approach to decentralized water sources while evaluation of the drinking qualities is grounded.

KEYWORDS

Ground water; Quality standards, Well; Sanitary indices, Chemical indices.

1 INTRODUCTION

The Zmiev district of Kharkiv Region is known for its quality surface water resources. However, the surface water quality is gradually deteriorating. In spite of the urban and village population growth, 65% of water supply is taken from the wells, i.e. at the expense of the first layer from the elevation of water –the ground waters.

Generally, underground waters are characterized by a relatively high level of stability of physical-chemical and bacteriological indices of the quality in comparison with surface water. That is why minor treatment of purification and disinfection is needed. But, the quality of ground water may change negatively under the influence of natural and anthropogenic factors. The aim of this study is to determine the present situation of ground water quality at Zmiev district of Kharkiv region which was used as the source of decentralized water supply of the population (for drinking and economic purpose).

2 DISCUSSIONS

The decentralized water supply of Zmiev district is provided with the help of common and private wells and the regular analysis of water quality is conducted only in common wells. Today the Sanitary Drinking Standard 1226-75 "The maintenance of cappings and wells" is used, and it regulates such quality indices as total microbe number, taste, smell, color of water, turbidity, Coli index, Coli titre and nitrogen compounds. In comparison with quality standards, that are normal for the sources of centralized water supply (State Standards) they are extremely inadequate and they restrain the villagers in their right to use and drink quality water. Such condition when the standards of water quality are low is the result of general economic backwardness. Today in Ukraine, in Russia, in Europe and in the whole world present normative documents determine the value of wide range of indices, that makes it

possible to give a many-sided characteristics of the quality of drinking water are represented in *Table 1*.

Table 1. Present standards of the quality of drinking water.

Indices	Unit measure	Standards				
		State Standards 2874-82 (Drinking water)	State Sanitary Drinking Standards 136/1940 (#383)	World Health Organization (WHO)	Sanitary Drinking Standards #1226-75	Sanitary Drinking Standards of Russian Federation 2.1.4.1074-01
<i>Organoleptic indices</i>						
Smell	mark	2	2	Should be good	Not >2-3	2
Taste and odor	mark	2	2		Not >2-3	2
Color	degrees	20	20(35)	15	Not >30	20(25)
Turbidity	mg/dm ³	1.5	0.5(1.5)	2.0	Not >2	2.6(3.5)
<i>Toxicologic indices</i>						
Aluminum	mg/dm ³	0.5	0.2(0.5)	0.2	-	0.5
Barium	mg/dm ³	-	0.1	0.7	-	0.1
Beryllium	mg/dm ³	2·10 ⁻⁴	-	-	-	2·10 ⁻⁴
Boron	mg/dm ³	-	0.6	0.3	-	0.5
Bromine	mg/dm ³	-	-	-	-	0.2
Molybdenum	mg/dm ³	0.25	-	0.07	-	0.25
Arsenic	mg/dm ³	0.01	0.01	0.01	-	0.05
Nickel	mg/dm ³	-	0.1	0.02	-	0.1
Mercury	mg/dm ³	-	-	10 ⁻³	-	5·10 ⁻⁴
Lead	mg/dm ³	0.03	0.01	0.01	-	0.03
Selenium	mg/dm ³	0.001	0.01	0.01	-	0.01
Strontium	mg/dm ³	7.0	-	-	-	7.0
Fluorine	mg/dm ³	0.7-1.5	0.7-1.5	1.5	-	1.5
Chrome	mg/dm ³	-	-	0.05	-	0.05
Phenols	mg/dm ³	-	-	-	-	0.25
<i>Indices influencing the organoleptic characteristics of water</i>						
pH value	pH	6.0-9.0	6.5-8.5	-	-	6.0-9.0
Solid residue	mg/dm ³	1000	1000 (1500)	-	-	-
General rigidity	Mg-eq/dm ³	1.5-7.0	7.0 (10)	-	-	7.0(10)
Oil products	mg/dm ³	-	-	-	-	0.1
Surface-active substance	mg/dm ³	-	-	-	-	0.5

Table 1. Present standards of the quality of drinking water (Cont)

General mineralization	mg/dm ³	1000	1000 (1500)	1000	-	1000(1500)
Iron	mg/dm ³	0.3	0.3	0.3	-	0.3(1)
Manganese	mg/dm ³	0.01	0.1	0.01	-	0.1(0.05)
Copper	mg/dm ³	1	1	1	-	1
Indices	Unit measure	Standards				
		State Standards 2874-82 (Drinking water)	State Sanitary Drinking Standards 136/1940 (#383)	World Health Organization (WHO)	Sanitary Drinking Standards #1226-75	Sanitary Drinking Standards of Russian Federation 2.1.4.1074-01
<i>Organoleptic indices</i>						
Sulphates	mg/dm ³	500	250(500)	250	-	350
Chloride	mg/dm ³	350	250(350)	250	-	350
Zinc	mg/dm ³	5.0	-	3.0	-	5.0
Nitrate nitrogen	mg/dm ³	45	45	50	Not >45	45
Nitrite nitrogen	mg/dm ³	-	-	3	-	3
Potassium	mg/dm ³	-	-	-	-	-
Calcium	mg/dm ³	-	-	-	-	-
Magnesium	mg/dm ³	-	10-80	-	-	-
General alkalinity	Mg-eq/dm ³	-	0.5-6.5	-	-	-
<i>Chemical substances generated in the process of water processing</i>						
Residual chlorine	mg/dm ³	0.3-0.5	0.3-0.5	0.6-0.1	-	0.3-0.5
Residual ozone	mg/dm ³	0.1-0.3	0.1-0.3	0.1-0.3	-	0.3
Polyacrylamide	mg/dm ³	2.0	-	1.0	-	2.0
Polyphosphates	mg/dm ³	3.5	-	-	-	3.5
<i>Integral indices</i>						
Oxidability	mgO ₂ /dm ³	4.0	-	-	-	5.0
Toxicity index	%	-	Not >50	-	-	-
<i>Microbiological indices</i>						
Coli index		3	Not >3	He >3	He >10	Not >3

In our opinion, the State Sanitary Drinking Standard “Drinking water hygienic requirements for the quality of water of the centralized economic and drinking water consumption” is the most convenient for evaluating the quality of water because it contains an integral index of quality – the index of toxicity together with usual list of standards from other documents. This achieves an objective view of drinking quality of any types of water very quickly and without a lot of expenses. Some quality indices of the ground water from the wells of Zmieiv district

that exceed the index of PDK in accordance with data of geological service are represented in Table 2.

Table 2. Quality indices of the ground waters from the wells of Zmieiv district.

#	Place of sampling and the address	Pb mg/d m ³	Solid residue mg/dm ³	General rigidity mg-eq/dm ³	Fe, mg/d m ³	Mn, mg/d m ³	NO ₃ , mg/d m ³	Oxidability mg/O ₂ /dm ³	Estimation of quality
	State Sanitary Drinking Standard "Drinking water"	0.01	1000	1.5-7	0.3	0.1	45	4	
	Limiting characteristic of harmfulness and dangerousity class	s-t. 2	g. 4	org. 4	org. 3	org. 3	s-t. 3		
1	v. Borki	0	495	5.11	0	0	59.2	2.24	-
2	v. Pogoreloe	0.01	1791	23.5	0	0	490	4.5	-
3	v. Kravtsovo	0.01	446	4.4	0	0	70.4	14.4	-
4	v. Timchenki	0	963	9.1	0.7	2.2	0.76	9.12	-
5	v. Trosnoe	0.01	736	10.7	0	0.13	40	4.96	-
6	v. Kuklyvka	0.01	1205	16.8	0	0	422.9	4.2	-
7	v. Jupe	0	535	7.3	0.7	0	88	3.6	-
8	v. Krasna Polyana	0.02	1170	13.8	0.5	0	220	1.9	-
9	v. Vodyanoe	0	1092	11.5	0.65	0	310	12	-
10	v. Ch. Bishkin	0	345	2.76	0.65	0	130.1	3.2	-
11	v. Gineevka	0	1285	6.31	0	0	48	10.1	-
12	v. N. Bishkin	0	1260	17.53	0	0	200	5.12	-
13	v. Liman	0	1322	17.3	0.8	0	58	8	-
14	v. Zadonetskoe	0	201	1.57	1.5	0	19.7	3.2	-
15	v. Omelchenki	0	581	6.7	0.5	0	130	7.2	-
16	v. Liman	0	740	10.1	0.3	0	7.2	2.5	-
17	v. Liman	0.06	256	3.8	2.8	0.22	0.85	4.2	-
18	v. Liman	0	1517	10.8	0	0	53	10.2	-
19	v. Liman	0	1762	16.1	0.3	0	324	16	-
20	v. Liman	0	1386	8.7	0.5	0	159	9.4	-
21	v. Konstantinovka	0.04	473	7.1	0.5	0	22.3	1.7	-
22	v. Borovaya	0	1471	14.9	0	0.49	14	12	-
23	v. Skripai	0.01	759	8.9	0.2	0	15.7	3.2	-
24	v. Sheludkovka	0.01	1706	20	0.2	0	395	7.7	-
25	v. Gineevka	0.01	490	7	0	0	18.9	2.4	+
26	Zanki station	0.01	1100	11.2	0.3	0	15	6.6	-
27	v. Artuhovka	0.06	459	5.4	0.8	0.15	2.3	24.2	-
28	v. Chemuzhovka	0.02	558	4.9	0.3	0	11	20.3	-
29	v. Vovyahovka	0.02	2123	31.1	0	0.15	284	5.2	-
30	s. Donets	0.07	902	13.4	0	0	79	3.2	-

Table 2. Quality indices of the ground waters from the wells of Zmiev district. (cont)

31	v. Blagodatnoe	0.02	3138	30.3	0	0	735	7	-
32	v. Pasiki	0.07	976	16.2	0	0	71.25	1.9	-
33	v. Bespalovka	0.05	1128	16.4	0	0	40.2	1.6	-
	v. Bespalovka, Chaikovskovo Street 1	0.05	3638	49.4	0	0	547.5	5.8	-
34	v. Taranovka	0.06	864	14.7	0	0	67.3	2.6	-
36	v. Sokolovo	0.01	964	15.2	0	0	179.8	1.28	-
	Average value	0.03	1106.58 3	13.055	0.6 6	0.55 666 7	148.03 78	6.742222	-
	% of samplings, not corresponding to the standards	33	47	72.22	33. 33	16.6 7	69.44	63.89	97.2

2 –highly harmful; 3–harmful; 4–reasonably harmful; +–the water is good in accordance with indices listed above; --the water is not good.

In connection with insufficient data, the data quality analysis of water from wells is obtained from Kharkiv Research Institute of Ecological Problems and by sanitary-epidemiological station of Zmiev district during the period of 1986-2005.

Some quality indices of water from wells were charted on the map of Zmiev district. The indices of general rigidity (Figure 1) and nitrates content (Figure 2) turned to be considerably contrast in the area. These are the main indices that characterize the water quality.

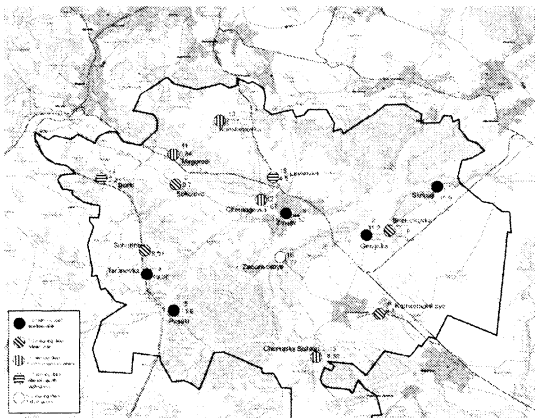


Figure 1. Rigidity values of subterranean waters of Zmiev district in Kharkiv region. Tested wells are marked by circles. The upper number signifies the well number, the lower one – rigidity value, in mg-eq/dm³ in the given well.

The data of the level of general rigidity are represented in *Table 3*. From all sampling there are 56% of samples that exceed maximum permissible rigidity (7 mg- eq/dm³).

Table 3 Distribution of water samples from the wells of Zmiev district with different indices of rigidity

Amount of samples (in % to the general number) with the value of rigidity				
0-2 mg- eq/dm ³	2-5 mg- eq/dm ³	5-7 mg- eq/dm ³	7-10 mg- eq/dm ³	>10 mg- eq/dm ³
6.25	12.5	25	25	31.25

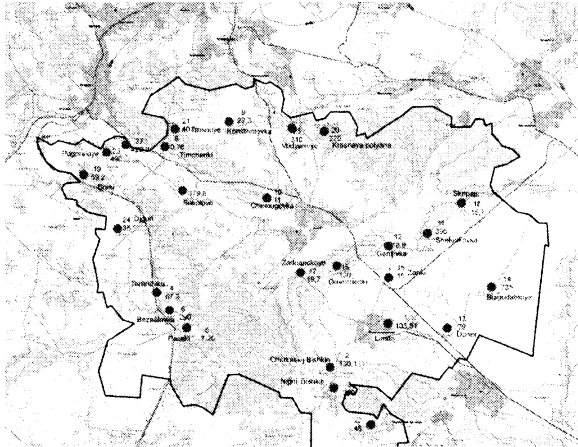


Figure 2. Nitrate content in subterranean waters of Zmiev district in Kharkiv region. The upper value signifies the well number, the lower one – nitrate content, in mg/dm³ in the given well.

The data about nitrates content are represented in *Table 4*.

Table 4. Distribution of water samples from the wells of Zmiev district with different indices of nitrates content.

Amount of samples (in % to the general number) with nitrates content				
0-10 mg/dm ³	10-45 mg/dm ³	45-90 mg/dm ³	90-180 mg/dm ³	>180 mg/dm ³
8	27	19	15	31

Maximum permissible nitrates content (45 mg/dm³) is exceeded in 65% of cases, and the maximum value reaches 490-735 mg/dm³

3 CONCLUSIONS

1. According to the data of Geological Survey the 97% water of domestic wells of Zmiev district in Kharkiv region does not correspond to the standards of drinking water of centralized systems. The inconsistency with the sanitary standards of water quality is observed in the following indices: general rigidity - 72.2% of samples; nitrates content - 63.9%; oxidability - 61.1%; solid residue - 44.4%; dissolved iron - 33.3%; lead content - 22.2%; manganese content - 16.7%.
2. In comparison with the quality standards which are applied to the centralized water supply sources (State Standards 2874-82 and State Sanitary Drinking Standards) for the sources of decentralized water supply at the actual time (State Sanitary Drinking Standards 1226-75 "Wells and capping content") an extremely poor listing of standards is applied which can be viewed as a restraint in the right of villagers to drink the drinking water of quality.

For objective evaluation of the quality of ground waters it is necessary to elaborate more rigid standards than the Sanitary Drinking Standards 1226-75. Before such standards are elaborated the most convenient normative document for practical usage in the evaluation of the water quality of decentralized water supply will be State Sanitary Drinking Standards # 383 "Drinking water. The hygienic requirements for the water quality of centralized household drinking water supply," as it includes integral quality index - toxicity index.

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