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THE PROBLEM OF GROUNDWATER EXPLOITATION AT PUGACHEVSKY WATER INTAKE IN KEMEROVO

ПРОБЛЕМА ЭКСПЛУАТАЦИИ ПОДЗЕМНЫХ ВОД В ГОРОДЕ КЕМЕРОВО

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В статье рассматриваются вопросы питьевого водоснабжения населения и технологического обеспечения водой объектов промышленности города Кемерово, для чего используется водозабор на Пугачевском участке. Рассматриваются вопросы местоположения участка «Пугачевский водозабор», расположение скважин. Представлен предельно разрешенный объем добычи подземных вод, средняя нагрузка на одну скважину. При обследовании, проведенном проектной организацией в августе 2010 года, установлено, что в эксплуатации находилось 11 водозаборных скважин. В настоящее время наблюдается общее снижение дебита практически по всем скважинам.

В результате анализа было установлено, что подземные воды водозабора пригодны для хозяйственно-питьевого водоснабжения при условии их предварительной водоподготовки, заключающейся в снижении содержания сероводорода, марганца и обезжелезивании.

Currently surface and underground water is extracted from 16 artesian wells; in Kemerovo they provide industry with drinking water and industrial process water [1].

Pump units (pumps, pipelines and fittings) and pumping stations (ground pavilions and wells) except wells are included in the water intake complex.

Our attention was drawn by the water intake in the Pugachev area. The license to use the area resources belongs to the JSC “SUEK”. The production activity includes water collection, water purification and distribution as well as other activities.

It is necessary to mention that it was planned to produce 43000 m^3/day by means of 16 wells, at present time water intake produces not more than 23000 – 25000 m^3/day. Water intake is drowned out and there is strong necessity in new sources of drinking water supply for population of Kemerovo.

In 1960 Krasnoyarsk hydrological Party began the hydrogeological exploration works to find underground water suitable for drinking water supply in Kemerovo [2].

In 1969 the second stage of prospecting began. The detailed exploration for the plan of linear water intake was carried out on the river Tom between Berezovo and Metallploschadka villages.

In 1971 exploration works on another part of the Pugachev area were begun between Berezovo and Shumiha villages. It was estimated that reservoir properties of rocks in the region are rather high, and water transmissibility of sandstone rocks of Elias subseries of upper permian deposits reached 1000-2000 m^3/day, whereas the mean value was 300 - 500 m^3/day [3].

In 1971 operating reserves of groundwater in the "Pugachevsky water intake" area were estimated in the amount of 67000 m^3/day including categories A - 42300 m^3/day, B - 24700 m^3/day [4].

Construction of the water intake using groundwater was realized by order of Kemerovo Region authorities in1981.

The area of Pugachev water intake and lands joining to the subsurface are part of the municipality "Kemerovo municipal district" of Kemerovo region.

The mining lease area is 80.1 hectares. The Pugachevsky water intake is located on the left bank of the river Tom between Metallploschadka and Novostroyka villages at the distance of 8.5 km from the town center. Within a radius of 2 – 3 km there are some villages: Pugachi, Elicaevo, Suhaia Rechka, Zhurgavan.

The water intake area is located in the floodplain of the river Tom at the distance of 100 m from its bed. Wells are situated at the distance of 350 m from each other. The depth of each well is 100 m from the surface.

The maximum allowed amount of underground water extraction is 48700 m^3/day, and 16750000 m^3/year. The permissible ground level lowering is 40 m. On the average the load per well should be 3200 m^3/day.

According to geological structure and conditions the subsurface site is related to the second group of reserves classification and inferred resources of drinking, industrial and mineral underground waters.

Aquifer system of Kazan terrigenous-carboniferous deposits of elias subseries of the Kuznetsk adartesian basin of the ground-block waters is used by wells.

Water-bearing formations of accessible area are covered by alluvial deposits of the floodplain and by the second above floodplain terraces of the valley of the river Tom, where water bearing gravels with capacity from 2 to 9 m are deposited.

The boundary hydrogeological conditions are the bounded strip aquifer with a boundary of the constant water head near the river Tom (the boundary of the first type) and the boundary with dropping filtration options on the joint with an original inclination (the boundary of the third type).

Water from operating wells is supplied in a storage tank of clean water №2 to the pumping and filtration station (PFS-2) with a productivity of 225000 m^3/day. It is supplied by a collecting telescopic conduit with a diameter from 250 to 1000 mm.

Submersible centrifugal pumps with a brand name SP "GRUNDFOS" were installed in wells of the Pugachevsky water intake. The assessment of the produced water is conducted according to instrument US-800 readings. The traditional

scheme for the water purification is used at the PFS-2. It includes clarification, bleaching and disinfection. At the same time, water is coagulated, treated with flocculant, settled, filtrated and undergone the primary and secondary treatment with sodium hypochlorite. Sometimes if there is a technological necessity, such processes as alkalizing, purification and aeration are realized.

Chemical analyses of underground water from wells of the Pugachevsky water intake are carried out by the quality control laboratory of the centralized laboratory service JSC "Kemvod".

The organization of the utility and drinking water system is desirable due to underground water because of its greater protection than the surface water protection. Characteristics of the water from the Pugachevsky water intake are presented in the table (table 1).

Due to the table we can get a visual water condition according to a comparison between normal values and analysis data.

The underground water of the subsurface is related to hydrocarbonate-calcium, less often to sodium-calcium and magnesium-calcium with mineralization 0.2-0.5 g/dm^3.

Table 1 – Characteristics of water from the Pugachevsky water intake

Characteristics	**Measurement units**	**Normals**	**Analysis data**
Mineralization	g/dm^3	No more than 1	0.2 – 0.5
pH values	-	6.5 – 8.5	7.32 – 7.72
Hardness values	^{o}dH	No more than 7	2.0 – 5.2
Content of dissolved salts	mg/dm^3	No more than 1000	400
Haze value	mg/dm^3	1.5	2.98 – 3.2
Iron	mg/dm^3	No more than 0.3	0.36 – 0.67
Manganese	mg/dm^3	No more than 0.1	0.11 – 0.27
Oxidation	mgO^2/l	5.0	0.25 – 0.72
Nitrites	mg/dm^3	No more than 3.3	0.003 – 0.025
Nitrates	mg/dm^3	No more than 45	0.05 – 6.8
Ion-ammonium	mg/dm^3	3	0.05 – 0.51
Phenols	mg/dm^3	No more than 0.001	0.0005
Oil products	mg/dm^3	No more than 0.3	0.034
Hydrogen sulfide	mg/dm^3	No more than 0.003	0.0034 – 0.0799

According to the analysis data, water is weakly alkaline (pH values change from 7.32–7.72), low hardness and moderately hard (hardness values change from

2.0–5.2° dH). The content of dissolved salts doesn't exceed values of 400 mg/dm^3. (1)

Organoleptic parameters (water colour and smell) basically are complied with the standard. At the same time, it is noted that in 2009 and 2011 there was exceeded concentrations of haze value (to 2.98 and 3.2 mg/dm^3). It was estimated that there was increased content of the organoleptic parameters (iron and manganese). In some water samples the excess of iron (to 0.36-0.67 mg/dm^3) is more than twice, of manganese (to 0.11-0.27 mg/dm^3) is in tree times.

Oxidation as proxy measure of organic compounds and sanitary conditions of underground waters corresponds to the standard (0.25-0.72 mgO^2/l).

Chlorine and sulfates as part of dissolved components are found within limits.

Lead, zinc, cadmium, molybdenum, copper, nickel, mercury and fluorine are within limits in micro composition.

Toxic nitrogen components (nitrates and nitrites, ammonia nitrogen) are in water in concentrations not exceeding the limits. (The content of nitrites in the water is not more than 0.003-0.025 mg/dm^3, nitrates – 0.05-6.8 mg/dm^3, the ion-ammonium – 0.05-0.51 mg/dm^3).

Phenols and oil products are in water and correspond to the norm and do not exceed values 0.0005 mg/dm^3 and 0.034 mg/dm^3. It is noticed that there is a high content of hydrogen sulfide (to 0.0034-0.0799 mg/dm^3) in some samples.

Content of heavy metals in underground water is in concentrations typical for Kuzbass and does not exceed the norm established for the drinking water quality.

Bacteriological water condition is adequate. Overall bacterial number is 0 CFU. Also, common coliform and thermotolerant bacteria were found there.

Thus, underground water of the water intake is suitable for the utility and drinking water system, if it is preliminary purified from hydrogen sulphide, manganese and deferrization.

Underground water is cleaned at existing water treatment plants. Examination of water samples selected before the water supply to customers shows that water conforms to all norms.

During research conducted by design organization in August of 2010, it was established that 11 water wells (№218, 212, 231, 240, 270, 257, 492, 298, 319, 513, 518) were exploited. Water from the well № 262 is piped out for spillage. The well № 283 was repaired. The wells № 223, 247, 502 were reserve sources.

At present time overall production rate decline is noticed practically in all wells. So, design capacity of 16 wells of the Pugachevsky water intake was planned about 43000 m^3/day, while at the present time intake produces no more than 23000-25000 m^3/day, in other words one well can supply no more than 1600 m^3/day.

In April 2007 wells № 3, 4 were put out of action because of the production rate decline. In August 2012 repair works to recover water discharge rate on the wells of № 3, 4 were carried out by specialized organization LLC "AquaSib". During this repair works hydro-geophysical operations and pneumatic cleaning of

wells' filters were carried out. After repair works the average water discharge increase was only 13.8%. (1)

Besides in January 2013 the well № 9 was put out of action because of the water discharge decline and hydrodynamic level lowering to 37 m (exceeding a standard value).

The calculated drinking water demand of the city at the most critical conditions of water supply is 183468 m^3/day (66965820 m^3/year).

The actual annual water draught from the surface water source (the river Tom) is 58349213 m^3/year on the average.

The wanted water flow is 66965820 – 50216285 = 16750535 m^3/year; it is supplied by underground water from the Pugachevsky water intake.

Thus, water discharge decline of wells can lead to deficit of water, supplied for population of Kemerovo.

In connection with the above mentioned, it is necessary to make a revaluation of reserves of underground waters in the Pugachev area and to consider the question of using underground water for water supply of Kemerovo on the extension of the Pugachevsky area – the Smolinsky area (between Berezovo and Shumiha villages). Reserves of groundwater were estimated with data of TKZ protocol in C1 category in the amount of 35800 m^3/day. The Smolinsky area can be considered as a potential area of underground waters for water supply of Kemerovo.

All in all, underground water storage of the Pugachevsky water intake is drowned. Analysis of the current situation was carried out using observational monitoring data of the underground water level position, the volume of water sample, that were completed during exploitation and analysis taking of water sample. For the solution of possibility of using underground waters for Kemerovo financing of these works and time for carrying out the inventory revaluation of underground waters in the Pugachevsky and its extension – Smolinsky areas are required.

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