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INFLUENCE OF SULPHATE REDUCING BACTERIA ON WATER QUALITY IN WATER NETWORK

WPŁYW BAKTERII REDUKUJĄCYCH SIARCZANY NA JAKOŚĆ WODY W SIECI WODOCIĄGOWEJ

Groundwater in the Pomerania region has the specific properties, which limit its usefulness to the consumption. One of them is microbiological parameter not included in routine bacteriological control of water quality, such as sulphate reducing bacteria (SRB) characteristic for groundwater environment. Routine control of water quality includes only evaluation of pollution with faecal bacteria, while SRB are not examined. SRB in its metabolic processes produces H_2S and as a consequence of this deteriorates the organoleptic quality of water distributed in network.
In the study groundwater and water in water-pipe network were examined. In the research it was indicated that SRB are found in raw water and in treated water occurred from water treatment plant and also are present in distributed water in water-pipe network.

1. Introduction

The investigation region is situated in the north of Poland at the coasts of Gdansk Bay, which belongs to the Baltic Sea. In this region some of the richest groundwater resources among hydrogeological units in Poland are found. This fact is own to superposition of aquifers present in well-developed and widely spread Cretaceous and Quaternary formations, morphological diversity of alimentation area and influence of the sea which is the basic draining reservoir of all aquifers, establishing flow directions.

Intensive take off as well as urbanization and industrialization of the area are the major reasons for substantial transformations of hydrogeological regime and deterioration of all aquifers quality.

In analysed region, some ground water is characterised by specific properties, which limited their usefulness to consumption as followed: relatively high concentration of iron, manganese, ammonia nitrogen and periodically appearing unpleasant hydrogen sulphide odour.

Routine bacteriological control of water quality includes only evaluation of pollution with faecal bacteria, while specific groups of bacteria, as manganese-oxidizing bacteria, iron-binding bacteria and sulphate reducing bacteria, characteristic for groundwater environment and in many cases responsible for deterioration of physical and chemical parameters of water, are not examined.

In the study occurrence of sulphate reducing bacteria (SRB) in groundwater and in water distribution system was investigated.

SRB are considered to the oldest organisms detected in this environment [1]. Their presence was observed in Quaternary aquifer on depth 15-50 m and 230 m [2] and also in Cretaceous aquifer on depths 360-410 m [3]. SRB are anaerobes, but also can survive under aerobic conditions [4] [5] [6]. They are commonly occurred in soils, sediments and in non-polluted water-bearing layers [7]. These bacteria use sulphate ions as acceptor of electrons in process of organic matter oxidation. In SRB metabolic processes sulphur hydrogen is formed.

The production of H_2S often indicates the activity and presence of sulphate reducing microorganisms in natural habitats. The presence of H_2S is obvious by its characteristic smell, black precipitation of ferrous sulfide when iron minerals are present. As result of SRB metabolism, sulphur reduced compounds can decrease organoleptic features of water making her unpleasant odour, and also can contribute to biological colmatation of well filters.

2. Materials and methods

The investigation region is equipped with drinking water only from underground resources, from three formations: Quaternary, Cretaceous and Tertiary aquifers. Water is collected from some tens wells (from 30 to 230 m depth) localised in the area of 6 water intakes. The water-supply system works as a multizone pump system and it equips in water more than 250 000 inhabitants. The pipes are mainly made of cast iron and in smaller part of artificial materials (PVC, PE, AC).

Groundwater of the investigation region is characterised by the stable physical and chemical composition and by high bacteriological quality. However, the water treatment is necessary from the point of view of exceedance of admissible concentrations of some water quality indicators, mainly iron and manganese. The chemical and bacteriological quality of the drinking water before sending to the water-pipe network and to customers is controlled.

Water samples were collected at two water treatment plants (WTP I and WTP II) and additional at 7 points of distribution system in investigation region. WTP II is the youngest and one of the biggest water intakes in analysed region. Nowadays WTP II supplies in drinking water almost 30% inhabitants of the city. WTP I is an almost 50 years old object and it needs a modernisation. Groundwater from both intakes contains elevated concentrations of iron and manganese. Raw water from the both plants is treated in system consisting of aeration process in the pressure-aerators, one-stage filtration at pressure filters and periodic desinfection. At the WTP I water is filtrated at the filters with quartz-sand beds, whereas at the WTP II – at the filters with pyrolusite-anthracite beds. Water delivered to water distribution system from both plants meets the latest obligatory criteria for drinking water.

At the water treatment plants samples of raw groundwater and treated water were collected – sampling points no. 2 – raw water and no.3 – treated water from WTP I and points no.7 and no.8 – raw and treated water from WTP II. The sampling points of water supply system were located in each of two zones: the first zone contained sampling points no. 1, 4, 5, 10, 11 – supplied with water from WTP I and the second one contained sampling points no. 6, 9 - supplied with water from WTP II.

In the period of half a year eleven series of investigations of water from all control points were performed. Bacteriological analyses included determination of the sulphate reducing bacteria (SRB) occurrence in 500 ml of water. Starkey liquid nutrient medium (0.5 g K_2HPO_4, 1.0 g NH_4Cl, 1.0 g Na_2SO_4, 0.1 g $CaCl_2*2H_2O$, 2.5 g $MgSO_4*7H_2O$, 6.0 g of sodium lactate (70%), 1000 ml of distilled water, 10 ml of $FeSO_4(NH_4)_2SO_4*6H_2O$ (10%), pH=7.0-7.5) was used. Incubation at 22^0C lasted for 4 weeks.

The values of physical and chemical parameters of raw and treated water from WTP I, WTP II and water from distribution system were received from municipal Waterwork Company and those results concerned the period of last five years.

Tab. 1 Occurrence of sulphate reducing bacteria in water

	Occurrence of SRB in water of each sampling point										
	1	2	3	4	5	6	7	8	9	10	11
	-	-	+							+	
	+	-	-		+					-	+
	-	+	-	-	-	-	-	+	+	-	-
	+	+	+	+	-	-	+	+	+	+	-
	+	+	+	-	+	-	-	+	+	-	-
	+	+	-	-	+	-	+	+	-	-	+
	-	+	-	-	-	-	+	-	+	+	+
	+	-	+	+	+	-	+	+	+	+	-
	+	+	+	+	+	+	+	-	+	+	-
	+	-	-	+		-	+	+			
	+	+	-	-	+	+	+	+	-	+	-
% of positive results	**73 %**	**64 %**	**46 %**	**44 %**	**67 %**	**22 %**	**78 %**	**78 %**	**75 %**	**60 %**	**33 %**

„+” - positive result represents occurrence of SRB in the sample
„-” - negative result represents lack of SRB in the sample

3. Results and discussion

Raw water from WTP I and WTP II contains elevated admissible concentrations of iron and manganese – average concentrations of these parameters ranged from 0,6 to 1,0 mgFe/dm^3 and from 0,09 to 0,13 mgMn/ dm^3. The Polish Regulation of Health Department which came into force in March 2007 and meets the requirements of the European Union for drinking water allow the concentrations of iron amount to 0,2 mgFe/dm^3 and manganese 0,05 mgMn/dm^3 [8]. Consequently groundwater treatment at the water intakes is necessary. As a result of treatment consisting in aeration and filtration, the concentrations of both parameters have decreased to 0,12 mg Fe/dm^3 and 0,02 mg Mn/dm^3 in the outflow. Another physical and chemical parameters did not exceed admissible values. The physical and chemical parameters of water from distribution system are similar to the parameters of treated water at the water treatment plants. The physical and chemical parameters of water quality have not deteriorated in distribution system.

Results of bacteriological investigations are shown in the Table 1. Sulphate reducing bacteria were present in water samples of all of 11 sampling points. The highest number of samples containing SRB (78%) were collected at the WTPII - sampling points: no. 7 and 8 –raw and treated water. At the WTP I SRB were detected in 64% of raw water samples and in 46% of treated water. Water from distribution system contained SRB in 22%-75% of samples. Percentage share of water samples containing SRB is shown in Fig.1.

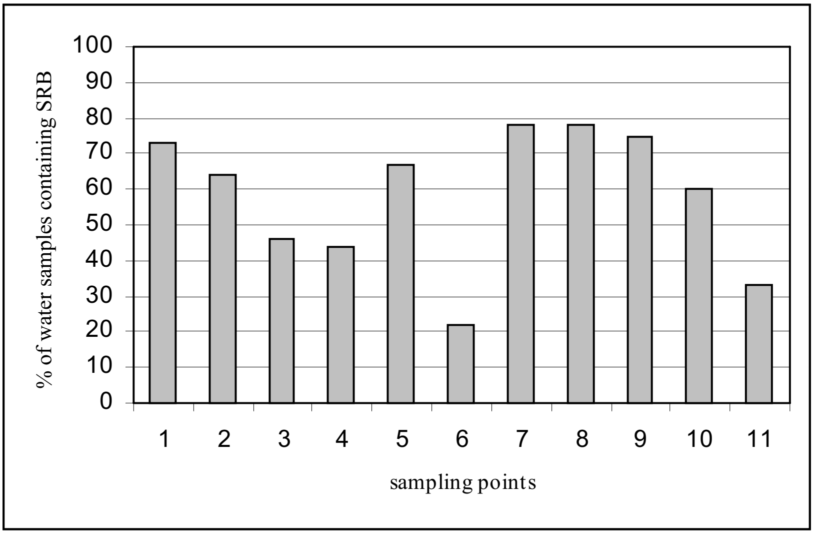

Fig.1 Percentage share of water samples containing SRB

4. Conclusions

Routine bacteriological control of water quality does not include sulphate reducing bacteria, therefore these indicator is not examined. SRB is not dangerous for human health, however it can cause unpleasant and unacceptable sulphur hydrogen odour of water, can contribute to biological colmatation of well filters and can be the reason of network pipes corrosion.

Occurrence of SRB in both raw and treated water was observed. Water treatment processes – aeration and filtration (on quartz-sand beds at WTP I and on pyrolusite-anthracite beds at WTP II) were ineffective in SRB elimination.

Nowadays the second pollution of water transported from water treatment plant to customers is a significant problem for many water suppliers in Poland. The second water pollution is due to the water-pipe network overdimensioning in comparison with current water demands. The reduction of water consumption in the last couple of years has caused the decrease of water-flow velocity and the increase of water stagnation in the pipes. In this case very good conditions for re-growth of microorganisms (e.g. sulphate reducing bacteria) in water are formed. Consequently organoleptic properties of water in the pipe network have deteriorate. Therefore the water-pipe network should be periodically rinsed and desinfected.

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