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Chemical and microbiological nature of produced water treatment biotechnology

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Abstract

The paper studied the chemical and microbiological nature of the produced water. The aim of study is to describe the interdependence of the chemical composition and microbiological activity of the produced water in combination with various types and amounts of shungite for the treatment of produced water. For the first time produced water from the Kumkol field was studied. The practical value of research is to develop a methodology where the implementation of biotechnology for a high degree of purification is given. From a practical point of view, carbonate-shale shungite is of interest because it provided the largest decline in chlorides (1.7 %) and the smallest increase in sulphates (13.5 %). Use of all shungite has a beneficial health effect on the process of water purification, as coliform bacteria were not found in experimental samples. Based on the results from microbiological analysis, the most beneficial effect on the activity of the studied taxa affects carbonate-shale shungite, and Russian shungite has a relatively neutral stance on this characteristic.

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Keywords: produced water; chemical compositions; microbiological activity; shungite

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1. Introduction

Water deposited in the same formations with oil or gas, is called the formation or produced water. The distribution of oil products in the reservoirs corresponding to their density: the upper part of the reservoir in occupied by gases, below by oil products, and finally by formation water. Produced water differs from surface water with absence of sulfates or their low concentration [1].

The topicality of the problem for the protection of soils and plants from the harmful effects of oil production and refinery production lies in the fact that oil production occupied large areas: exploited and potential oil and gas basins occupies more than one third of the world's land [2]. Because of imperfections or infringement in oil extraction technology, petroleum products and produced water are the main environmental pollutants. The oil industry has the third largest risk of exposure to the environment among the 130 branches of modern production [3].

Formation water, extracted with oil is forming dispersion; usually contains a considerable amount of soluble mineral salts [4]. Numerous studies of the mineral composition of formation waters show that the bulk of the dissolved substances are sodium chloride, magnesium and calcium. Besides, depending on the field, iodine bromide, sodium, iron, calcium, vanadium salts, germanium, and others minerals can be present [5]. Types of salt and trace elements present in produced water drastically change the state of ecosystems, leading to degradation of ecological communities [6]. Leaking of formation water into the ground water leads to an increase in salinity and chloride, as well as causing impact outside visible violations [7].

Thus the paper studied the chemical and microbiological nature of the produced water. The aim of study is to describe the interdependence of the chemical composition and microbiological activity of the produced water in combination with various types and amounts of shungite for the treatment of produced water. For the first time produced water from the Kumkol field was studied. The practical value of research is to develop a methodology where the implementation of biotechnology for a high degree of purification is given.

2. Methodology

The following methods were used to carry out the scientific research:

- Sample water selection method. Selection of formation water samples was carried out in accordance with the requirements of GOST 31861-2012 [8], 53415-2009 [9], 17.1.5.05-85 [10]. These standards apply to all types of waters and establish general requirements for the selection, transportation and preparation for storage of water samples for determining indicators of its composition and properties;
- Chemical analysis of water. The chemical analysis of produced water was carried out in accordance with the requirements of GOST 51232-98 [11], GOST 26449.1-85 [12], GOST 21727-76 [13], GOST 27384-87 [14], GOST 31864-2012 [15], GOST 31868-2012 [16] according to the procedures set forth in the works of Alekseeva [17], Karyuhina & Churbanova [18] and Ivchatova & Malov [19]. Chemical analysis of the water was carried out on Spectrometer DR 2800, HACH, LANGE;
- Microbiological analysis of water. Microbiological analysis of produced water was carried out in accordance with the requirements of GOST R 51446-99 [20], ISO 16140:2003 [21], GOST 7218-2011 [22], GOST 20264.1-89 [23], GOST R 51446-99 [24] and SanPiN 42-123-4940-88 [25], SanPiN 42-123-4423-87 [26] according to the procedures set forth in the works Gusev & Mineeva [27], Emtseva & Mishustin [28], Netrusova & Kotova [29] and Holt [30]. Quantitative accounting of microorganisms carried by the Koch method, the essence of which is the limiting dilution method [31]. Cultivation of microorganisms was carried out in an oven at a temperature of 29 °C for 24–72 hours to determine the growth of the colonies on dense nutrient agar for heterotrophic bacteria plate count and coliform bacteria and from 120 to 168 hours to determine the growth of the colonies on dense nutrient agar for *Actinomycetales* and *Micromycota*;
- Statistical analysis of the results was carried out using mathematical biology techniques [32– 34];
- Biotechnological research; the scheme of which is presented in Fig. 1. As seen in Fig. 1, four types of shungite (carbonate, shale, carbonate-shale, Russian) were used for the purification of produced water. The amount of the shungite in all experiments was 60 g/l produced water.