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Biodestruction of wasted drilling starch-based reagents and its modifications

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Abstract

Choosing the right organic additive to the drilling water as to protect the environment we should take into consideration its experimental data of the biodestruction. Biological destruction research of the most common drilling starch-based reagents identified significant biostability of wasted drilling carboxymethyloxyethyl, carboxymethyl and hydroxyethyl starch-based reagents. The evaluation of phytotoxicity of starch-based drilling reagents derivatives shown that the inhibitory polymer effect decreases with their biodegradability and products accumulated are not phytotoxic.

Keywords: drilling waste, polymeric drilling reagents, starch, biological destruction

Streszczenie

Badania nad biodegradacją najpowszechniej stosowanych płuczek wiertniczych zawierających takie pochodne skrobi jak karboksymetyloceluloza oksietilkrahmal, karboksymetyloceluloza i hydroksyetyloskrobia, wskazują na znaczącą odporność na biodegradacje powstających odpadów wiertniczych. Przeprowadzona w pracy ocena fitotoksyczności kilku rodzajów płuczek skrobiowych wskazuje, że efekt hamowania przez badane polimery kiełkowania roślin, spada wraz z ich podatnością na biodegradację, a powstający produkt nie jest fitotoksyczny.

Słowa kluczowe: wiertnicze, polimerowe płuczki wiertnicze, skrobia, biodegradacja, fitotoksyczności

1. Introduction

Current development stage of oil and gas production process of well flushing has large variety of used drilling reagents and waste generated. Average well depth 4500 to 5200 m construction produces up to 6 to 8 thousand m^3 of wastewater [1]. Drilling waste contact with fertile soil layer leads to a complete loss of productivity, and its partial restoration is observed not earlier than in 3-6 years from the moment of contamination [2, 3]. Especially dangerous is drilling fluids and drilling waste ingress into surface water sources during operations on offshore drilling rigs and in case of accident. It is a well known fact, that the sea benthos is repressed when the sludge content in water reaches 0.5 g/l, and concentration of 0.8–1.25 g/l is extremely dangerous [1].

The reagents based on starch and its modifications, such as, for example: Poly-sal, Mi-lo-jel, Bio-Los, FITO RK, Dextride LTE, IKR, Bur, BurS, Flo-Trol, Politsell KMK-BUR 1, Politsell KMK-BUR 2, Politsell GKR, Politsell PSB, Politsell FKR, KLEN-BT KMK, RK, RKS, Gagboza EHV, Krakhmal fito-R, PoliKR-F (K, D) and many others, are widely used in drilling. The overwhelming majority of these compounds are gel-forming organic with the expressed stabilizing effect, that in combination with colloidal mineral part of the suspension particles (the clay fraction) gives the high aggregate stability to the drilling waste. Such stabilized colloidal-dispersed systems are less sensitive to physiochemical action. However, these additives are ecologically dangerous. The great energy resources are required to destabilize these systems. Choosing the right organic additive to the drilling water we should take into consideration of its biostability, just to protect the environment.

The purpose of paper is the estimation of biological degradation degree of wasted drilling starch-based reagents and its modifications (Politsell PSB, KMK-BUR, Politsell GKR, BURS, FLO-TROL) and toxic effect of biodegradation products.

2. Material and methods

For comparative analysis of the biological stability of the starch-based agents (Politsell PSB, KMK-BUR, Politsell GKR, BURS, FLO-TROL) cultivation of the following associations have been done: *Pseudomonas putida VKM 1749 D, Rhodococcus erythropolis AS 1339 D, Fusarium sp. № 56* in total mineral McClang medium with admixtured of the investigated reagents, as carbon and energy source (1% mass). As a growth factor yeast autolysate have been used in concentration 0.01 g/l. As a control, medium without introducing microorganisms have been chosen; inoculation was carried out at the rate of 3% of the association volume of *Pseudomonas putida VKM 1749 D, Rhodococcus erythropolis AS 1339 D, Fusarium sp. № 56* in a 1:1:1 ratio.

Politsell PSB – drilling agent based on carboxymethyloxyethyl starch.

KMK-BUR – chemically modified starch (carboxymethyl starch), used as a drilling fluids stabilizer and filtration reducing. Agent effectively reduces water losses (both fresh and salted) and provide stable rheological parameters during drilling. In the drilling fluids with low solid phase contain reagent serves to limit clay rock dispersion, providing good flow rates.

Politsell GKR – drilling agent based on hydroxyethyl starch.

BURS – drilling mud starch-based agent (TU 9187–002–26101282–2006) made by JSC “Burservice”.

FLO-TROL – fluid loss preventing agent, a type of modified starch, specially designed for use in the "Flo-Pro," used in combination with calcium carbonate. Recommended concentration – from 3 to 12 kg/m^3.

Cultivation was carried out on a thermostated shaker at 30 ° C and a speed 100 rev/min for 7 days [4]. The biodestruction of drilling reagents have been described by the reducing the permanganate oxidation and viscosity of the culture fluid, growth of heterotrophic microorganisms [5, 6], changes in pH [7]. The initial and final values of permanganate oxidation of culture fluid was determined by titrimetric method at the Analytical Center of "Neftekamskvodokanal" (the accreditation certificate ROSS RU 0001.5122). The sampling was carried out according to GOST R 51592-2000. Conditions for performance measurements PNDF 14.1:2:4.154–99: air temperature – 20 ± 5 ° C, relative humidity – up to 80%, the frequency of the AC – 50 ± 1 Hz, the power supply voltage – 220 ± 22 V. pH was measured on ionomer I–500 ("Aquilon"). To measure the relative viscosity standard field viscosimeter (SPV–5) have been used.

3. Results and discussion

Dynamics of changes in the culture liquid permanganate oxidation in the samples is shown in Figure 3.1.

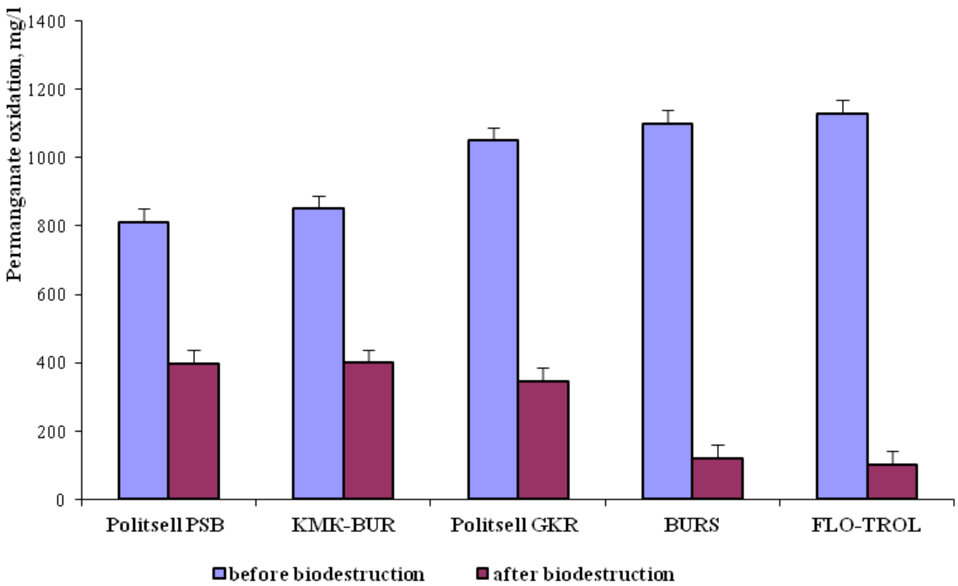

Figure 3.1. Permanganate oxidation in the researched samples of wasted drilling starch-based agent 1.0% mass after 7 days of cultivation

As seen from Figure 3.1, the largest decline of permanganate oxidation after 7 days of cultivation of *Pseudomonas putida ВКМ 1749 Д, Rhodococcus erythropolis AS 1339 D, Fusarium sp. № 56* associations, has been observed in the experiment with FLO-TROL, BURS and Politsel GKR – 91, 89 and 67%, respectively. The analysis of permanganate oxidation allow to conclude that the highest degree of biodestruction was observed in the case of admixture of "FLO-TROL" agent.

Research results on relative viscosity are presented in Figure 3.2.

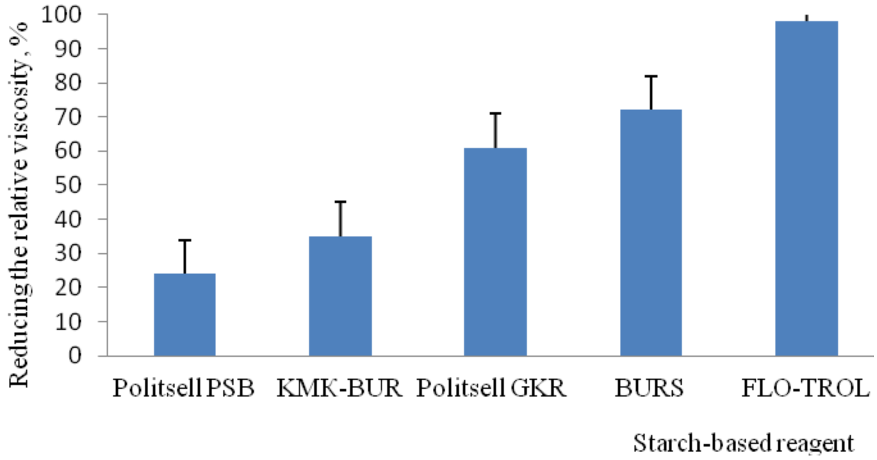

Figure 3.2. Viscosity reduction in analyzed samples of wasted drilling starch-based agent 1.0% mass

Figure 3.2 shows the decreasing in the relative viscosity in experiments with FLO-TROL, BURS and Politsel GKR (98, 72 and 61% correspondently). Test samples without introducing microorganisms do not shown relative viscosity changes.

The dynamics of heterotrophic microorganisms growth in liquid mineral medium with drilling starch-based agents and its modifications 1% mass represented in Figure 3.3.

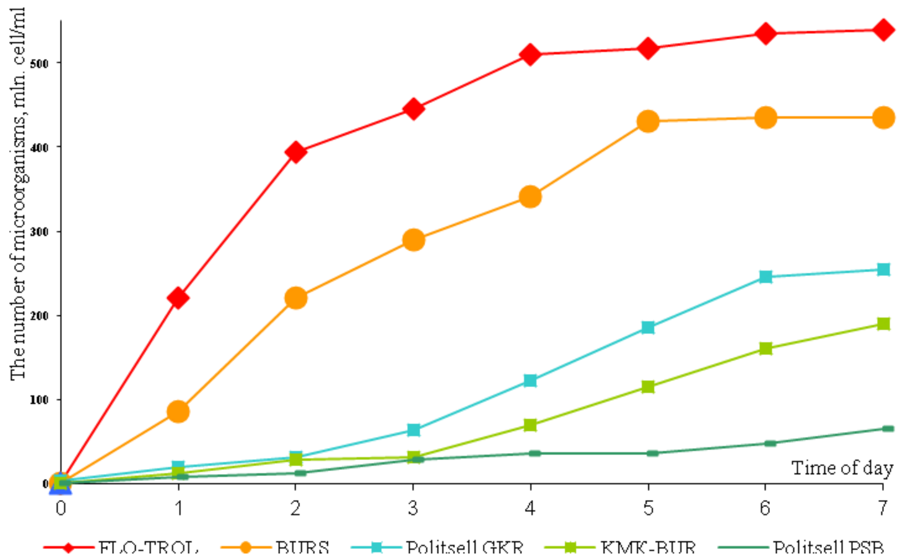

Figure 3.3. The dynamics of heterotrophic microorganisms growth in experiment with drilling starch-based agent and its modifications (1% mass)

Results of research indicate the ability of the association *Pseudomonas putida VKM 1749 D, Rhodococcus erythropolis AS 1339 D, Fusarium sp. № 56* for active growth in an environment with drilling agent based on FLO-TROL 1% mass; for 7 days of cultivation total number of microorganisms in the environment with BURS and Politsel GKR increased by 3 times, with the KVM-BUR – 2 times. The highest number of bacteria throughout the experiment was observed in the FLO-TROL, and the lowest – in the Politsell PSB. The evidence of biodegradation is the reduction of pH from 8.7 to 7.9.

To determine the phytotoxic activity of starch-based drilling reagents and its derivatives in the soil Lepidium sativum was used, as the most common biological indicator [5, 6]. Research results of phytotoxic activity of starch-based drilling reagents and its derivatives in the soil are presented in Figure 3.4.

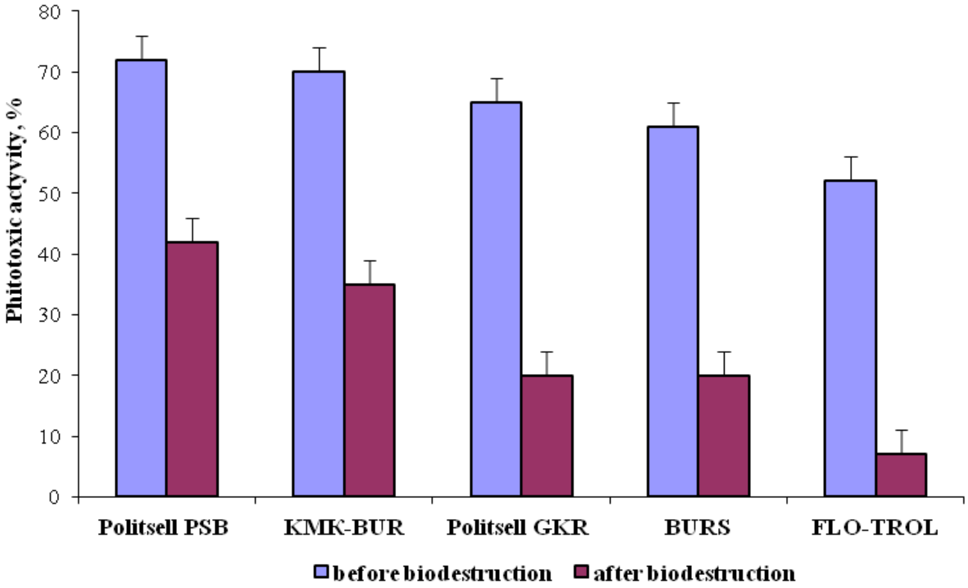

Figure 3.4. Phytotoxic activity of starch-based drilling reagents and its derivatives in the soil

Seed germination in the soil with the starch-based drilling reagents 1% by mass and associations of *Pseudomonas putida VKM 1749 D, Rhodococcus erythropolis AS 1339 D, Fusarium sp. № 56* 3% of the volume was 30–45% higher than in the soil with starch-based drilling agent without inoculation. This fact leads to the conclusion that the accumulated metabolites of drilling starch-based agents are not toxic to the seedlings.

According to the biological stability investigated starch-based agents can be arranged in the following order: Politsell PSB> KMK-BUR> Politsell GKR> BURS> FLO-TROL. Biodegradation products investigated starch-based drilling reagents association *Pseudomonas putida VKM 1749 D, Rhodococcus erythropolis AS 1339 D, Fusarium sp. № 56* are not phytotoxic.

Literature

1. Yagafarova G.G., Mavlyutov M.R., Ilyina E.G., Barakhnina V.B. Technology bioremediation of oil sludge and drilling waste // Bashkir Environmental Bulletin, 2000. - № 3 (10). - pp. 50-52.
2. Yagafarova G.G., Mavlyutov M.R., Gataullina E.M., Barakhnina V.B. Biotechnological method of disposal of oil sludge and drilling waste // Mining Journal, 1998. - № 4. - pp. 43-45.
3. Barakhnina V.B. Ways to intensify bioremediation of soil and water from oil, petroleum products and certain drilling waste: Author. dis .. ... candidate. tech. science. Ufa State Petroleum Technological University. - Ufa., 1999. - 24 p.
4. Guide to practical training in microbiology / edited by NS Yegorov. Moscow: Moscow State University Press, 1983. - 210 p.
5. Tepper E.Z., Shilnikova V.K., Pereverzeva G.I. Workshop on microbiology. Khimiya, 1983. - 260 p.
6. Methods of Soil Microbiology and Biochemistry / Edited by DG Zvyagintsev. Moscow: Moscow State University Press, 1991. - 304 p.
7. Lurie Y.Y. Standardized methods for analysis of water. Khimiya, 1973. - 320 p.