International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-7 Issue-4s2, December 2019

Microorganisms in Oil Reservoirs of West Kazakhstan

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Abstract: ***Nowadays, the oil and gas branch of Kazakhstan is the largest, fastest growing area, where development of oil and gas is steadily increasing. The efficiency of oil extraction of from oil-bearing strata by modern, industrial by mastered methods of development in all oil-producing countries for today is considered to be unsatisfactory, despite of the fact that the consumption of petroleum products in the world is growing every year . The average ultimate of oil recovery in different countries and regions is from 25 to 40%.One of the most effective method for enhanced oil recovery is the microbial enhanced oil recovery (MEOR). The use of microbiological approaches in the development of the ways of increasing oil production requires a thorough screening of active microbial strains with a high target activity among a large diversity of microorganisms' species of a natural microflora objects of the environment on the territory of the deposit. The aim of this work was the isolation microbial strains resistant to extreme conditions in oil-producing regions, for further constructing the microbial consortium for using in biotechnology development that leads to the oil recovery enhancement.***

Index Terms: Microbial Enhanced Oil Recovery, Microorganisms,

I. INTRODUCTION

It is clearly evident that consuming of oil products grows throughout the world in recent years. The efficiency of oil recovery from oil reservoirs with modern industrially developing methods is considered unsatisfactory.

Kasakhstan has brown fields at the present time. Extracted production reached a high level of watercut (80-90%). Volumes of unworked oil resourses amounted to 60-70%. A majority of basic fields has already been opened in Kazakhstan. Besides, places for gadding remain lesser and lesser accessible. Design of new technologies is currently important problem. New technologies provide for vastly increasing oil recovery (Miroshnikov V et al., 2011).

Microbial vital activity is the factor determined successfulness of biomethods. Phosphorus, nitrogen and oxygen determine development of microbial flora in reservoirs. Natural reservoir is depleted in light hydrocarbons. The usage of microbiological methods on these objects is difficult due to it is required accommodation

of vital activation processes (supply of nutrient substance) of biocenosis and regime of recycling (Jimoh IA., 2012).

Manuscript published on 30 December 2019.
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Aerobic microorganisms have been found in formations with temperatures ranging from 20 to 70°C and pH ranging from 6.0 to 8.4. Some of these aerobic bacteria have been identified as Rhodococcus ruber, Arthrobacter oxydans, Kocuria rosea, Gordonia rubropertincta, Cellulomonas cellulans, Bacillus subtilis, B. cereus, Pseudomonas fluorescens (Al-Bahry SN et al., 2013, Nazina T. et al., 2012). The anaerobic microflora present in oil reservoirs are commonly bacteria of the genera Bacteroides, Clostridium, Thermoanaerobacter, Thermococcus, Thermotogales (Lien T et al., 1998), Desulfotomaculum (Eden B et al., 1993). Screening for microbial consortia from some Omani oil wells by Al-Bahry et al. (Eden B. et al., 2013) showed a total of 30 genera and 69 species of microorganisms. In this study, most of the detected genera were found to be anaerobic, thermophilic, and halophilic and some of them were documented to be suitable candidates for MEOR.

MEOR technology makes use of special indigenous or exogenous microbial strains and nutrients that are injected into the reservoir to enhance oil production. The metabolic action of the injected exogenous microbial strains and the indigenous reservoir microflora produce metabolites such as gases, alcohols, and surface active compounds (biosurfactants) that interact with the crude oil. Biogases provide additional reservoir driving pressure; while bioalcohols and biosurfactants reduce oil viscosity and surface tension between oil-water and oil-rock, respectively. Under the effect of metabolites, the crude oil flowing properties are modified causing its release and mobilization toward the production wells enhancing the oil flow output.

II. METHOD OF RESEARCH

Traditional microbiological methods such as spread plate method, seeding to the liquid culture medium (inoculated volume amounted to 10%), method for determination total microbial count (the variant of Koch method), method for determination total microbial count, were applied to the cultivation of microorganisms in the work. Microbial morphology was researched with binocular microscopes Micмедво-1 and «Motic BA 300» by generally common procedures in laboratory practice. Preparations were made according to generally common methods of light-field microscopy. Elective conditions were created for the determination of various physiological groups of microorganisms. Elective conditions are special nutrient media that create more favorable conditions for the growth of a particular type of microorganisms of interest to the researcher. By creating elective conditions, it is possible to obtain accumulative cultures of microorganisms.

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Samples of water of oil reservoir oil fields "Zhetybai" and "Kulsary" were used as research materials:

1) A sample of oil reservoir water was collected from "Zhetybai" oil field, 5B horizon, sample thief from well spring № 4726, on the occurrence depth 1900m, pressure in the reservoir is 15,5 MPa, 57°C;

2) A sample of oil reservoir water was collected from "Kulsary" oil field, II-alt-neocom horizon, sample thief from well spring № 216, on the occurrence depth 250m, pressure in the reservoir is 13 MPa, 47 ° C.

III. ANALYSIS AND DISCUSSION

Bacterial activity determines successful microbiological methods of oil recovery. Presence of formed biocoenosis is a characteristic of oil reservoir development in the process of water flooding on the late stage. First and foremost the biocoenosis is limited of nutrient substances and degree of mineralization. Usage of microbiological methods presents difficulties on these objects due to accommodation of activation processes of biocoenosis and state of water recycling. Presence of autochthonal microbial flora is demonstrated in deep-seated water -bearing and oil-bearing horizons. Moreover, microorganisms come with surface solution during gadding and water injection (Miroshnikov V et al., 2011). Microbiological quantitative characteristic of sample of oil reservoir water from "Zhetybai" and "Kulsary" oil fields was carried out by index of colony-forming units. Results of research of quantitative characteristic aerobic and anaerobic microorganisms in oil reservoir water of "Zhetybai" and "Kulsary" oil fields are demonstrated in the table 1.

Table 1. Quantity of microorganisms of oil reservoir waters from oil reservoirs, cells/ml

Samples	Total numerical rating of microbes, cells/ml	
	Aerobes	Anaerobes
Zhetybai	$1,8x10^6$ $\pm 0,08x10^6$	$0,38x10^5\pm$ $0,013x10^5$
Kulsary	$25,1x10^6$ $\pm 1,2x10^6$	$0,5x10^2\pm 0,02x10^2$

It is clearly evident, that total number of aerobes is 1,8x106 cells/ml and 25,1x106 cells/ml in the Zhetybai and Kulsary, respectively. As it is seen, number of aerobic microorganisms in the oil reservoirs water of "Zhetybai" lower than total number of aerobes in "Kulsary", whilst the pattern is complete reverse when it comes to anaerobic microorganisms ("Zhetybai" samples - 0,38x105 cells/ml, "Kulsary" samples - 0,5x102 cells/ml). These results correlate

With occurrence depth of oil reservoir. Water samples of "Kulsary" were collected on the depth of 250m and

Samples from "Zhetybai" were collected on the depth of 1900m. It was accepted a value which is not less than 1mln per 1g of substrate for conditional test of microorganisms. Every ecological factor (temperature, quantity of nutrient substances, concentration of macro- and microelements) is characterized by quantitative indexes such as optimum and a factor when organisms feel depressed. Organisms feel depressed in the conditions of instability bounds (whole interval of factors from minimal to maximal, when growth and development of organism are possible). Research of total number of aerobic microorganisms in the oil reservoir water of "Kulsary" and "Zhetybai" fields is demonstrated a significant ecological meaning of them due to their numerosity and high vital activity.

Biodiversity of microorganisms is not relatively enormous. Research of presence the following groups of microorganisms was carried out: micromycetes, spore-forming microorganisms, pseudomonas and enterobacteria. Results of research of qualitative characteristic aerobic and anaerobic microorganisms in oil reservoir water of "Zhetybai" and "Kulsary" oil fields are demonstrated in the table 2.

Table 2. Qualitative characteristic of oil reservoir water from "Zhetybai" and "Kulsary" oil fields, cells/ml

Groups of microorganisms	Total number of microbes, cells/ml	
	Zhetybai	Kulsary
Micromycetes	$0,35x10^3$ $\pm 0,014x10^3$	$1,5x10^5$ $\pm 0,1x10^5$
Bacillus	$0,4x10^3$ $\pm 0,02x10^3$	$8,5x10^4\pm$ $0,2x10^6$
Pseudomonas	$11,7x10^2$ $\pm 0,5x10^2$	$17x10^3$ $\pm 0,5x10^3$
Enterobacteria	$0,6x10^3 \pm$ $0,01x10^3$	$6,6x10^4\pm$ $0,33x10^4$
Spore-forming microorganisms	$2,3*10^3 \pm$ $0,6x10^3$	$2,5x10^5\pm$ $0,12x10^5$

As it seen, all the being researched groups of microorganisms are demonstrated: spore-forming microorganisms, Micromycetes, Pseudomonas, representatives of g. Bacillus and Enterobacteria. However, spore-forming microorganisms is a prevail group - 2,3*103 cells/ml and 2,5x105± 0,12x105, respectively. It is known, that allochthonic microorganisms come with injected water or water exchange in the oil reservoir.

At reservoir depths of 1–3 km, thermophilic microbial communities are found. These microbial communities are made up of microorganisms commonly found in deep reservoirs and bacteria normally encountered in shallow areas of the reservoirs (i.e., <1 km) but in lower numbers.

IV. CONCLUSION

The studies of microbial communities conducted on samples of formation water from the Zhetybai and Kulsary oil fields located in Western Kazakhstan gave total aerobic counts of 1,8x106 cells/ml and 25,1x106 cells/ml, respectively. The number of aerobic microorganisms present in the water samples from the Zhetybay field is lower than the bacterial count from the Kulsary field by an order of magnitude. At reservoir depths of 1–3 km, thermophilic microbial communities are found. These microbial communities are made up of microorganisms commonly found in deep reservoirs and bacteria normally encountered in shallow areas of the reservoirs (i.e., <1 km) but in lower numbers.

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For instance, the Zhetybai and Kulsary oil reservoirs contain several groups of microorganisms including spore-forming bacteria, Micromycetes, Pseudomonas, Bacillus, Enterobacteriaceae, with the most prevalent being the spore-forming bacteria whose counts reach 0,2x105 cells/ml.

V. ACKNOWLEDGEMENTS

This study was sponsored by the project (AP05134203) of the Ministry of Education and Science. The authors

wish to thank the technical personnel in the Zhetybai and Kulsary Oil Field

(Kazakhstan) for kindly collecting samples for investigation.

REFERENCES

1. Al-Bahry SN, Al-Wahaibi YM, Elshafie AE, Al-Bemani AS, Joshi SJ, Al-Makhmari HS, Al-Sulaimani HS. Biosurfactant production by Bacillus subtilis B20 using date molasses and its possible application in enhanced oil recovery. International Biodeterioration and Biodegradation. 2013; 81:141–146.
2. Al-Bahry SN, Elshafie AE, Al-Wahaibi YM, Al-Bemani AS, Joshi SJ, Al-Maaini RA, Al- Alawi WJ, Sugai Y, Al-Mandhari M. Microbial consortia in Oman oil fields: a possible use in enhanced oil recovery. Journal of Microbiology and Biotechnology. 2013; 23(1): 106–117.
3. Eden B, Laycock P, Fielder M. Oilfield Reservoir Souring. HSE Books; 1993. 90 p.
4. Jimoh IA. Microbial enhanced oil recovery. PhD thesis. Luma Print; 2012. 6700 Esbjerg.
5. Lien T, Madsen M, Rainey FA, Birkeland NK. Petrotoga mobilis sp. nov., from a North Sea oil production well. International Journal of Systematic Bacteriology. 1998; 48:1007– 1013.
6. Miroshnikov V, Kurbanbayev MI, Tolokonskyi S. EOR at fields in Kazakhstan. In: Proceeding of International Symposium on Theory and Practice of Application of Enhanced Oil Recovery Methods, Moscow; 2011. p. 34–41 (in Russian).
7. Nazina TN, Pavlov NK, Tatarkin Y, Shestakov NM, Babich TL, Sokolov DS, Ivoylov VS, Turov TP, Hisametdinov MR, Ibatullin RR, Belyaev SS, Ivanov MV. The development of biotechnology increase the degree of oil recovery from carbonate oil reservoirs on the territory of the Republic of Tatarstan. Electronic Scientific Journal Georesources. Geoenergetika. Geopolitics. 2012;2(6):1–6 (in Russian).

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