Brief information about the project

Name of the project	AP19577160 «The study of microorganisms producing biosurfactants and their applicability for enhanced oil recovery» (0123PK00131)
Relevance	The project is aimed at studying biosurfactants of indigenous microorganisms of Western Kazakhstan fields for a basic understanding of oil recovery processes. The main idea: selection of indigenous microorganisms and optimal conditions for their effective use to reduce the viscosity of residual oil, in general, enhance oil recovery from mature reservoirs of Western Kazakhstan oil fields. Before being used in a model experiment, indigenous microorganisms and their biosurfactants will be studied in the laboratory.
Purpose	The goal of the project is to study biosurfactant-producing microorganisms and their applicability for enhanced oil recovery.
Objectives	1. Chemical and microbiological analysis of formation water of mature oil fields in Western Kazakhstan. 1.1 Choice of the wells and sample the formation water. Chemical analysis of water samples; 1.2 Meta-genomic analysis of the microbial community of formation water samples. 1.3 Isolation of indigenous microorganisms of formation water samples. For this task, oil reservoir water samples will be taken from mature fields in Western Kazakhstan based on their low productivity and geochemical characteristics associated with high oil viscosity. The first sampling is planned after the start of the project, and subsequent samples will be taken in the third year for model experiments. The chemical composition of production water will be determined using ion chromatography and total organic carbon analysis. To understand the microbial status of oil reservoirs, major groups of microorganisms will be identified using next generation sequencing. This will allow identifying the dominant cultures of microorganisms in oil reservoirs and control the process of enhanced oil recovery. Microorganisms will be isolated on various specific nutrient media. 2. Study of biosurfactants of isolated microorganisms. 2.1 Screening for microorganisms producing biosurfactants. 2.2 Qualitative and quantitative determination of the genes of microorganisms responsible for the synthesis of biosurfactants. 2.3 Physico-chemical characteristics of biosurfactants produced by microorganisms.

	At this stage, the selection of biosurfactant-synthesizing microorganisms by various methods will be carried out and their emulsifying activity will be determined. The presence or absence of the main genes responsible for the producing of biosurfactants will be determined, the name of the genes will be determined depending on the isolated strains. The presence or absence of the main genes responsible for the formation of oil-displacing metabolites will be determined, the type of the genes will be determined depending on the isolated strains. This stage will allow the selection of active strains-producers, based on the data obtained, associations will be created for use in model experiments Physico-chemical characterization of biosurfactants produced by microorganisms will be given. Modern physical and chemical methods, such as gas-liquid chromatography, IR spectrometry, will be applied here. 3. Model experiment 3.1 Selection of the optimal nutrient medium 3.2 Determination of the oil recovery factor using selected microorganisms in model experiments In the modeling experiment, conditions as close as possible to the reservoirs will be implemented, using the natural core of the studied field, formation water, as well as the association of microorganisms selected in task 2. The selection of nutrients for model experiments will depend on the availability of raw materials suitable for injection into the oil reservoir, for example, availability and accessibility of local processing plants (dairy, starch and syrup plants, fertilizer plants). The oil-thinning and oil-displacing properties of the association of microorganisms will be studied in model experiments. The final stage will be the determination of the oil recovery factor under the influence of microorganisms, as well as an assessment of the economic efficiency of the technology implementation.
Expected and achieved results	In this project, biosurfactants of indigenous microorganisms isolated from mature deposits of Western Kazakhstan will be studied. As a result of the implementation of this project, data on the chemical and microbiological state of mature fields in Western Kazakhstan will be obtained. Microorganisms producing biosurfactants will be selected, a complete characterization of these biosurfactants will be given, including genetic, microbiological and physicochemical analyzes. In model experiments, results will be obtained on changing the composition of oil and extracting oil under the influence of selected microorganisms. An economic assessment of the effectiveness of introducing a microbiological method of enhanced oil recovery using indigenous microorganisms producing biosurfactants will be given.

	In general, valuable fundamental results related to the functional microbial ecology of the oil reservoir will be obtained, which will serve as the basis for future development of microbial EOR in Kazakhstan. Microorganisms with target activities will be obtained and added to the collections of microorganisms of the Republic of Kazakhstan. An application will be filed for a domestic patent for a microorganism strain that produces biosurfactants. The results of the project may provide an understanding of the microbiological status of the oil reservoir and bring new knowledge on the biosurfactants of these microorganisms and can be used in future field trials as well as for the commercialization of the project. Thus, this project will contribute to the development of resource-saving and environmentally friendly technologies to reduce the impact of the extractive industry on the environment, thereby increasing its sustainability. In the context of the economic crisis, when oil prices are falling and the peak of oil production from old fields has already been passed, it turned out to be more profitable and more efficient to turn to old oil reservoirs than to conduct new expensive geological exploration. It is possible to restore oil production from former high-yielding wells by intensification methods. There are many different technologies for intensifying hydrocarbon production, but each well needs a strictly individual approach. And only scientific research guarantees a high technical and economic effect. MEOR technology can be used to improve the efficiency of the development of high-viscosity oil fields, where conventional flooding does not give the expected results. Thus, their economically viable development seems to be possible only due to the development of resource-saving technologies for their production with partial conversion of a part of hydrocarbon resources directly in the reservoir in order to reduce the viscosity of the produced oil. Impact of the expected results on the development of the main scientific direction and related fields of science and technology: the project is interdisciplinary and will be carried out with the participation of microbiologists, biotechnologists, a chemist, an oil and gas engineer and a biochemist, therefore the results of the project will contribute to a greater understanding of the state of local oil fields and capabilities of indigenous microorganisms of oil reservoirs. The obtained fundamental results can be further applied in practice. The results of the project will be disseminated to interested parties, microbiological laboratories, as well as oil companies, and thus will bring economic, environmental, scientific and technical benefits, since the obtained fundamental results can be supplemented by other studies and in the future can lead to the introduction

	of an environmentally friendly, inexpensive method of enhanced oil recovery. The project will result in the sharing of scientific knowledge and research practices between academia and industry, which will benefit both parties and promote further cross-sectoral collaborations. Further, the inclusion of strong international partner will bring to Kazakhstan novel expertise and set-up for further research collaboration.
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