ANNOTATION

of PhD thesis for the degree of philosophy doctor on the specialty
6D073900 - "Petrochemistry"

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Enhanced oil recovery in the late stage of field development and destruction of oily sludge by hydroreactive compositions

Relevance of the research. At present, when the share of hard-to-recover reserves constitutes the main part of the residual oil reserves, the search and implementation of new effective methods to optimize the development process and inject working agents into the reservoir to achieve an increase in oil recovery are highly relevant. There is an urgent need to use methods to increase oil recovery, primarily gas, water-gas and heat.

In Kazakhstan at this time, researches are underway to test various methods of enhanced oil recovery. However, many of them are distinguished by the technical complexity of the design process, and technological and economic high cost.

The implementation of various mechanisms of heat exposure can be affected by an infinite number of criteria associated with this effect. As criteria for the implementation of various mechanisms can act as reservoir conditions (shape, filtration-capacitive characteristics, geometrical dimensions, reservoir pressure and temperature, the presence or absence of a gas cap, underlying water, segmentation of the reservoir, etc.), fluid properties saturating the reservoir (density, oil viscosity, gas composition, etc.) and the possibility of implementing the technology at a particular field (availability of special equipment and professional specialists, source of injection agent, infrastructure and etc.). In order to take into account these criteria, to evaluate the effectiveness of the use of the technology proposed for the implementation, it is necessary to conduct a significant number of laboratory experiments to displace oil with water, gas, and their combinations. In this regard, research aimed at developing a safe and efficient technology for enhanced oil recovery is of particular relevance.

Obtaining additional volumes of crude oil can be achieved not only by introducing new methods of enhanced oil recovery, but also by extracting oil from waste oil. Oil sludges are one of the most significant solid wastes produced by the oil industry and are complex oil-water emulsions containing various hydrocarbon components, water, heavy metals and mechanical impurities. Due to the environmental hazards of these sediments, as well as ever-increasing volumes, interest in the efficient processing of oil sludge is steadily increasing.

In recent years, many methods have been developed for treating oil sludge, such as oxidation, stabilization, solvent extraction, ultrasonic treatment, photocatalysis, pyrolysis, biodegradation, etc. environmental protection and low processing costs. Thus, the search for new ways and methods for the destruction of oil sludge is relevant.

To solve these problems around the world are developing a large number of technologies and methods. The use of hydrogen energy of activated aluminum alloys would increase the efficiency of their solution. But for this, the problems of its efficient production and highly efficient use must be overcome.

In this regard, it seems promising to develop methods for producing hydrogen directly from water by reacting its interaction with aluminum. In prevalence in nature, aluminum ranks first among metals. Its content in the crust is 8.8%. At the same time, it is known that a dense oxide film formed upon the contact of aluminum with atmospheric oxygen creates diffusional limitations to the oxidation of aluminum even in boiling water. Therefore, the development of methods and conditions for the activation of aluminum by activator metals, which lead to the destruction of the oxide film and ensures the reactivity of aluminum to water, is also relevant. There is no doubt that the role of activator metals, alloy composition, crystallization modes, and features of the formation of activated aluminum is obtaining high rates of hydrogen evolution from water and aluminum oxide with predetermined physicochemical properties. Conducting work to solve this problem allowed us to solve a number of practical problems in the development of methods and conditions for the activation of aluminum by activator metals, which provide water reactivity to aluminum.

Goals and objectives of research. The aim of the work is to create an effective, environmentally safe thermogas-chemical complex method of wellbore zone treatment, which provides for cleaning the bottom-hole zone from ARPD in a variety of geological and technical conditions, as well as the destruction of abnormally stable oil-water emulsions and oil sludge with the maximum extraction of oil composition based on activated aluminum alloys.

To achieve this goal, the following objectives were defined:

1. Development of technology for the use of hydro-reactive compositions based on activated aluminum alloys for thermo-gas-chemical impact on the well bottom zone;
2. Modeling the process of thermogas chemical treatment of reservoir fluids in the laboratory;
3. Conducting field tests and evaluating the effectiveness of the thermogas and chemical effect of the GDS at the candidate wells;
4. Development of a safe, highly efficient and environmentally friendly technology for utilization of abnormally stable water-oil emulsions and oil sludge, based on the thermogas-chemical effect of the alloy of activated aluminum on the studied objects
5. Study of oil properties using modern physicochemical methods before and after thermogas and chemical processing.

Research methods. The study of activated alloys of aluminum, hydrocarbons, formation waters and mechanical impurities was carried out using modern physicochemical methods: IR spectroscopy, SEM, TG / DSC, X-ray fluoroscopy, X-ray phase analysis.

Simulation of the well borehole zone processing under conditions as close as possible to the reservoir, on a PLS - 200 unit with a hydrostatic core holder on natural

cores.

Designing a laboratory reactor with a jacket for thermostating with built-in mixing paddles for conducting experiments on the destruction of oil sludge.

The results of the study are confirmed by the use of modern equipment with an accuracy class of 0.25-0.5, and methods of analysis carried out according to State sdandarts, as well as reproducibility of research results.

The scientific novelty of the thesis is for the first time, theoretically substantiated and experimentally proved the possibility of using activated aluminum alloys for thermo-gas-chemical effects on a CCD for cleaning a well from ARPD and, as a result, for increasing oil recovery. For the first time, a pattern was found between the total mineralization of formation waters and the specific heat of reaction of activated aluminum alloys with formation waters with the addition of hydrochloric acid. A thermochemical and chemical method was first developed and optimal conditions for the destruction of oil sludge using activated aluminum alloys were determined. A comprehensive comparative physico-chemical analysis of the oils subjected to the thermogas-chemical effect of an activated aluminum alloy was carried out and the course of the hydrogenolysis process was proven.

The main provisions for the defense:

1. Development of a new thermo-gas-chemical method for processing a CCD with the aim of enhanced oil recovery using reagents based on activated aluminum alloys;

2. Development of a thermogas-chemical method for the destruction of oil sludge by composite compositions based on activated aluminum alloys;

3. Effect of atomic hydrogen on high molecular weight hydrocarbons in the composition of oil after TGHO and the destruction of sludge.

The theoretical and practical significance of the work.

The theoretical significance of the work lies in the found regularities in the course of oxidation reactions of activated aluminum alloys with formation water. The possibility of destructive hydrogenolysis of hydrocarbons using activated aluminum alloys.

The practical significance of the work lies in the effectiveness of the method TGHO CCD wells from ARPD in order to increase oil recovery confirmed by pilot tests. Production of activated aluminum alloys and their use as coagulants for the treatment of formation waters. Development of optimal compositional compositions based on activated aluminum alloys for the destruction of oil sludge LLP Atyrau Refinery, LLP Pavlodar Petrochemical Plant, JSC Ozenmunaygaz.

Approbation of the work.

The results of the thesis were reported and discussed at scientific conferences and symposia: - International Satpaev readings "The role and place of young scientists in the implementation of the Kazakhstan-2050 strategy", April 2014, Almaty, Kazakhstan; -International scientific-practical conference "Fundamental and applied research in the modern world", July, 2014, St. Petersburg, Russia; - Scientific-practical conference "New achievements in design: a look into the future." - NIPI "Caspiymunaygaz" LLP -2016 April, Atyrau, Kazakhstan; - International

Conference - International Beremzhanovsky Congress on Chemistry and Chemical Technology, December 9-10, 2016, Almaty, Kazakhstan; - XX Mendeleev Congress on General and Applied Chemistry, 26- September 30, 2016 - Yekaterinburg, Russia; - International Satpayev readings “Scientific heritage of Shakhmardan Esenov", April 2017, Almaty, Kazakhstan; - International Congress - Contress “Société Française de Génie des Procédés” (July 12-13, 2017 Nancy , France); - Satpayev readings "Innovative solutions to traditional problems engineering and technology, 2018, Almaty, Kazakhstan; - International scientific and practical conference "New geophysical equipment and technologies for solving problems of oil and gas companies", May 22-25, 2018, Ufa, Russia; - International scientific and practical conference "Modern trends Higher education and science in the field of chemical and biochemical engineering ”, September 13-14, 2018, Almaty, Kazakhstan.

Publications.

According to the results of the thesis 16 works were published, including:

The main results of the study are set out in 2 articles in publications from the list approved by the Committee on the Control of Education and Science of the Republic of Kazakhstan, 1 innovative patent of the Republic of Kazakhstan equated to the articles approved by the Committee on the Control of Education and Science of the Republic of Kazakhstan, 2 articles in the journal “Scopus” data, 1 article in the journal “Web of science” data. 10 abstracts in international conferences, including 1 abstract in foreign countries.

The structure and scope of the thesis. The thesis work consists of introduction, chapters (sections) with conclusion after each part, conclusion, list of references and appendixes.

The thesis is presented on 123 pages of computer typing, including 40 figures and 44 tables, the list of sources used consists of 184 titles; there are 4 applications in the research work.

Summary of the dissertation.

The introduction substantiates the relevance of the dissertation work and presents its main provisions**.**

In the first chapter of the thesis provided an analysis of the current state of technological and scientific advances in the methods of processing bottom hole formation zone treatment and methods of enhanced oil recovery. The most effective modern physicochemical methods of oil sludge utilization are also presented. The methods of aluminum activation and their influence on the rate of the water oxidation reaction have been analyzed.

In the second chapter presents the main techniques used in this work. It also describes the method for producing activated aluminum alloys, the design of installations for modeling reservoir conditions for oil-saturated cores of the thermal gaseous chemical treatment and a thermostatically controlled laboratory reactor for conducting experiments on the destruction of oily sludge.

The third chapter is devoted to the analysis of the physicochemical properties of hydro-reactive compositions based on activated aluminum alloys, the study of the reaction activity of activated aluminum alloys with respect to the mineral

composition of the formation water model. Presents the results of the dissolution of Asphalts resin paraffin deposits by compositions. The results of laboratory studies of thermal gaseous chemical treatment on oil-saturated cores in modeling reservoir conditions are shown. The results of experimental field tests of the developed method are given. The most effective compositions for the destruction of oil sludge "Pavlodar petrochemical plant" LLP, "Atyrau oil refinery" LLP and "Ozenmunaygas" JSC are presented.

In conclusion, the main results and conclusions on the thesis work are described.