

ANNOTATION

Theses for the degree of Doctor of Philosophy (PhD) in the specialty
6D070800 – «Petroleum engineering»

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Justification of the choice operational facilities and associated petroleum gas utilization system at the field Kenlyk and similar reservoirs of the South Turgai basin

The relevance of the research lies in the fact that today a multifactor technical and economic problem is not solved, which allows for the most efficient utilization of oil gas in the amount of 95%. It is necessary to develop methodological techniques to link the variety of existing methods for utilization of oil gas with the individual characteristics of the fields.

The research proposes a new approach to choosing the most effective methods of utilizing oil gas and creating conditions in the country that stimulate the implementation of these methods in oil fields, taking into account the conditions of their operation.

To solve the problem of gas utilization at the fields of Kazakhstan, it is planned to use APG in order to obtain electricity for the needs of the oil field (gas turbine station) and a commercial product, in the form of liquefied petroleum gas, the remainder of the dry gas is flared.

In comparison with the standard technology for preparing gas for combustion, a technology is added to remove heavy hydrocarbon fractions in order to avoid the buildup of these fractions on the surfaces of plants with the formation of plugs and maintaining optimal conditions for fuel combustion. Moreover, the specificity is that, despite the multistage technologies for the preparation of oil gas existing in large-scale industries, for the use in small-scale energy, the issue of preparation should be decided in favor of low-cost, but efficient plants.

Goals and objectives of research. The objectives of the study are to increase the level of associated petroleum gas utilization in the fields of the South Turgay basin by choosing effective methods for its use; creation of conditions for an effective process for the separation of hydrocarbons in the apparatus of an integrated gas treatment unit with a decrease in the content of heavy C_{3+} hydrocarbons.

To achieve this goal, the following research objectives are formulated:

- to identify the characteristic features of the extraction and utilization of oil gas in the operation of oil fields;
- develop criteria for choosing effective methods of utilizing oil gas and creating conditions that stimulate the implementation of these methods in the fields;
- establish the reasons for the incomplete utilization of oil gas;

– to study the process of low-temperature gas separation and the establishment of patterns of change in phase equilibrium parameters associated with the establishment of thermobaric conditions and flow rates of liquids and gas, and their impact on transient modes of operation of apparatuses in dynamic conditions.

– estimate the emissions of pollutants into the atmosphere at the field.

The studies were carried out on the operating unit of “Kenlyk” Gas Plant and in the analytical laboratory of “KazFrac” LLP, in the laboratory of energy and theoretical and applied mechanics (LEMTA) of the University of Lorraine (Nancy, France) together with a foreign scientific consultant.

Research methods. The results of the study were obtained on the basis of theoretical and practical provisions of the theory based on the laws of phase transformations of hydrocarbon systems and heat transfer processes under dynamic conditions. Experimental studies were carried out on an existing installation using original techniques and modern measuring equipment, methods of mathematical and physical modeling.

The initial materials for the study were the analytical laboratory of KazFrac LLP equipped with a modern chromatograph Khromatek Gas. The results obtained in this work were based on well-known proven engineering methods of calculation, methods of mathematical statistics when processing data using a PC. The convergence of experimental data and theoretical calculations is confirmed by acts of testing and implementation.

The scientific novelty of the topic lies in the development of a system for the utilization of associated petroleum gas with the creation of conditions for an efficient process for the separation of hydrocarbons in the apparatuses of an integrated gas treatment unit with a decrease in the content of heavy C_{3+} hydrocarbons.

The conditions and factors affecting the choice of equipment and technology for oil production, associated petroleum gas utilization systems;

Arguments have been substantiated for improving low-temperature gas separation and for recovering heavy hydrocarbon components from petroleum gas; It was established that under dynamic conditions, the pressure and temperature of the technological system, the flow rate and composition of hydrocarbon flows change nonlinearly under the action of inertial processes and feedbacks upon transition to a stable state.

Based on laboratory and experimental studies, it has been established that the use of the proposed parameters of low-temperature gas separation will ensure the most efficient separation of oil gas in the amount of 95-99%.

Protection provisions:

– a new systematic approach developed to select effective methods of using oil gas according to criteria that take into account the individual characteristics of the fields being developed;

– the results of theoretical and experimental studies on the establishment of patterns of change in phase equilibrium parameters associated with the establishment of thermobaric conditions and flow rates of liquids and gas in dynamic conditions;

– the developed dynamic model of the process of low-temperature gas separation allows us to estimate the time to reach a new steady state, taking into account all the attendant fluctuations in the operating parameters of the apparatus included in the installation;

– research results on the influence of control parameters on the efficiency of a low-temperature separation unit;

– conditions for the dependence of the yield of target products on the main operating parameters of the feed gas.

The **theoretical and practical significance** of the results of the work is that the study of the process of low-temperature gas separation allows us to estimate the time to reach a new steady state, to take into account all the attendant fluctuations in the operating parameters of the apparatuses that make up the industrial unit. Recommendations are given for the operation of the unit with the most efficient separation of the hydrocarbon mixture.

Approbation of work. The dissertation materials were discussed at international conferences:

– XI International scientific-practical conference “Science and technology: a step into the future - 2015” (Prague, Czech Republic, 2016);

– XII International scientific-practical conference “Science and technology: a step into the future - 2016” (Prague, Czech Republic, 2016);

– International Satpayev’s readings “The scientific heritage of Shakhmardan Yesenov” (Almaty, Kazakhstan, 2017).

And also the results of the study were reported and discussed at scientific and technical meetings of subsoil users:

– “Technical meeting on increasing the productivity of the Gas plant”, “KazFrac” LLP, (Shymkent, Kazakhstan, 2016);

– “Scientific and technical meeting on the development of the Kenlyk field”, “South-Oil” LLP (Kenlyk oilfield, Kyzylorda region, Kazakhstan, 2017).

Publications. On the topic of the dissertation, 10 scientific papers have been published, including 3 articles in leading peer-reviewed journals recommended by Education and Science Monitoring Committee of Republic Kazakhstan. 2 articles in foreign scientific journals with non-zero impact factor included in the Scopus database.

The structure and scope of the dissertation. The dissertation consists of introduction, 5 sections, conclusion, list of used sources from 71 items. The work is presented on 103 pages, includes 33 figures and 20 tables.

Summary of the dissertation.

In the **introduction**, the relevance of the dissertation is given and its main provisions are presented.

In the **first section** of the dissertation, an analysis of research projects aimed at improving methods and technologies for the utilization of oil gas and gas preparation in field conditions is given.

Existing methods of oil gas utilization technology are considered. According to the results of the analysis of literary sources, corresponding goals are set and according to the stated tasks.

The **second section** presents analytical studies of technological processes and gas treatment in field conditions.

It also describes the establishment of rational parameters for low-temperature gas separation using a dynamic modeling system.

The **third section** shows the results of experimental studies of technological processes aimed at establishing the dependence of low-temperature gas separation. And also the economic efficiency of optimizing the technology of NTS was calculated.

The **fourth section** discusses the environmental aspects of a gas recovery system. An assessment was made of emissions of pollutants into the atmosphere at the field.

In the **fifth section**, scientific recommendations are developed to improve the utilization and preparation of gas.

In **conclusion**, the main results and conclusions on the dissertation are given.