Lake Chernoe has contrasting anomalies of mercury distribution in the upper part of the section, the formation of which can be explained by its location in the zone of Tomsk - Seversk industry impact, and, consequently, a high level of anthropogenic influence. The accumulation of mercury in the upper part of the sediment core starts with 10 cm depth. By the dating methods using isotope ^{210}Pb the age of the sediments was compared with technogenic events that took place in the vicinity of the lake. This depth corresponds to 1955, so the sharp change in geochemical environment may be associated with the construction of the SCC in 1951, as well as the launch of the first nuclear reactor I-1 in 1955 [2].

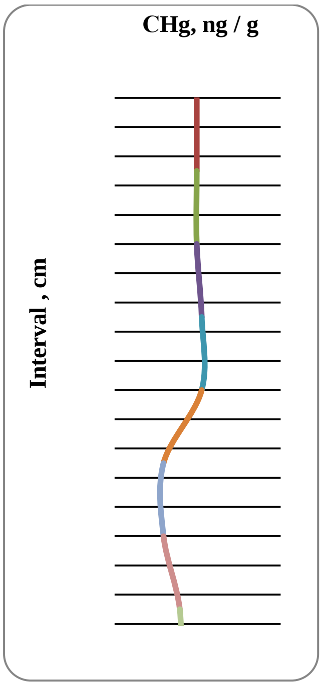

Fig. 1. Hg in BS of Lake Um

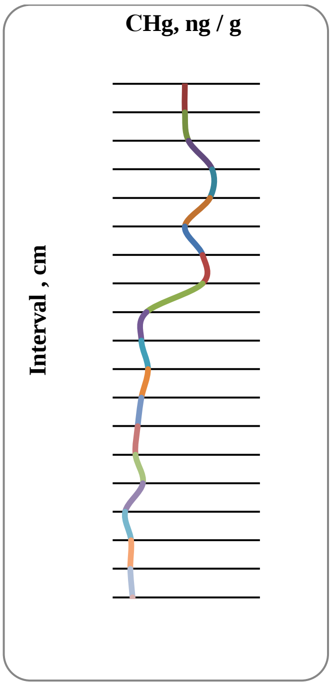

Fig. 2. Hg in BS of Lake Timiryazevskoe

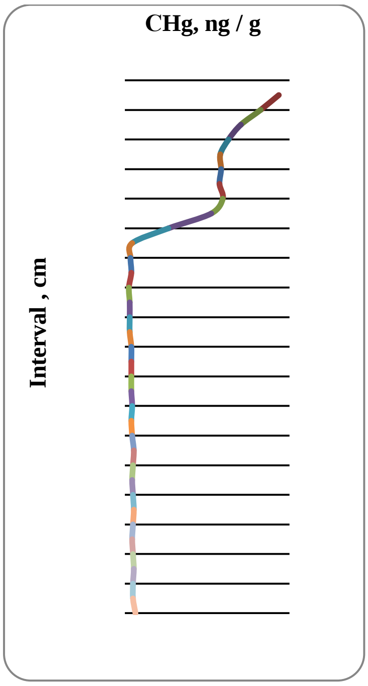

Fig. 3. Hg in BS of Lake Chernoe

To sum up, this research has shown the dependence of geochemical features of the environment on not only the natural factors but also from the anthropogenic ones. In this case, they include the intensity of impact on the objects under consideration which are located near the sources of anthropogenic pollution. Sharp changes of geochemical environment allow monitoring the dynamics of social development of the region, identifying industrial facilities that impact specifically on the environment.

References

1. Chemical Encyclopedia: / Ed. N. S. Zefirova. - Moscow: Soviet Encyclopedia, 1995. - V. 4. - PP. 278 - 639.
2. Ivanov A. Y. Uranium and thorium in the sediments of stagnant waters south of Tomsk Region // Bulletin of the Tomsk Polytechnic University, 2011 - V. 318, - № 1. - PP. 159-165.
3. Mercury in coal of Siberia / A. V. Volostnov [et al.] // The mercury in the biosphere: ecological and geochemical aspects: Proceedings of the International Symposium, Russia, Moscow, Vernadsky Institute, September 7-9, 2010. - Moscow: 2010. - S. 99-104.2

OPTIMIZATION OF DEVELOPMENT OF A SECTOR OF OIL-GAS CONDENSATE FIELD X USING AND INTEGRATED FIELD MODEL

P.Y. Gusev, Y.S. Berezovsky
Scientific adviser professor S. M. Slobodyan
National Research Tomsk Polytechnic University, Tomsk city, Russia

This individual project presents the integrated reservoir simulations which combines hydrodynamic flow models of two different formations, and results of development optimization for these formations of a sector of Field X. Field X has two separately developed formations. A decision not to apply a commingled production for formations having similar fluid saturation and close hypsometric marks has been caused by a significant difference in the physic-chemical properties of the hydrocarbon fluids and the reservoir properties. The formations are tied to a common gathering and separator node. Formation U11 has one oil bearing accumulation and 20% of oil in place of Field X, while formation U12 is identified as an oil-gas condensate reservoir with a gas cap and has 80% of oil in place of Field X. The optimal production plan for each formation is the goal of the field development. The considered formations have separate hydrodynamic flow models which do not consider surface facilities constraints. Therefore, production rates from formations are overestimated and vary with predicted results from formations hydrodynamic flow models. But the created integrated model "reservoir-well-pipeline" will allow optimization of the gathering system and achievement of the optimal maximum production levels for the considered formations.

This individual project presents algorithms of field production optimization. The optimal field development strategies are simulated on the integrated model taking into account production system constraints and results are discussed.

This paper considers the Field X, the main problem of which lies in the fact, that the productive formation U11 and formation U12 developed separately, but they have common gathering system which constrains maximum optimum production from considered formations.

Therefore the main objective of individual project is analysis of the different conceptual designs of gathering system and selection of the most suitable for the further development of the considered Field X basing on results obtained during integrated modelling simulations.

Three different conceptual designs of gathering systems were considered: implementation of methanol treatment unit in existing gathering system, using of old oil pipeline for formation U12 and building high-pressure line formation U11. These conceptual designs were simulated and results of efficiency are calculated.

Then, each of conceptual designs was assessed in terms of economic efficiency vs. the cumulative oil and gas production.

In general, this work allowed making definite conclusions about the influence from implementation of integrated modeling in field development, that can be used in the future optimizations schemes.

FIELD DESCRIPTION

Field X is an oil-gas condensate field with low permeability upper Jurassic sandstone reservoirs. Field X was discovered in 1967. Hydrocarbon accumulations are located in the southern part of the Vasyugan petroleum bearing area in the West Siberian oil and gas province (Russian Federation). Accumulations are confined to the upper Jurassic formation of the Vasyugan suite. Hydrocarbon-bearing formation of Vasyugan suite is formed by coastal-marine and marine deposits represented by interbedding of mudstones, siltstones, sandstones, and clays. Internal structure of the Vasyugan suite has a complex geology, due to the presence of hiatal surfaces and clay impermeable substitutions in some parts of the reservoirs.

Field X is located in the southern part of Tomsk region, in Parabel administrative district.

The properties of formation fluids are presented below in Table.

Table

Field properties

Formation	U_1^1	U_1^2
Field initial oil in place, %	20	80
Accepted average GOR, m^3/ton	883.8	350
Measurement interval of GOR, m^3/ton	378 - 2323	107-362
Oil viscosity at reservoir conditions, MPa·s	0.04	0.3
Formation fluid density, kg/m^3	382	576.7
Density of separated oil, kg/m^3	741	777
Bubble point pressure, MPa	22.7	20.3
Initial reservoir Pressure, MPa	24.5	24.9
Oil formation volume factor, m^3/m^3	5.032	2.003

Very low viscosity of the oil at reservoir conditions and a relatively high permeability of formation U11 determine the higher mobility of the oil from formation U11 in comparison with the oil from formation U12. Taking into account all the above considerations it was decided to develop these formations separately.

DESCRIPTION OF GATHERING SYSTEM

Formations of Field X are developed by 91 production wells (31 production wells in formation U11 and 60 production wells in formation U12) that are located on nine well pads. In total, it is planned to introduce 36 well pads which will accommodate 436 production wells (138 wells in formation U11, and 338 production wells in formation U12).

A pressure sealed radial fluid gathering system from well clusters is implemented at Field X. The gathering collector is laid underground (0.8 m below surface). Oil, water, and gas from wells enter flow lines, pass on to measuring units, and then through a gathering system to a treatment facility.

PROBLEM ASPECTS FIELD DESCRIPTION

Wellhead pressure of wells producing from formation U11 equals 170-190 bars (naturally flowing wells), while wellhead pressure of wells producing from formation U12 equals 13-40 bars (equipped with ESP). The considered formations are tied to a common gathering system which has a maximum line pressure limitation of 40 bars and have a commingled separator node. So, wells producing from formation U11 have a very high wellhead pressure and these wells should be choked. These wells are often hydrated and blocked due to high pressure difference between the wellhead and the downstream choke flowline when these wells are equipped with a small choke. Hydrate formation occurs because the stream of formation fluid is throttling through the choke and, as the fluid undergoes instantaneous expansion after the choke, temperature decreases and water which is present in the fluid mixture falls out as hydrates. Therefore, these wells are equipped with chokes of a bigger cross-section size and hydrate formation is prevented. However, a bottleneck effect occurs in the flowline due to increased pressure, and some ESPs cannot provide enough head. Absence of methanol treatment unit complicates the situation. As a result, oil production schedule is delayed.

MAIN OBJECTIVES

The main objective of this project is to optimize the development of a sector of oil-gas condensate Field X using an integrated field model created in METTE software. In order to meet this objective, it is necessary to create an accurate integrated model, simulate this model with different variants of gathering systems, estimate at what extent the gathering systems constrain oil production, and select an optimal variant based on economic and technical efficiencies of the considered variants. Creation of an integrated model was divided into several parts which are discussed below.

Part 1: Conversion and adaptation of hydrodynamic flow models from Eclipse reservoir simulator into Tempest MORE.

As METTE software can be integrated with hydrodynamics flow models built in Tempest MORE reservoir simulator, existing hydrodynamic flow models originally created in Eclipse software had to be converted to Tempest MORE and matched with history parameters.

Part 2: PVT model creation.

PVT model was created by correlation module of METTE software.

Part 3: Construction of well profiles and well calibration.

Construction of well profiles based on results obtained from directional surveys was performed. Calibration was carried out on well test investigations.

Part 4: Network construction and its integration with a well model.

CONCLUSIONS

In this study confirmed the influence of common gathering system on the efficiency of field “X” development. With the help of integrated model reveals the phenomenon of well bottlenecking caused by high wellhead pressure of wells exploiting formation U11. This has become possible with the integration of hydrodynamic flow models with production system in METTE software.

Offered conceptual designs were considered and conceptual design with high-pressure line has shown the best results. After simulations deferred oil production from variant accepted in company equals to 136000m3. According to rough economic estimates implementation of variant with high pressure line can bring two billion RUR profit for company in first two years. Thus using the results of modeling shows can predict the development scheme of field “X”.

In the future, it is planned to work out the most detailed scheme of development Field X with integrated model. The real-time it is also planned to continue this project in order to create more accurate integrated model.

References

1. Antonenko D.A., Pavlov V.A., Sevastyanova K.K., Usmanov T.S., Zhdanov R.M. Integrated modeling of Priobskoe Oilfield, 2008. (SPE 117413)
2. Barsukov V. Summary measurement report of GOR for TomskGazprom company, 2013. (Oilteam company)
3. Khasanov M.M., Bahitov R.R., Sitnikov A.N., Ushmaev O.S., Dmitruk D.N. and Nekhaev S.A. Optimization of production capacity for oil field in the Russian Artic, 2013. (SPE 166905)
4. Lomovskikh S., Smyslov V., Sukhov E., Shashel V., Lozhin V., Nekipelov Y. Optimization of produced water dumping using conceptual model of field infrastructure, 2010. (SPE 138078)
5. Mustaeva S., Vasilev V. Integrated reservoir modeling of two Urengoy gas fields, 2012. (SPE 162007)
6. Heriot-Watt University Manual Petroleum Economics (2013-2014).
7. Schlumberger. Eclipse reference manual 2012.

TRACE ELEMENTS IN THE TAZARE COAL FIELD, ELBRUS COAL BASIN, IRAN

M.Z. Kazhumukhanova
Scientific advisors associate professor V.I. Rybalko, associate professor I.A. Matveenko
National Research Tomsk Polytechnic University, Tomsk, Russia

The major purpose of this paper is to analyze the concentration of some trace elements in the Tazare coal field; to compare the stated content values with respective Clarke values for coals as well as possible commercial values.

The Tazare coal feld is situated in the Elburs coal basin, Iran. The coal-bearing sediments are sandstones, siltstones, claystone, coal seams, which are of Triassic-Jurassic age. The coals are classified as bituminous, from forge coal to gas and longe flame coal [1].

Geoecology and Geochemistry Department’s members (NRI, TPU) have performed geochemical sampling at Tazare coalbed. 38 samples were selected from 7 coalbeds (table).

The applied methods were instrumental neutron activation analysis (INAA) and atomic absorption spectroscopy (AAS) elemental analysis.