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Determination of the Operational Situation at Accidents at Objects of Development of Hydrocarbon Deposits

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ABSTRACT. In the article results of the operational assessment of emergency situations at the objects of development of hydrocarbon deposits due to the selection of oil and gas are presented. It was shown that the thickness of the earth, the porosity of the reservoirs and the abnormally high reservoir pressure greatly influence the amount of subsidence of the earth's surface over the area of deposits and the occurrence of emergencies at ground facilities.

KEYWORDS: Geodynamics, subsoil, safety, contents, hydrocarbons, deposits, technogenic, seismicity, activity, pressure, crust, accident, surface, subsidence, source, process

I. INTRODUCTION

Currently, the study of the problems and mechanisms of manifestation of the geodynamics of the subsoil during the development of hydrocarbon deposits is an urgent task in terms of assessing the impact of these processes on the environmental and industrial safety of engineering structures and the human environment. However, in the development of hydrocarbon deposits this problem is not given due attention. When drafting projects for the development of hydrocarbon deposits, the influence of technogenic factors on the geodynamics of subsoil is practically not considered. Although it has been established at numerous fields, founded in foreign countries, that the process of their development leads to an increase in seismic activity and deformation of the earth's surface (1, 2, 3, etc.).

II. SIGNIFICANCE OF THE SYSTEM

In the article results of the operational assessment of emergency situations at the objects of development of hydrocarbon deposits due to the selection of oil and gas are presented.The study of literature survey is presented in section III, methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and conclusion.

III. METHODOLOGY

Systematization and analysis of published works on this problem show that only a small amount of the hydrocarbons contained in the fields in the world carried out qualified sufficiently lengthy geodynamic studies / 5-20 /, the results of which are given in Table.1.

The results of these studies show that a decrease in pressure during the development of oil and gas deposits leads to a change in the stress-strain state of the earth's crust in the vicinity of the field and is inevitably associated with technogenic deformations of the productive formations and, as a result, subsidence of the earth's surface. Under certain conditions, this can lead to accidents and the failure of ground-based structures of oil and gas fields. Therefore, the study of the processes of subsidence of the earth's surface in the process of developing hydrocarbon deposits is relevant not only from a scientific point of view, but also has great practical significance.

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Table 1

№	Place of Birth	Type of deposit	Country	Settling rate, mm/year	Total settling, mm
1	Ust-Balyk	oil	Russian	20	-*
2	Shershenev Unhappy Chashkinsk Siberia Archangel	oil	Russian	30	-
3	Romashkin	oil	Russian	Before100	-
4	North Stavropol	gas	Russian	Before37	920
5	Urengoy	oil and gas - condensate	Russian	-	340
6	Shebelin	oil	Ukraine	20-24	366
7	Anastasiyav	oil	Ukraine	6	-
8	Surkhan	oil	Azerbaijan	48	3000
9	BalakhnySabunchiRamani	oil	Azerbaijan	10-15	400-1700
10	Wilmington	oil and gas	USA	250	8700
11	Ecofisk	oil	Norway	40-70	2900-3000
12	Maracaibo	oil	Venezuela	390	4000
13	GooseGreek	oil and gas	USA	50-70	2000
14	Belduin-Hills	oil	USA	40-50	1170-1320
15	Lacquer	oil and gas	France	-	30
16	Groningen	oil	Netherlands	30	1000

*** data not available.**

The article assesses the subsidence of the earth's surface as a result of their development in the geological conditions of some gas condensate fields in Uzbekistan.

IV. EXPERIMENTAL RESULTS

The gas condensate deposits under consideration are confined to the XV-p, XV-HP and XV-horizons of the Upper Jurassic deposits composed of limestone. The main parameters of the productive horizons and the reservoir properties of the reservoirs vary in the following ranges: average depth 2325-2990 m; gas area 10320-57840 thousand m2; effective gas-saturated thickness 72-146 m; reservoir temperature 96-112 °C; open porosity 0.06-0.17; permeability 0,040-0,900 μm2; gas saturation 0,74-0,90; initial reservoir pressure 24,44-57,5 MPa (Table 2). It should be noted that, with the exception of the Urtabulak field, all fields are classified as having abnormally high reservoir pressures. The ratio of reservoir pressure to normal hydrostatic varies from 1,22 (Shurtan field) to 2,17 (Alan field).

By the value of the balance of gas reserves, the Zevardy, Kultak, Pamuk, Urtabulak deposits are classified as large (up to 300 billion m3), and the Shurtan field is unique (more than 600 billion m3). By the magnitude of the initial reservoir pressure, only the Urtabulak field belongs to the category of fields with high pressure (up to 30.0 MPa), the rest of the fields belong to the category of super high reservoir pressure (more than 30 MPa). By the content of hydrogen sulfide in the gas, all objects with the exception of the Urtabulak (high-sulfur) deposit are classified as low-sulfur.

The studied deposits were put into development from 1973 to 1985, i.e. are in operation from 21 years to 33 years. The maximum projected level of gas extraction (in% of the initial geological reserves) is 2,44-7,28%, and the current rate of gas extraction varies from 0,11 to 7,28%. From the fields, 42,9 to 76,6% of the initial gas reserves were selected (Table 3).

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Table 2

The main parameters of productive horizons and reservoir properties of reservoirs

№	Field	Type of deposit	Horizon	Average depth, m	Area of gas content, thousand m2	Effective gas-saturated thickness, m	Reservoir temperature, °C	.Open porosity, fractions. units	Permeability, μm2	Gas saturation, fractions	Initial reservoir pressure, MPa
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1	Zewards	GK	XV-P+XV-HP	2650	42145	97	108	0,17	0,4	0,89	50,2
2	Kultak	GK	XVa	2950	57840	72	110	0,11	0,41	0,74	57,04
3	Pamuk	GK	XV-P+XV-HP	2990	10320	125	108	0,16	0,38	0,9	49,8
4	Alan	GK	XV-P+XV-HP+XVa	2650	20215	146	115	0,163	0,85	0,87	57,5
5	Urtabulak	NGK	XV-P+XV-HP	2325	48830	126	96	0,06	0,04	0,75	24,44
6	Shurtan	GK	XV-P+XV-HP	2950	11170	117	112,5	0,14	0,107	0,88	36

To assess the absolute value of the subsidence of the earth's surface during the development of hydrocarbon deposits V.V. Savchenko and I.A. Fomenko proposed the following formula / 11 /:

$$\Delta H = H \cdot \frac{e^{\beta}(P_{н} - P_{T})}{\frac{1}{M} - e^{\beta}(P_{н} - P_{T})}$$

whereRn, RT are, respectively, the initial and current reservoir pressure, MPa; H-power of compressible rocks of a productive section, m; β-weighted average compressibility coefficient of pores, MPa-1; m-coefficient of porosity, fractions of units

The values of pH, RT, H, and m are given in Tables 2 and 3. The value of the weighted average coefficient of compressibility of pores for the considered deposits has not yet been established. But the most probable are the values ρ = (7 ÷ 10) x10-4 MPa-1.

For example, for deposits with abnormally high reservoir pressures, the value of β in the work is taken equal to 7.8 x 10-4 MPa-1.

Since the objects of research belong to the category of deposits with anomalously high reservoir pressure, when assessing the absolute values of subsidence of the earth's surface during the development of hydrocarbon deposits, the value of P is also taken equal to 7.8 x 10-4 MPa-1.

The calculation results for various values of the current reservoir pressure are given in table 4.

Based on the analysis of the results of assessing the absolute values of the subsidence of the earth's surface during the development of the studied gas condensate fields in Uzbekistan, the following conclusions can be drawn:

- after reducing the initial reservoir pressure by more than 50% at all sites, the absolute value of the subsidence of the earth's surface exceeds its critical values for engineering structures, technological equipment and pipelines given in the guidance document “Instructions for surveying and geodetic works in the oil and gas industry”;

- The greatest subsidence of the earth's surface is characteristic of deposits with abnormally high reservoir pressures and relatively high reservoir porosity. One of the reasons for this may be that deposits with abnormally high reservoir pressures have a poor hydrodynamic connection with the contour zone of the reservoir (sometimes they are completely isolated), as a result of which the rocks are initially lightly loaded, i.e. rock pressure is generally perceived as a saturating gas;

- objects with normal hydrostatic pressure, which, ceteris paribus, usually have a lower porosity of the collectors due to their strong compaction during sedimentation, from the point of view of anthropogenic consequences are significantly safe.

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Table 3

№	Field	Horizon	Opening year	Year of commissioning	Current reservoir	Current Condensation	Maximum annual	Average selection rate	Gas sampling rate in 2004	Production since the start of development, gas, mln.m3		Degree of proficiency	The degree of depletion of condensate reserves,%	
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*		*12*	*13*	
1	Zewards	XV-P+XV-HP	1968	1978	12,28	29,9	3,86	2,84	1,92	211031,5	11040,7	76,6	52,1	66,8
2	Kultak	XVa	1963	1978	15,19	23,9	2,44	1,73	1,43	42619,6	1935,2	46,8	38,6	53,2
3	Pamuk	XV-P+XV-HP	1965	1979	13,72	45,5	4,4	2,67	3,23	79864	5017,5	69,5	49,1	75,3
4	Alan	XV-P+XV-HP+XVa	1972	1979	27,6	25,8	7,28	1,65	7,28	76699,1	3598,1	42,9	43,3	51,7
5	Urtabulak	XV-P+XV-HP	1961	1973	6,61	5,5	4,47	2,04	0,11	67170,6	617,5	65,5	51,9	64,9
6	Shurtan	XV-P+XV-HP	1979	1985	13,37	35,0	3,26	2,84	2,74	360095	16897,7	56,7	45,4	57

For such deposits, the value of subsidence of the earth's surface is an order of magnitude lower than at objects with abnormally high reservoir pressures.

To establish the reliability of the calculated values of the subsidence of the earth’s surface during the development of gas condensate fields, we present the results of studies on vertical deformations of the earth’s surface in the Zevardi field by repeated high-leveling carried out by the Samarkand AGP Office of Geodesy and Cartography from 1988 to 1995.

As a result of these studies, a change in the heights of the leveling marks was established by December 1995, compared with the beginning of work in 1985, to minus 158,5 mm, i.e. over 8 years of development of the field, the subsidence of the earth's surface reached 15,85 cm.

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Check the calculation of the absolute subsidence of the earth's surface of the Zevardy deposit for the period 1988-1995. according to the above formula for the values of Pn = 31,41 MPa and Pt 9,79 MPa, as a result, we obtain a value of ΔH equal to 0.179 mm. The calculated value of the absolute subsidence of the earth's surface for the period 1988-1995.slightly differs from the results obtained by high-precision leveling measurements by specialists of the Samarkand AGP, which allows us to recommend the formula proposed in /11/ for estimating the ΔH value in the process of developing hydrocarbon deposits.

V. CONCLUSION AND FUTURE WORK

In conclusion, it should be noted that in many oil and gas producing countries of the world, including the CIS countries, it is mandatory to conduct geodynamic monitoring in the process of developing hydrocarbon deposits in order to identify specific foci of technological processes. The need has ripened for conducting geodynamic research in the fields of Uzbekistan, as most of them are located in earthquake zones. As an example of the technogenic process in Uzbekistan associated with the development of hydrocarbon deposits, one can cite the subsidence of the earth's surface and the earthquake in 1976 and 1984 at the Gazli field.

The main objective of studying technological processes in the development of hydrocarbon deposits is to prepare recommendations for improving the stability and reliability of the operation of facilities and ensuring the safety of the population living in the area of technological impact.

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