NEW DOMESTIC TECHNOLOGIES OF DIRECTIONAL WELLS RESEARCHES

S.A. Zhvachkin

Russia
ABSTRACT

It is well-known, that operational reliability, ecological safety, and operation efficiency of directional wells and especially of horizontal wells are determined mostly by the presence of adequate information concerning the productive section of well bore.

The existing modern methods of research suppose the analytical determination of gas flow parameters in horizontal section of well bore and may cause inaccuracies in calculations. Shortcomings of the existing methods are caused mostly by the absence of the equipment, which is able to carry out the profound researches of operating directional and horizontal wells.

In order to fulfill this task the following items were elaborated in the Scientific – research centre «Kubangazprom»:

1. Several models of multiparameter autonomous borehole devices for gas-dynamic researches of vertical, directional and horizontal wells.

2. Methodical and programmed maintenance for application of these devices and for the interpretation of the received data.

3. Self-propelled system for gas-dynamic researches of vertical, directional and horizontal wells with data transmission through geophysical cable, consisting of multiparameter borehole device, transportation arrangement of the system into horizontal section of the well bore, surface control and parameters registration desk.

4. Stand for modeling of horizontal section, calibration and testing of borehole devices.

Since 2001 the scientific-research centre of JSC Kubangzprom has been performing the gas-dynamic researches of horizontal wells in Kuschevskaya and Krasnodarskaya Underground Gas Storages with application of the elaborated autonomous borehole devices at the coiled tubing installations and with the help of the self-propelled systems. During this period of time, more than 30 productive wells with horizontal end of well bore have been investigated.

The results of the researches reflect that the practice of horizontal wells operation differs significantly from the theory.

The adoption of autonomous borehole devices and self-propelled systems in Kuschevskaya and Krasnodarskaya Underground Gas Storages makes it possible to reach the increasing of reliability and operational efficiency of wells thanks to the optimization of their operation mode. Economic effect of their application in JSC Kubangazprom is 21245.65 thousand roubles (€ 574.21 thousand) over the period of 2002-2004.
TABLE OF CONTENTS

Abstract

1. Introduction
2. The equipment for gas hydro-dynamic researches employing a coiled tubing installation
3. Results of the researches of horizontal well with coiled tubing installations
4. Self-propelled system for gas hydro-dynamic researches of horizontal wells
5. Results of the researches of horizontal well with the application of self-propelled system
6. Conclusion
7. List of figures
1. INTRODUCTION

At present, the directional wells, including the wells with horizontal end of the borehole, have become the main instrument in new hydrocarbon raw material field development. For the improvement of the efficiency of well operation it is necessary to determine the filtration characteristics of the productive strata, the reasons of water cutting of well production and interval production of well bores horizontal parts. That is why the realization of regular gas hydrodynamic researches in the process of their operation is a vital necessity.

It should be noted that several years ago such investigations were not carried out in Russian Federation, because there were no required facilities and equipment of the domestic production and because of a high cost of foreign firms services. That is why JSC Kubangazprom carried out in-house activities to create the necessary researching systems and technologies for operating horizontal wells.

2. THE EQUIPMENT FOR GAS HYDRO-DYNAMIC RESEARCHES EMPLOYING A COILED TUBING INSTALLATION

The analysis shows that in the world practice there are two main ways of the investigation of strong deviated (more than 60°) parts of the borehole of the operating well: employing a flexible tube of coiled tubing and with the help of the special arrangements of conveyance, called thrusters.

For well researches with the help of coiled tubing installations, the autonomous borehole devices were worked out and made in JSC «Kubangazprom»; these borehole devices are able to register the following parameters: pressure, temperature, zenith angle, speed of the gas (oil) axial flow and the lateral one, water content, level of natural gamma radiation and noise level. Innovative technologies are employed in the indicated devices, protected by patents № 2230902 and № 2230903 of RF.

The advantage of the application of autonomous borehole devices during the coiled tubing researches is the absence of the necessity of geophysical cable presence inside the flexible tube. In order to carry out such researches, any coiled tubing installation, which is applied on the fields and in the underground gas storages, can be used. (Fig.1).
3. RESULTS OF THE RESEARCHES OF HORIZONTAL WELL WITH COILED TUBING INSTALLATIONS

In Fig. 2 an actual borehole profile of one of the operating wells with horizontal end and in Fig. 3 the results of the surveys, which have been carried out in it, are given.

**KUSCHEVSKAYA 161 WELL PROFILE**

![Graph of Kuschevskaya 161 Well Profile]

Fig. 2

Depth reading binding was made according to the data of natural gamma radiation measurement (1) and directional survey (2) of the well (Fig. 3).

Analysis of the curves of moisture metering (3), barometry (4) and thermometry (5) has given an opportunity to discover the zones with higher quantity of liquid (Fig. 3) and to determine the interval filtration properties of a productive stratum. According to the flow metering data (6), a profile of the rate of inflow of the well has been determined clearly. The zones of the intensive gas influx rate are registered in accordance with the flow metering readings of the lateral inflow (7) (Fig. 3).

4. SELF-PROPELLED SYSTEM FOR GAS HYDRO-DYNAMIC RESEARCHES OF HORIZONTAL WELLS

Together with the method of the research of the operating directional wells and the wells with horizontal end which presupposes the use of the coiled tubing installations, there is one more method of research, characterized by the application of the self-propelled investigative systems.

The most complicated element of the self-propelled system is a thruster – an arrangement, which gives an opportunity to move in the inclined borehole and then in the horizontal borehole. The main characteristic of the research in the operating wells is a necessity of the thruster to pass via the tubing with its further opening and movement in the casing string. In order to remove the system to the surface, a safe folding mechanism of the thruster both in the design mode and in the emergency situation is necessary.
In JSC «Kubangazprom» several models of thrusters were elaborated for the device transportation to the horizontal section of the borehole of the operating well. (Fig. 4).

**DEVICES FOR SURVEY INSTRUMENTS TRANSPORTATION INTO THE HORIZONTAL SECTION OF THE BOREHOLE (THRUSTER)**

![Fig. 4](image)

The worked out thrusters are based on various principles: a wheel drive and a caterpillar one (UDP-1 and UDP-2, UDP-3), step-by-step thrusters with electromagnetic fixation (UDP-4) and with the
Innovative technologies are employed in the indicated devices, protected by patents No 2230902 and No 2230903 of RF.

The self-propelled system, elaborated in JSC «Kubangazprom», includes PGI-42 - a downhole geophysical instrument, which registers the following parameters: pressure, temperature, water content, flow rate, noise power, natural gamma radiation level, and zenith angle with coupling location. The downhole instrument transfers the parameters, which have been measured, to the surface in a real time mode via logging cable.

The photo of the assembled self-propelled system is given in Fig. 5.

**ASSEMBLED SELF-PROPELLED INVESTIGATIVE SYSTEM**

![Fig. 5](image)

5. **RESULTS OF THE RESEARCHES OF HORIZONTAL WELL WITH THE APPLICATION OF SELF-PROPELLED SYSTEM**

Wellhead sealing is carried out with the help of a standard lubricator being equipped with a packing seal for the geophysical cable and a preventer for an urgent well sealing in emergency situations.

The system is delivered to an inclined section of a well bore (zenith angle ≈55°-60°) due to it’s own weight; then it is delivered to a horizontal section of the borehole of the operating well with the help of the thruster. A diagram of the well research, carried out with the help of the self-propelled research system is given in Fig. 6.

The survey results in one of the well with horizontal end in the underground gas storage are given in Fig. 7.

As it is evident from the given data, on the section of the well bore, where the zenith angle is close to 90° value, there is an increase of the readings of moisture metering (2), barometry (3) as well as a reduction of the readings of the lateral inflow metering data (4) and noise metering (5) up to 0. It has proved that there is a hydraulic seal at the designated depth.
On the basis of these data, it was decided to remove the water, which was accumulated in the well. After removing the water, the rate of flow increased by 64%.
6. CONCLUSION

Thus, the received data make it possible to take timely and reasonable decisions, which improve operation efficiency of the wells and of the fields in general.

Thanks to the appliance of the devices elaborated by JSC Kubangazprom, there were carried out gas hydrodynamic researches in more than 30 wells with horizontal end. Economic effect over the time period of 2002-2004 is € 574.21 thousand.
7. LIST OF FIGURES

1. Horizontal well gas-dynamic surveys with the use of a coiled tubing installation

2. Kushchevskaya 161 well profile

3. Kushchevskaya 161 well research results

4. Devices for survey instruments transportation into the horizontal section of the borehole (thruster)

5. Assembled self-propelled investigative system

6. Diagram of carrying out fluid gas-dynamic surveys of the wells with horizontal endings with the use of the self-propelled investigative system

7. Operation results of the investigative system during its movement along the slant-horizontal section of the borehole with the help of the thrusters