RESEARCH OF OPERATION MODES OF GAS WELLS IN COMPLICATED CONDITIONS

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Annotation. The influence of the properties of reservoir rocks on sand intrusions in wells is considered. It is concluded that the mountain rock should be considered not from the point of view of its strength, but from the point of view of the type of cementing substance and its distribution. When predicting sand manifestations, it is necessary to take into account the internal stresses of the rocks, and also the change in these stresses during drilling, perforation, and reservoir operation due to their violation initial state.

This article presents an analysis of the main causes of sand production during the operation of gas wells and the negative consequences of sand production for gas production equipment. It has been established that water breakthrough, reservoir depletion, and pressure drop at the bottom of wells due to their frequent shutdown are the main prerequisites for the removal of sand from the bottom hole formation zone. Sand mining is associated with such negative consequences as plugging in wells, erosion of underground and surface equipment, and collapse of the roof of the bottom hole formation zone and production strings.

Keywords: pipe - cement – rock, technological mode, gas wells, permissible.

The main technologies for preventing and eliminating accidents associated with the removal of mechanical particles from the reservoir are considered. Based on the results of the research, an algorithm was proposed for selecting technological modes of good operation in conditions of water and sand intrusions. The parameters for choosing the optimal mode of operation of a gas well are substantiated, in which

sand is not produced with subsequent disabling of the well and wellhead equipment, the integrity of the bottom hole zone is not violated, and the well is not self-damping.

The results obtained can be applied to improve the efficiency of gas wells' operation and predict their trouble-free operation. Today, a significant part of gas fields is at the final stage of development, which is characterized by a number of complications: an increase in the water cut of the produced products, a drop in reservoir pressure, a violation of the integrity of the bottom hole zone, an increase in the accident rate of wells associated with the removal of mechanical particles from the reservoir. Intensification of hydrocarbon production, as a rule, is accompanied by sand production if the reservoir is represented by weakly cemented rocks or is flooded. Formation sand can settle in downhole and surface equipment, preventing its normal operation, reducing the rate of production, affecting the phase changes of hydrocarbons, and increasing overall operating costs.

Today, the management of sand production processes is a complex task, which includes the forecasting of sand production and the choice of methods to minimize and prevent the negative impact of removed mechanical impurities. The development of solutions that correctly describe the rationale for the operation of gas wells in conditions of active sand production is an urgent task today. Further, the main causes of sand manifestations are considered, and measures to combat sand manifestations and the conditions for the application of methods for preventing sand manifestations and eliminating emergency situations are analyzed. The purpose of the work is to increase the efficiency of the operation of gas wells in areas complicated by water and sand conditions.

When developing gas fields, especially in the final stage, it is important to consider the state wellbore formation zone. So, with a detached drawdown level, the integrity of rock reservoirs is violated, and mechanical particles are carried out. Accumulation of water in the bottom hole zone, wetting of the rock, reservoir depletion, and pressure drop at the bottom of wells due to their frequent shutdowns are also the main factors of the destruction of productive horizons. In oil wells, the

phenomenon of sanding is mainly caused by water breakthrough into the well, which reduces the strength of sand reservoirs and capillary interaction between sand particles. For gas wells, water inflow into a sand well is not required. For example, at the Urengoy oil and gas condensate field 73% of wells complicated by sand water breakthrough are observed. Moreover, this negative phenomenon does not appear immediately, but only after 10-12 years after commissioning.

A.A. Akhmetov, investigating the behavior of super collectors Urengoy oil and gas condensate field, came to the conclusion that the main factors influencing the beginning of sanding of gas wells are:

• Reservoir pressure reduction;

• total volume of produced gas per unit super collector thickness;

• location of perforation intervals relative to soles and roofs of the Cenomanian horizon;

• breakthrough of bottom waters to the bottom of the well.

He also argues that an important role in the process and production is played by the well-completion method. If the well is equipped with an open hole, then the rock stability of the bottom hole zone depends, mainly on stresses including mining pressure and filtration stresses. in a cased well, in addition, stresses come into the force system "pipe - cement - rock". G.A. Zotov carried out studies stability of sand reservoirs from the designed bottom hole: and found that cased a perforated well is more likely to destroy the bottom hole formation zone than an open well slaughter. To maintain stability, the bottom hole should be open if the loading conditions of the rock on the surface of an open face do not go beyond the strength of this rock in the entire range of change reservoir pressure, or be equipped with a filter if loading conditions go beyond the ultimate strength.

In a scientific article, R. Amentor and M. Wise [1] make attempt to determine the relationship between breakthrough water into the well and a sharp increase in sand production. The authors put forward two theories about this:

1. Due to the fact that the main part of the sandy productive horizon is wetted by water, water breakthrough into the well causes a sharp decrease in capillary pressure between sand particles. Due to the declining pressure, the force that holds sand particles together weakens, and the removal of sand along with water is observed.

2. Due to the breakthrough of water into the reservoir, they decrease relative to gas and oil permeability. The service personnel takes actions aimed at maintaining the pace of selection fluids by increasing the pressure drawdown. This in turn initiates the movement of sand particles into formation. Also, water due to the increase in viscosity of selected hydrocarbons increases the hydraulic formation resistance, which contributes to the growth of the ability of a fluid to carry sand particles.

Technological mode - a mode in which the maximum possible well flow rate is ensured under the influence of limiting factors and compliance with safety and environmental standards. It is chosen based on the type of gas deposit, composition gas, initial reservoir pressure and temperature, reservoir properties and other factors. There are six main technological modes that take into account various groups of factors:

• constant gas filtration rate mode v(t)=const (used to limit corrosion equipment, if the reservoir gas contains corrosive components);

• constant gas flow rate Q(t)=const (used in conditions of strong collectors, when there is no danger of a breakthrough of the plantar and contour water, formation destruction);

• mode of constant bottom hole pressure Pb (t)=const (used in gas condensate fields, when bottom hole pressure reduction is undesirable due to condensation);

• constant wellhead pressure mode Pu(t)=const (used in the absence of booster compressor stations or delay in their construction);

• constant depression mode dP=ppl(t)–pz(t)=const (used to prevent penetration plantar and contour waters into the well, crushing columns, collector deformations);

• constant pressure gradient mode dP/dR = const (used in conditions of loose rocks, when high the rate of selection can lead to the destruction of the breed).

The best technological regime for unstable collectors is a gradual creation of a load on the reservoir and work at minimum filtration rates. As a rule, this is achieved by reducing the flow rate up to the maximum allowable values, according to geological knowledge of the rock. Calculation of the mode of an individual well is carried out in combination with the calculation of the technological regime of the entire gas field, taking into account the geological properties of the rock, physical fluid properties, field, and downhole equipment.

To calculate the optimal well operation mode, it is necessary to take into account four parameters of the gas flow rate [2]:

• QMN - the minimum required flow rate, at which liquid is lifted to the wellhead;

• QMD(ΔP) – the maximum allowable flow rate with taking into account the maximum allowable drawdowns on the reservoir;

• QMN.sand - the minimum required flow rate, at which removal of mechanical impurities from the bottom is ensured;

• QMD.sand - the maximum flow rate in terms of “permissible” abrasive wear of equipment.

Parameter QMN, the calculation of which is necessary for preventing the accumulation of fluid in the well define theoretically. The calculations take into account parameters such as surface tension, gas pressure, gravitational influence, and fluid viscosity. To date, there are various methods for calculating critical gas velocities. The most well-known authors include A.A. Tochigin, B.G. Akhmedova, S.N. Buzinova, R.J. Turner, and V.N. Gordeeva. Experience in calculating minimum allowable debits gas at wells of oil and gas condensate fields Urengoysky and

Medvezhy showed that the technique A.A. Tochigin is the most accurate when calculating key parameters [2].

Algorithm for selecting the technological mode of operating wells in conditions of water and sand manifestations.

According to the algorithm, initially calculated the value of the QMH parameter. This takes into account such indicators as the minimum gas velocity required for the removal of liquid, the density of the liquid, and the surface tension coefficient [3]. Then the value of QMD(ΔP) is calculated taking into account the filtration resistance of the reservoir, reservoir pressure, and the maximum allowable drawdown on the formation.

Parameter QMD.sand is calculated for the condition when abrasive wear of the equipment does not exceed allowable well content standards for mechanical impurities in the produced gas [3–4]. The calculation is carried out when the actual and allowable rate of erosion of the pipe wall, while hardness, angularity factor and particle penetration, quantitative content mechanical particles in a gas stream, particle velocity, and internal diameter of the pipeline at the wellhead [5].

Next, the calculated values of QMD(ΔP) are compared and QMD.sand. If QMD(ΔP)>QMD.sand, then take QMD=QMD.sand, otherwise take QMD=QMD(ΔP).

Next, the obtained values of QMD and QMN are compared:

• if QMD<QMN, then the working gas flow rate in the well it is necessary to maintain QG<QMD. In this case, there is a possibility of fluid accumulation on the bottom hole and future self-damping of the well. For to prevent these complications is recommended;

• if QMD>QMN, QG must be maintained in the range between QMH and QMD(ΔP).

Thus, as a result of the analysis, an algorithm for calculating the technological regime for gas wells operating in difficult conditions. The parameters for choosing the optimal mode of operation of a gas well are substantiated, in which sand is not

produced with subsequent disabling of downhole and wellhead equipment, the integrity of the bottom hole zone is not violated, and the well is not self-damping. These recommendations will improve the efficiency of gas wells' operation and predict their trouble-free operation.

Conclusion

Thus, the main causes of sand intrusions in gas wells have been identified, and the negative consequences of sand production for gas production equipment and methods of dealing with mechanical particles have been considered. An algorithm for calculating the technological regime is proposed for gas wells operating in complicated conditions. In the course of the analysis, the parameters for choosing the optimal operating mode of a gas well were substantiated, in which sand is not produced, which entails the failure of downhole and wellhead equipment, and the integrity of the bottom hole is not violated. zones, there is no self-damping of the well.

The results of research on optimizing the technology for preventing complications during good operation will make it possible to predict the conditions for the occurrence of sand manifestations, which is necessary for the effective development of the field as a whole and trouble-free operation of wells, underground and surface equipment of gas fields in particular.

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