Application Strategy of Drainage Gas Production Technology in Shallow Gas Fields

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Abstract. During the use of gas wells, the production time must be increasing. If reasonable measures are not taken for a long time, the bottom hole pressure will be reduced. If the gas flow in the gas well can no longer drive the water at the bottom to the ground, it will lead to the accumulation of water at the bottom of the well and produce back pressure, which will have a very obvious impact on the production of the gas well until the gas well finally can not meet the normal production requirements. This paper first analyzes the water production law and productivity details of shallow gas fields, then analyzes the diagnosis mode of wellbore effusion, and finally puts forward the practical application mode and strategy of drainage gas production technology, hoping to provide a reasonable reference for the optimal development of related work.

Keywords: Drainage gas production; Wellbore unblocking; Shallow gas field

1. Introduction

In the production process of gas wells in shallow gas fields, liquid will be produced when gas is produced. If the bottom hole pressure is high enough, the liquid will be driven to the ground, but if the pressure is insufficient, the liquid will remain at the bottom of the well, which is a common phenomenon of gas well effusion. If this phenomenon is not treated for a long time, it will continue to accumulate and eventually form a high liquid column, accompanied by the phenomenon of well water back pressure. The impact of these pressures on the gas well will reduce its self injection capacity and eventually lead to shutdown. In addition, if the gas-liquid mixing occurs in the gas well, it will also lead to the reduction of the purity of the produced natural gas.

2. Study on water production law and productivity of shallow gas fields

2.1 Water production mode and type

The first is the water source of gas wells in shallow gas fields [1]. The periodic characteristics of condensate water yield are not obvious. The influencing factor closely related to the water yield is the condensate water gas ratio. What will affect this parameter is the temperature and pressure of the gas reservoir. Obviously, the condensate water yield will show a relatively different water yield state according to different gas reservoir conditions. The primary layer is also a common water source. It is easy to find the law when this water source gets water. In the relevant process from the start of operation of shallow gas fields to stable production and production reduction, the water volume is always decreasing. The water channeling in the interlayer will not occur in the non exploitation stage of the gas reservoir, but the bottom hole pressure will decrease after a period of gas reservoir exploitation. In this case, the water will cross the interlayer and finally enter the wellbore with the help of pressure. In addition, the edge water source with random water output exists in the whole process of gas well production and operation. Compared with the water output time of interlayer water, the water output time of edge water is usually relatively late, and the specific factors affecting the time are uneven factors such as pressure and energy conversion[2].

The second is the type analysis of produced water. The main content of this work is to analyze the properties of produced water, in which the formation saturated steam water content is the key parameter to be calculated. The water content in the formation refers to the saturated equilibrium water vapor in the formation under the influence of formation temperature and pressure. Conventional gas reservoir formation is often accompanied by a large amount of formation water. Therefore, it is normal for the gaseous fluid of gas reservoir to contain water vapor, and the state of water vapor is also saturated. In fact, the water vapor content is closely related to reservoir temperature, pressure and gas. The relationship between temperature and water vapor content is positive, while the relationship between pressure, heavy hydrocarbons in gas and water vapor content is negative. There are various ways to confirm its content, among which the simulation of Mcketta-wehe belongs to the common algorithm, and the algorithm diagram coefficients are shown in Tab.1.

Tab.1 Coefficients of simulated Mcketta-wehe algorithm graph

Pressure (MPa)	a_0	a_1	a_2
4	-24.7175	0.1120	-1.0085×10^{-4}
6	-25.1163	0.1128	-1.0264×10^{-4}
10	-25.4407	0.1133	-1.0425×10^{-4}
15	-22.6263	0.0973	-8.4136×10^{-4}
20	-22.1364	0.0946	-8.1751×10^{-4}
30	-20.4434	0.0851	-7.0353×10^{-4}
40	-21.1259	0.0881	-7.4510×10^{-4}

Finally, it is the reference basis for judging the produced water type of gas reservoir and gas well, and the specific contents are shown in Tab.2.

Tab.2 Judgment standard of produced water types of gas reservoir and gas well

Source of water	Mineralization degree (mg/L)	Water gas ratio (t/m^3)
Condensate water	< 10000	≤0.13
Formation water	≥10000	> 0.13

2.2 Water production law and characteristics

The analysis of water production law and characteristics of shallow gas fields should be combined with actual cases. Through the analysis of water gas ratio and mineralization degree of a shallow gas field, the gas wells can be divided into gas wells of producing condensate water, gas wells with liquid production signs and gas wells of producing formation water. The first is the gas well of producing condensate water. The water gas ratio and mineralization degree of this gas well are relatively stable, and even if they change, the synchronization degree is relatively high, which means that the formation belongs to homogeneous formation. The second is the gas well with liquid production signs. The mineralization degree and water gas ratio of this gas well do not meet the judgment standard of the gas well of producing formation water, and a certain index of the gas well in this case always shows an upward state. Finally, the water gas ratio and mineralization degree of gas wells of producing formation water will change synchronously. It may also be that the change of water gas ratio is slower than mineralization degree , or the water gas ratio is always rising, which is normal.

2.3 Influence of water production on gas well productivity

In the late stage of development, the gas wells in shallow gas fields will be affected by formation pressure and the threat of formation water entering wellbore, resulting in water production from gas wells. In view of this situation, technicians need to study the actual inflow performance characteristics of gas water co-production wells [3], and work on the management and evaluation of these wells. There are three conventional working methods, namely, converting water production into gas production, single-phase treatment, and dividing the gas reservoir into two overall regional ranges [4]. It should be noted that the two-phase flow area in this way is to artificially reduce the formation permeability. In fact, it is still a single-phase treatment method.

3. Wellbore effusion diagnosis

3.1 Theoretical analysis of gas well effusion

Wellbore effusion actually refers to the problem that the formation produced liquid cannot be carried out of the well due to insufficient gas energy. This situation will inevitably lead to the slow accumulation of liquid in the well, and finally form an obvious additional liquid column pressure, resulting in the reduction of gas well production and work efficiency. If this situation continues to develop, the fluid accumulation in the well will continue to increase, and the gas well will eventually stop production. At the initial stage of production, the gas well is in the stage of the strongest energy and can carry the liquid out of the gas well through its own strength. The gas rises rapidly at this stage, and there is basically no effusion in the wellbore. After the gas well is put into production for a period of time, the energy of the gas reservoir will also

have an obvious decreasing trend, and the effusion gradually begins to accumulate in the wellbore.

3.2 Evaluation method

In shallow gas wells, there are mainly the following evaluation methods for gas well effusion. One is the IP and IC index method of gas wells, which needs to calculate the IP and IC values of gas wells under different water production conditions. In this way, technicians can systematically master and judge the index changes in different effusion wells, and master the effusion in gas wells at the same time. However, it should be noted that this method can not achieve the effect of prediction in advance, and can only be used as a judgment method.

The other is the field test method, which contains more technical details. The flow pressure detection method needs to draw up the test curve through the field test of the flow pressure value. If the curve itself has an inflection point, it indicates that there is effusion in the gas well, and the technicians can realize the purpose of depth confirmation of the enterprise interface with the help of the inflection point. This technology is a common and mature technology, which is applicable to a variety of gas wells. The detected data are very accurate and can accurately judge the actual situation of effusion in gas wells.

4. Field application of drainage gas production process

4.1 Optimized drainage gas production tubes

This technology needs to select the tubes with reasonable size for use, which is also the key core of the application of this technology. It should be noted that the smaller the tubes diameter, the greater the resistance of the fluid in the tube. Under the same wellhead pressure and flow pressure, serious energy loss will occur. Taking a gas well as an example, after comprehensively considering the friction resistance of the tubes and the liquid carrying effect, the technicians believe that the use of 2-3/8' tubes can meet the actual requirements of liquid carrying of the gas well. For the gas well with obvious decline in production capacity, the use of 4-1/2' tubes can not only optimize the liquid carrying effect, but also improve the stable production capacity.

4.2 Using foam method to assist drainage gas recovery

This kind of gas recovery technology is in fact a kind of auxiliary exploitation technology of gas field development. With the aid of equipment, surfactant is added into the casings, and the surfactant reacts with water to produce foams. A large number of foams significantly reduce the overall density. This technology is very convenient to use and can produce high economic benefits. It is a common technology in drainage gas production.

The key point of the use of this technology is the selection of foaming agent. Technicians can evaluate the performance of foaming agent by stirring method. When adding 0.5% foaming agent to each 100ml, the foam volume will be detected immediately after mixing 1min, and the time of taking out the liquid in 50ml foams is observed and recorded. This is the half-life period of the foam. The larger the foam volume and the longer the half-life period[5], the better the foam effect.

4.3 Drainage gas production by gas lift

The application of this technology needs to rely on external gas sources. Generally, nitrogen or carbon dioxide will be used. After pressurization with compressors and other equipments, the gas can be compressed and polymerized into high-energy gas and added to the wellbore, so as to reduce the overall density and improve the efficiency of carrying liquid out of the well. The use of this technology requires the addition of drainage assistance process on the basis of the original gas well process, and finally forms the annular space of the gas well. After the gas-liquid mixture is produced through the oil tubes, it can be directly used as the gas source.

4.4 Drainage gas production by mechanical pumping

The application of this technology requires the use of deep well pumps to repeatedly pump the effusion in the wellbore to the surface, and then use mechanical equipments to assist in drainage. The advantage of this technology is that it can start and stop work at any time, change the liquid level under the influence of different working systems, and finally act on the wellbore liquid column to produce back pressure on the bottom of the well. It is a mining method with high rationality.

5. Conclusion

Based on the results and discussions presented above, the conclusions are obtained as below:

(1) Drainage gas production itself is one of the secondary gas production technologies. The working principle is to use a variety of technologies to work together to reduce the bottom hole flow pressure, and can also form an obvious production pressure difference to lift the bottom hole liquid.

(2) In order to alleviate the problem of water production of gas wells and improve their liquid carrying capacity, technicians need to select a drainage gas production technology more suitable according to the actual situation, and increase the system operation stability and work efficiency. In addition, it also has a very obvious effect on the control of operation cost and the improvement of economic benefits.

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