Design of IOT Sensor for Horizontal Well Development in Thin and Poor Reservoir Based on 5G Communication

Xiaolu Huang(✉)

Geological Brigade in No.7 Oil Production Plant of Daqing Oilfield Company Ltd., Daqing 163458, China
uangxiaolu@petrochina.com.cn

Abstract. Horizontal well increases the relative contact area of underground reservoir. Horizontal well has the advantages of large controlled reserves, large oil drainage area and high production. Horizontal well development technology is suitable for the whole process of oilfield development, and is an important technology to improve oil well production, oilfield recovery and development benefits.

Keywords: Low production reason · Existing problems · Stable production · Horizontal well development

1 Introduction

In January 2012, 77 wells were opened in an oil production plant, with a daily liquid production of 698 m^3, a daily oil production of 360 t, an average single well productivity of 36, a basic comprehensive water cut of 436%, an average dynamic liquid level of 1210 m, corresponding to 11 wells, and a daily water injection of 1213 m^3, The average daily injection of a single well is 96 m^3 1.1 points, and the production composition and productivity classification of the reservoir, The daily oil production of 41 relatively high-yield horizontal wells is 153T. According to the data classification analysis of productivity records, the production of 50% of wells is less than 3, in which the share of high-yield wells is small. The number of 14 horizontal wells is more than 8t, and the data is 143% of the total number of wells. The number of horizontal wells between 3 and 6 is 36, and the total number of wells is 367%. The number of wells less than 3 is 45, According to the analysis of water cut data classification data, 38 wells with water content less than 21%, accounting for about 45.1% of the total number of wells, 18 wells with water content more than 80%, accounting for about 235% of the total number of wells.

In order to further explore the technical means of enhancing oil recovery of tight conglomerate reservoir in Mahu oil area, Baikouquan oil production plant of Xinjiang Oilfield introduced group pressure on the basis of the obvious results of natural selection and repeated fracturing. The direct underground energy storage of 12 wells in ma18

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vertical well area and Aihu 1 fault block vertical well area in Mahu oil area of the plant is broken, and the output of single well is increased through "energy increasing" underground oil production.

During the implementation, the planning researchers of Xinjiang Oilfield Exploration and Development Research Institute made full use of logging and seismic materials to carry out spatial exhibition of target oil layer, stress distribution of target layer and overlying formation, and fine describe the target point of design horizontal well. It has important guiding significance for the development and efficient production of ultra deep conglomerate tight oil, and promotes a new stage of the development of mahulu tight oil. It has important guiding significance for expanding the scale of reservoir evaluation and development deployment. This paper consists of the following parts. The first part introduces the relevant background and significance of this paper, the second part is the related work of this paper, and the third part is data analysis. The fourth part is example analysis. The fifth part is conclusion.

2 Related Work

Wu et al. provide a reference for enhanced oil recovery for thin heavy oil reservoirs after steam injection [1]. Jaoua et al. present a concept for the optimization of oil production from an oil rim reservoir by numerical simulation [2]. Close collaboration between the operator and the directional drilling/logging-while-drilling (LWD)/geosteering service provider was a key component of developing a fit-for-purpose solution [3]. An integrated well-pattern optimization frame in adaption to the geological setting of Ordos basin is systematically proposed by Ref [4]. Taking the thin and poor reservoir sand body at the edge of a development zone as an example, Zhou introduced the horizontal well geosteering technology in detail, five techniques have been developed, including marker layer selection, seismic software aided guidance, target identification, lwd data analysis and rate of penetration control [5]. Carpenter summarized the design processes, selection criteria, challenges, and lessons learned during design and execution phases [6]. Ref [7] invested hot-water flooding after steam injec-tion to improve oil recovery in thin heavy-oil reservoir, according to the investion, the team explored a new reservoir for heavy-oil, so the method is better than the other methods. However, for the low permeability tight sandstone gas reservoirs, the paper share the development of gas field, according to the experiment, we know the method is effective [8]. Ref [9] solve the liquid loading in gas development, by normal work, the remote-controlled automated foam injection is working, so if the digital controller is effective. The new production capacity of the plant reached a record high, with a new production capacity of more than 1 million tons. However, due to the influence of the characteristics of low porosity and ultra-low permeability of Mahu tight lava reservoir, its production wells showed the characteristics of declining production rate and low predicted harvest rate. How to further improve reservoir recovery and realize energy increase, pressure maintenance and long-term stable production in Mahu oil area has become the focus of plant researchers.

2.1 Technical Difficulties in Drilling Horizontal Wells in Thin and Poor Reservoirs

(1) The error of reservoir depth is large, and it is difficult to accurately hit the target
The fundamental reason for the underdevelopment of thin and poor reservoirs is that the vertical depth of reservoirs often changes greatly. In some places, when the operators complete the drilling work, the data are not particularly detailed, which brings many unnecessary troubles to the efficient development of horizontal drilling construction, resulting in the inability to reasonably analyze the oil reservoir, which adds many unnecessary difficulties to the smooth development and implementation of follow-up work.

(2) The reservoir is thin and the trajectory control is difficult
The effective thickness of thin and poor reservoirs is less than 1 m. In some extreme cases, the reservoir thickness is even less than 0.5 m, and it is also very common that the reservoir is suddenly undeveloped. Facing this situation, when drilling a horizontal well for wellbore trajectory control, the operator should pay attention to the necessary control of its vertical depth range. Only in this way can the effect be more remarkable. Through calculation, the actual vertical depth range of well trajectory should be strictly controlled within 0.5 m, which meets the construction requirements of horizontal wells in thin and poor reservoirs.

(3) There is a blind area between the measuring instrument and the bottom hole, and the trajectory control is difficult
At present, when using the existing LWD system and bottom hole bit, there is often a certain distance blind area. In the face of this situation, we can only rely on the experience of relevant operators to estimate the distance of this blind area. This makes it very difficult to control the well trajectory. For example, when entering the reservoir, good results can be obtained only by accurately entering the target, but this work is very difficult and is not conducive to the actual operation.

2.2 Calculation Method of Dynamic Programming

In this paper, a dynamic programming algorithm for τ UE and false information diffusion ability (DPA) is proposed for the night broadcast model of true and false information, This method includes two steps: finding the shortest path and calculating the forwarding probability. In the experimental part, the calculation method based on dynamic programming proposed in this paper is compared with the evaluation method based on Monte Carlo in many different topological networks, The method proposed in this paper can quickly get the approximate results with Monte Carlo simulation method, taking into account the time efficiency and accuracy, and provides a new feasible method for analyzing the propagation influence of true and false information in different networks and the evaluation of information filtering ability.

Index of information filtering ability ty.TTA Message transmission ability (FTA) is defined as formula (1) respectively:

$$F_T = \frac{{N_T}'}{N} F_F = \frac{N_F}{N} \tag{1}$$

Information filtering ability (FA) is defined as formula (2):

$$F = F_T - F_F \tag{2}$$

Generally speaking, the propagation probability of a node should be the sum of the probabilities of all its neighboring back in edges forwarding information to it. This paper adopts a single access propagation model, that is, when a node is first accessed by an information, it decides whether to forward or not. Even if the node is accessed again later, it will not change its forwarding state, Only when there is no other incoming side forwarding the information to the node before, the new incoming side can forward the information to the node. The simple probability sum can not restore the propagation process under the model. Taking the network shown in Fig. 1 as an example, the probability step to which the source information is sent and propagated is calculated, and its alse represents the information type.

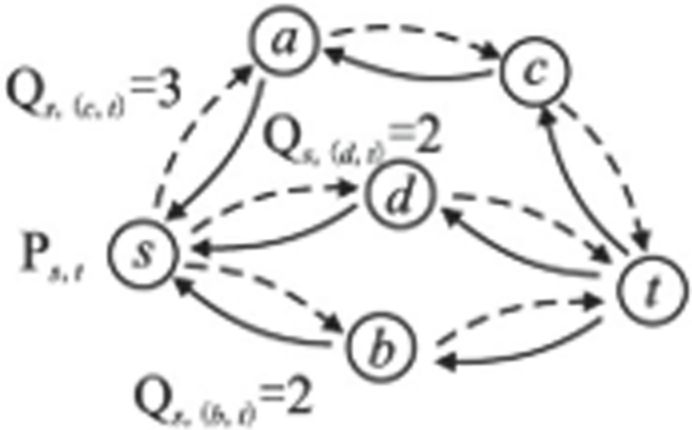

Fig. 1. Example of calculating forwarding probability

3 Data Analysis

In November 2020, Hanzhong development and Reform Commission mentioned the exploration and development of natural gas and shale gas in Zhenba County, southern Shaanxi in response to the proposal of CPPCC members. The proposal on further paying attention to and accelerating the exploration and development of natural gas and shale gas in Zhenba County, southern Shaanxi, put forward at the fourth session of the fifth CPPCC Hanzhong Municipal Committee, has been approved. The reply is as follows, Analysis formula of water well thin layer data:

$$\begin{cases} E(t)\dot{x}_k(t) = f(t, x_k(t)) + B(t)u_k(t) \\ y_k(t) = C(t)x_k(t) \end{cases} \tag{3}$$

$$\begin{cases} E(t)\dot{x}_d(t) = f(t, x_d(t)) + B(t)u_d(t) \\ y_d(t) = C(t)x_d(t) \end{cases} \tag{4}$$

Zhenba area belongs to the Daba Mountains and the geological structure belt in front of the mountains. The structural belt is rich in natural gas reserves and is one of the main fields of mountain exploration in China. It is a natural gas exploration and development block registered by Sinopec in Sichuan Basin, with an area of about 6980 km^2, including 1351.7 km^2 in Zhenba. According to the theoretical data, the natural gas reserves are 3.061 in the upper group $\times$ 1011 m^3 + 306.1 billion m^3, lower group 1.3235 $\times$ 1014 m^2 3 + 132.35 trillion US dollars. The total gas content of shale gas is 1.47–5.44 m^3t, with an average of 3.71 mm^3t. According to the national oil and gas geological evaluation data and the preliminary exploration results of Sinopec, Zhenba County has large reserves of natural gas and shale gas resources. It has high exploration and development prospects and is expected to become a new base of Shaanxi energy industry.

In May 2015, the oil and gas center of the Ministry of land and resources deployed the shale gas investigation well “i.e. Township 1 well” in Yongle Town, Zhenba County. The exploration task was completed at the end of November. The drilling depth is 1771 m, major discoveries have been made, and high-quality shale layer of 80m has been encountered. The page rock gas shows well, and the shale gas resources in towns and Ba County have been preliminarily explored. On January 21, 2016, the China Geological Survey Bureau of the Ministry of land and resources released the 2015 China Geological Survey Report on CCTV. It is expected that Zhenba will become the next important base for shale gas exploration and development in China. The learning law is as follows:

$$u_{k+1}(t) = u_k(t) + \Gamma_{l1}\dot{e}_k(t) + \Gamma_{l2}\dot{e}_{k+1}(t) + \Gamma_{p1}\Delta\dot{e}_k(t) + \Gamma_{p2}\Delta\dot{e}_{k+1}(t) \tag{5}$$

With the strong promotion of provincial and municipal governments at all levels, after full contact and demonstration, Shaanxi coalfield geology Group Co., Ltd. “Shaanxi Energy Group” signed a joint investigation and development agreement with Sinopec exploration branch in October 2018. According to the Zhenba shale gas resources cooperation and development agreement, Shaanxi Energy Group plans to invest more than 86 million yuan to carry out two-dimensional seismic survey in Zhenba County and deploy a parameter well of shale gas. In order to ensure the smooth entry of exploration equipment, Shaanxi Provincial Development and Reform Commission issued RMB 10 million for shale gas exploration road project in September 2019. A 15.9 km long shale gas exploration road will be built from Yongle Town to Dazhu village to facilitate the mobilization of large exploration equipment. On June 23 this year, shale gas parameter wells were officially drilled in Dazhu village, Yongle Town, Zhenba County.

“Shaanzhen Ye 1 well” is the first shale gas parameter well in Zhenba area, marking that the exploration and development of shale gas resources in Zhenba area has entered a new stage. According to the overall arrangement of the project, the drilling and evaluation of vertical well section is planned to be completed on September 31, and the drilling and evaluation of horizontal well will be completed on December 31, with fracturing test.

3.1 Main Difficulties in Development

Identification of interlayer by field logging guidance.

1. Judgment of drilling time
   Whether it is physical interlayer or lithologic interlayer, the drilling time is generally large. If the average drilling time of the whole reservoir is small, you can refer to micro drilling or instantaneous drilling, judge the change of lithology through the comparison of drilling time, stop drilling for cyclic observation, and take rock cuttings to confirm whether the interlayer is drilled. Figure 2 shows the operation flow of well layer data.

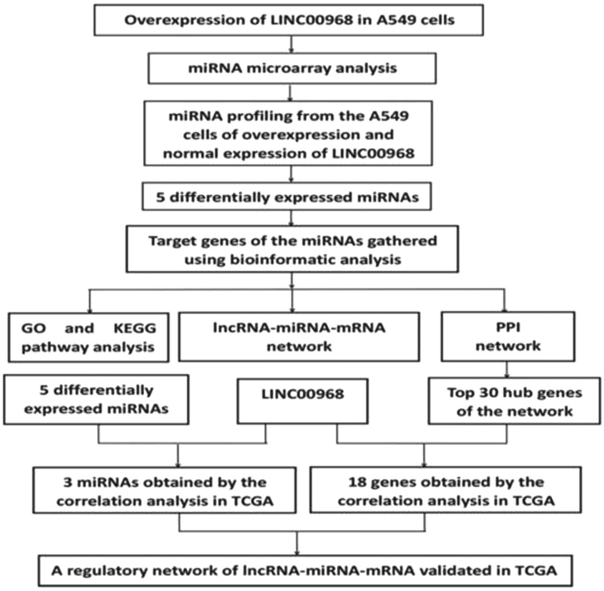

Fig. 2. Operation flow of well layer data

2. Physical properties and oiliness
   As interlayer, its physical properties and oil content are poor. This can be judged from the change of whole meridian content. 3. Lwo curve while drilling.
   The change of lithology can be judged from LWD curve. Generally speaking, the natural gamma of argillaceous intercalation is high, the bilateral curves show low resistance and the deep and shallow survey line curves are close to coincidence, and the resistance value of calcareous sandstone intercalation generally shows high resistance, and the deep and shallow survey line curves are close to coincidence.
3. Study on quantitative fluorescence IC index
   On site, we can judge the permeability of rock cuttings by secondary analysis of lithology to obtain IC index to judge the permeability of rock, so as to judge whether it is a dense interlayer.

Adjustment strategy for interlayer trajectory.

1. Sublayer correlation
   In order to provide the penetration rate, small layer comparison shall be carried out for the target horizon of adjacent wells, the horizontal variation shall be analyzed, and the actual drilling profile of construction wells shall be predicted. In the process of tracking while drilling, in combination with the feasibility analysis of drilling technology, interlayer shall be avoided or quickly passed through interlayer as far as possible to ensure the penetration rate of horizontal well reservoir.
2. Comparative logging
   Analyze and compare the logging data, compare the lithology and electrical properties with adjacent wells, identify the interlayer that may be drilled, and adjust the well trajectory as soon as possible.
3. Altitude difference
   In stratigraphic correlation, the difference of bushing altitude should be fully considered, which is particularly important for the avoidance of interlayer and the adjustment of trajectory.
4. Profile correction
   It is mainly to determine the difference between the predicted formation lithology and the actual drilling lithology through the projection of the actual drilling trajectory on the predicted profile, determine the actual depth and thickness data of each horizon, repeatedly modify and correct, predict the change of reservoir profile, then predict the next drilling profile, determine the horizontal and vertical change characteristics of reservoir, and improve the coincidence rate between the predicted profile and the actual profile, At the same time, the effective penetration rate of horizontal well reservoir is improved.

   1) After water breakthrough, the period of analyzing the direction of water inflow in horizontal wells is relatively long
   2) The matching technology of horizontal well is not perfect.
   3) The development of supporting facilities is still at the primary level of exploration
   4) The decline value of horizontal wells is relatively large. In 2014, the drawdown value of horizontal wells in an oilfield was 47.8%. In contrast, the decline value of directional wells in Chang 1 + 4 reservoir in d33 area is 291% and that of horizontal wells is 471%.

4 Example Analysis

In the process of shale gas horizontal well drilling, it is necessary to continuously improve the overall work efficiency of drilling construction, solve a series of technical difficulties of drilling fluid, adopt the best technology to select the most appropriate drilling fluid system, achieve the expected optimization goal, improve the overall quality of work, and meet the shale development effect and production demand. Based on the shale gas itself has a certain compactness, in the process of horizontal drilling, a series of problems such as the technical difficulties of drilling fluid need to be solved in order to ensure the safety

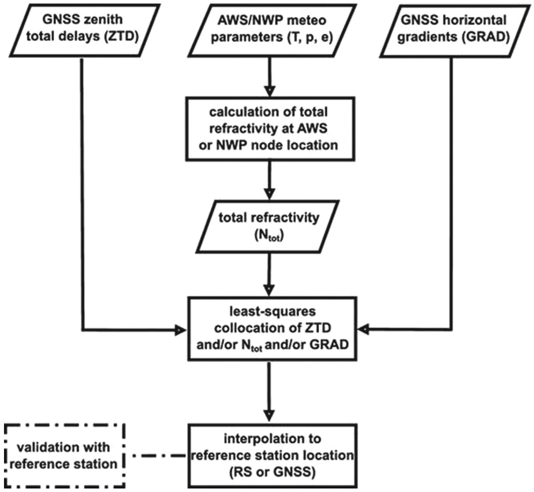

Fig. 3. Solve the technical difficulties of drilling fluid

of drilling construction. As shown in Fig. 3, solve the technical difficulties of drilling fluid.

Before using drilling fluid technology for horizontal wells, it is necessary to analyze what problems exist in shale gas development to be solved, which can be predicted in advance to find the direction of construction in the follow-up technical construction. The data investigation on improving the overall quality of construction shows that the borehole in shale gas development is complex, one of the reasons is that the wellbore stability is relatively poor, Shale gas horizontal well drilling fluid technology also faces a series of problems. For the technical analysis of shale gas horizontal well drilling fluid, it will interact with the underlying fractures and the weak underground layer in the process of use, resulting in very obvious changes in the pressure and strength of shale gas itself. Due to the interaction between shale and drilling fluid, both the wellbore and the stability of shale gas will change, In order to improve the quality of shale gas horizontal well drilling fluid technology, it is necessary to further analyze the causes of the problems. The main reason is that there is a certain dimension gap between the wellbore and the soil layer. Under the effect of the gap pressure, the liquid will have a certain interaction force with shale gas, The result is that the swelling stress and hydration stress in the middle of the underground clay layer will change to a certain extent, so that there will be a lot of liquid flowing in between the formations. The emergence of liquid will lead to the clay minerals contained in shale gas react directly with water, showing the overall expansion phenomenon. The direct result is that the tension will gradually expand, For the wellbore, its own stability has changed.

5 Conclusion

To sum up, the analysis of the technical difficulties and selection principles of horizontal well drilling fluid can improve the overall quality of shale gas horizontal well drilling fluid construction technology, and meet the relevant characteristics and requirements of current shale gas exploration in China. In the study of shale gas horizontal well drilling fluid technology, we need to learn from the past work experience, summarize, according to the actual situation of the whole construction process, constantly optimize the shale gas horizontal well drilling fluid construction technology, meet the whole construction requirements of shale gas horizontal well drilling fluid in the construction, and improve the use efficiency of shale gas horizontal well drilling fluid. Drilling high-quality shale gas horizontal wells can achieve the efficiency of shale gas exploration and development, and promote China to further achieve ideal scientific research results in shale gas research and development.

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