Study on Optimal Economic Evaluation of Industrial Drilling Platform for Shale Oil and Gas Development

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Abstract: The development of shale oil and gas in China is at a critical stage, and the technology of factory drilling platforms, as the key technology of shale oil and gas development in North America, is worthy of in-depth study on its function, optimization mode and economic evaluation in China's shale oil and gas development industry. The number of wells and the operation mode of factory drilling platforms will directly affect the economics of factory drilling platform technology, but there is a lack of technical and economic evaluation models of such platforms. Therefore, by analyzing the application of factory drilling platforms and the international advanced design method, a technical and economic evaluation model is established, and data from the Sichuan Shale gas field are calculated and analyzed. The research shows that the proposed economic evaluation and analysis method, and the calculation of the optimal number and operation mode of factory drilling platforms, can provide guidance for the overall deployment and design of this technology, and some relevant suggestions are proposed in the light of the problems related to the use of these platforms by Chinese oil and gas companies.

1. Introduction

From a global perspective, the successful mining of tight oil has brought about major changes in the world's oil and gas exploration and development, but is also gradually affecting the world's energy supply and demand pattern. According to the latest results of a global evaluation of tight oil and gas resources released jointly by the U.S. Energy Agency EIA and the American company Advanced Resources International (ARI), global tight oil technology can produce 47.3 billion tons of oil, accounting for 10\% of total oil resources, and in the period 2018–2035, tight oil production is expected to more than double from the current 247 million tons to 514 million tons, mainly due to the high reserves of tight oil and to technological progress. China also has a wealth of tight oil resources, but due to technical constraints has so far only carried out experimental development. It is very important to choose the appropriate development technology and mode as the key factors to deal with the challenge of tight oil development. Based on systematic analysis of industrial drilling platforms, which are the key technology in the successful exploitation of tight oil abroad, this paper carries out an in-depth study to evaluate the economic benefits, future development prospects and problems faced with the technology, and provides a powerful reference for the development and production of tight oil in China.
2. Technical requirements for shale oil and gas development

China's tight oil resources amount to about 7 billion tons, of which the amount of technologically recoverable resources is about 2~2.5 billion tons, accounting for 9.3% of the world's tight oil resources, and mainly distributed in Songliao, Ordos, Sichuan and other basins, which have great potential for exploitation. With the increasing shortage of oil and gas resources and the intensifying gap between supply and demand, many countries have accelerated the development of tight oil. Among them, large-scale mining of tight oil in North America successfully reversed the 24-year decline in oil production in the United States, and American oil companies attached great importance to improving their rig efficiency and oil and gas well production during the previous period of low oil prices. Although the number of rigs used at that time decreased significantly, the oil and gas produced by each rig increased steadily. The was firstly because when a rig is moved to the core of the shale oil and gas, the output of that single well is improved, and secondly that when the operator gives priority to the elimination of old drilling rigs, the number left in operation decreases, so the oil and gas produced by the single drilling rig increases. The third reason is the use of factory drilling platform technology, which is key to improving the drilling efficiency and shortening the drilling cycle, such that the annual drilling output of a single drilling rig is increased.

In China, the shale oil and gas industry is in the initial stage of large-scale development. With the increase of the reservoir depth, the degree of geological evolution is deepened, the structure is more complex, and the exploration technology requirements are higher, while there are inefficiencies in development, tension over land use, and high costs, etc., so there is need to optimize the drilling technology. Thus, factory drilling platforms are advantageous in solving these shale oil and gas development problems.

3. Definition and application of factory drilling platform technology

3.1. Definition of factory drilling platform technology

The basis of industrial drilling platform technology is a well layout based on a large-scale cluster of horizontal wells (a well pad). Since the application of "well factory" technology in shale oil and gas development in the United States, a new drilling platform has been generated, which is called the factory drilling platform.

The factory drilling platform was first proposed by Schlumberger at the 2011 International Association of Drilling Contractors (IADC) Advanced Drilling Rig Technical Conference. This platform is a drilling process "factory", applied to the oil and gas field development process, which enables the use of repeatable experience and the mastery of downhole risks, with a specially manufactured drilling rig or specialized drilling technology using mechanized labor, instead of manual construction of the field production platform technology.

The factory drilling platform technology synthesizes a remote operation drilling control center, field technology and real-time data control, and the technically optimized design of the factory drilling platform optimizes the number of wells operated, the selection of the drilling rig, the factory construction process and other parameters under the condition that the surface and underground well distance are known. The objective is to keep the cost of a shale oil and gas development project to a minimum, from a fast mobile drilling rig to a single well field of multiple wells for batch drilling completion and offline operations, in a pipeline-type way, in order to achieve side drilling, side fracturing, side production, and improve the efficiency of oil extraction.

3.2. Application of factory drilling platform technology

In the United States and Canada in the major shale oil and gas and dense hydrocarbon producing areas, the use of the factory drilling model to allow the rapid growth of wells has now exceeded 70%, and in some individual production areas has reached more than 90%, with a large number of retrofitted rigs and complete sets of custom-built drilling rigs put into use. Chevron not only uses factory rig technology to develop local shale oil and gas in the United States, but also applies it in other regions, drilling more than 300 wells a year in Thailand, where the company is using factory drilling platform technology to achieve the maximum efficiency with minimal investment, and all its platforms are
developed using the same process, practice and design. These factory rigs make Chevron the largest producer of crude oil and natural gas in Thailand.

At present, North America has not only undergone a transformation of the existing drilling rigs, and the installation of rapid mobile devices formed by factory drilling rig platforms, but also has a complete set of customized new factory drilling platforms in operation. The successful development of a variety of advanced drilling rigs suitable for factory drilling platforms has provided equipment support, giving full play to the technical advantages of factory drilling, and has effectively promoted the popularization and application of factory drilling platform technology in North America.

4. International optimized design method of factory drilling platform

At present, the optimized design of advanced factory drilling platforms by international petroleum companies mainly includes the following:

4.1. Development of multiple production layers for a single factory drilling platform.

A single drilling platform is used to a) achieve joint development of multi-production layers, b) make full use of the well platform, c) reduce the spacing between the working wells and wells in the platform, d) increase the number of wells in a single operating platform, e) reduce the footprint of the drilling platform, f) reduce operating costs through sharing of land, drilling equipment, mud tanks and water treatment systems, and g) improve efficiency through factory operations. This collectively improves the overall benefit of the block. This approach is widely used in shale oil and gas development in the United States at Eagle Ford and the Permian Basin and at Montney, Canada. Laredo Oil Company in the Permian Basin, using a single well field multi-production layer development, operates 20 well factory platforms drilling 60 horizontal wells, with the development of 4 layers of shale oil and gas, and achieving 6%~8% lower operating costs.

4.2. Flexible factory drilling platform.

Due to the large variation of a reservoir within dozens of meters, the traditional factory rig may result in less contact area between some wells and the reservoir, or the quality of the reservoir in contact may be poor, so that the production capacity is not as expected. Chevron has developed a flexible factory drilling platform, using data collection from the first few wells to adjust the well structure and to position later wells more effectively in real time, so as to improve the economic benefits of well plant development. From a comparison of 12 well group platforms in the Permian Basin, it is found that although the net present value of stand-up wells is similar, the total net present value of a flexible factory rig is more than twice that of the traditional factory drilling platform owing to the use of spare well positions.

4.3. Factory drilling platform batch drilling mode.

This refers to the drilling operation of the surface, straight well section and horizontal well section of multiple wells in batches according to a certain order, and greatly improves the efficiency of drilling operations through the use of water operations. The batch drilling operation mode has the following features: First, one or a number of drilling rigs can be used to achieve the same well section in the same well group configuration of the same drilling rig and bottom drilling tool combination, saving a lot of time changing drilling tools; The second involves the use of a number of drilling rigs suitable for the simultaneous operation of 2~3 wells; it is common to use a single mobile drilling rig for groups of 4~6 wells; Third, the multi-mouth well open, cementing, in turn, second open, cementing, so that drilling, cementing, and logging equipment continues to run, reducing the non-production time, and improving operational efficiency; Fourth is the reuse of the drilling fluid, reducing the alternation of drilling fluid. ConocoPhillips, Statoil, Halliburton and Schlumberger have used this technology during drilling in the Eagle Ford shale oil and gas areas.

Therefore, the construction of a factory drilling platform should include the following considerations:

First, the large-scale deployment of cluster drilling platforms; Second, a custom special drilling rig, fracturing equipment, especially a mobile drilling rig, high-performance drilling pump and circulation...
system, and high-power density fracturing vehicle; Third, a drilling rig automation upgrade, top drive, automatic drilling, automated wellhead operation equipment, and a pipe automatic discharge system; Fourth is mature, practical, and integrated drilling technology standardization; Fifth is a large-scale complete automatic fracturing fluid set of technology; Sixth is clean production technology, a functional platform area design, clear sewage diversion technology, a non-landing circulatory system, electric oil power technology, noise suppression technology, debris treatment technology, drilling fluid recovery technology, fracturing fluid recovery technology, and waste treatment technology.

5. Economic evaluation model and example of analysis of industrial drilling platform technology optimization

5.1. Evaluation model

The ultimate goal of the research and application of factory drilling platform technology is to reduce the cost of the project, shorten the engineering cycle, optimize the design of the platform by optimizing the surface and underground well distance through optimizing the number of wells, selecting the factory drilling rig, constructing the factory drilling platform and other parameters, thereby minimizing the cost of shale gas development projects. Therefore, the purpose of establishing a technical and economic evaluation model of the factory drilling platform and the contents of the economic evaluation model are as follows: To calculate and evaluate the average cost increase and decrease of a single well with different well spacings (300, 600 and 900 m), different factory drilling platform operation modes, different well numbers per platform (2, 4, 6,..., 20), and thus to select the optimal number of wells and the optimal operation mode for the platform. For the technical and economic evaluation of the factory drilling platform, a model of the project cost increase and decrease of a shale gas industrial drilling platform is established:

\[Q = \Delta Q_{ZQ} + \Delta Q_{DR} + \Delta Q_{FR} - \Delta Q_{RQ}\]

\[\Delta Q = \Delta Q_{ZD} + \Delta Q_{L} + \Delta Q_{G}\]

\[\Delta Q_{DR} = \Delta Q_{R} + \Delta Q_{M} + \Delta Q_{C} + \Delta Q_{D}\]

\[\Delta Q_{FR} = \Delta Q_{S} + \Delta Q_{DF} + \Delta Q_{ZS}\]

In the formula: Q is the increase or decrease of the engineering cost under the mode of the factory drilling platform (all costs in million yuan); \(\Delta Q_{ZQ}\) is the pre-drilling costs increase or decrease; \(\Delta Q_{DR}\) is the drilling costs increase or decrease; \(\Delta Q_{FR}\) is the fracturing costs increase or decrease; \(\Delta Q_{RQ}\) is the equipment upgrade and transformation costs, \(\Delta Q_{ZD}\) is the land requisition costs increase or decrease; \(\Delta Q_{L}\) is the well site road construction costs increase or decrease; \(\Delta Q_{G}\) is the fracturing water supply pipeline construction costs increase or decrease; \(\Delta Q_{R}\) is the drilling daily fee increase or decrease, \(\Delta Q_{M}\) is the drilling fluid cost increase or decrease; \(\Delta Q_{C}\) is the casing cost increase or decrease; \(\Delta Q_{D}\) is the orientation cost increase or decrease; \(\Delta Q_{S}\) is the fracturing construction cost increase or decrease; \(\Delta Q_{DF}\) is the fracturing dynamic demobilization increase or decrease; \(\Delta Q_{ZS}\) is the drilling plug demobilization increase or decrease.

The calculation formulas for each sub-item in formula (1) are as follows.

1) The formula for the increase and decrease of pre-drilling costs is:

\[\Delta Q_{ZQ} = qzQ(1 - \frac{1}{N-1}1.1^{N-1})\]

The increase and decrease of the daily drilling fee is closely related to the shortening of the well construction period.

The calculation formula is:
\[ \Delta Q_R = f_R(\Delta T) = \sum_{i=0}^{K} (C_{IR} \Delta T_i) \]  
(3)

2) In the formula: \( C_{IR} \) is the daily rig fee for the i time to open (million yuan/d); \( \Delta T_i \) is the first to open the well cycle of shortening (d); i is the order of opening the drilling, first open, second open, etc.; K is the total opening of a single well.

3) Considering the recycling of drilling fluid, the calculation formula of the average cost increase or decrease of single well drilling fluid on an industrial drilling platform is:

\[ \Delta Q_M = f_M(\Delta q) = \sum_{i=0}^{K} (C_{IM} \Delta q_i) \]  
(4)

In the formula: \( C_{IM} \) is the unit price of the drilling fluid for the i time (million yuan/m³); \( \Delta q_i \) is the amount of drilling fluid used for the i time and repeated use (m³).

4) The calculation formula of the casing cost increase is:

\[ \Delta Q_c = f_c(\Delta L) = \sum_{i=0}^{K} (C_{IC} \Delta L_i q_i) \]  
(5)

In the formula: \( C_{IC} \) is the price of the i open casing (million yuan/t); \( \Delta L_i \) is the i time to open the increase in the casing length (m); \( q_i \) is the line weight of the i time open casing (t/m).

5) The increase in directional costs is proportional to the increased directional operating time and is calculated as:

\[ \Delta Q_D = f_D(\Delta T) = \sum_{i=0}^{K} (C_{ID} \Delta T_i) \]  
(6)

In the formula: \( C_{ID} \) is the target construction day fee for the first (million yuan/d); \( \Delta T_i \) is the first increase of the targeted construction time (d).

6) For the factory drilling platform equipment transformation and upgrade costs, the calculation formula is:

\[ \Delta Q_{RQ} = \frac{1}{N} Q_{RQ} \]  
(7)

In the formula: \( Q_{RQ} \) is the total factory drilling platform equipment upgrade and transformation cost (million yuan/d).

The calculation formula for the increase and decrease of the fracturing construction cost of the factory drilling platform is:

\[ \Delta Q_{FR} = f_{FR}(\Delta T) = \sum_{i=0}^{N} (C_{IFR} \Delta T_i) \]  
(8)

In the formula: \( C_{IFR} \) is the fracturing construction cost of the i well (million yuan/d); \( \Delta T_i \) is the fracturing construction time saved for the i well (d); i is the well order of the factory rig platform.

7) The calculation formulas for the increase and decrease of fracturing and drilling plug demobilization in the factory drilling platform are:

\[ \Delta Q_{DF} = \frac{1}{N} Q_{DF} \]  
(9)

\[ \Delta Q_{ZF} = \frac{1}{N} Q_{ZF} \]  
(10)

In the formula: \( Q_{DF} \) is the cost of fracturing and demobilization of a single well (million yuan), \( Q_{ZF} \) is the single well’s drilling plug and demobilization costs (million yuan).

5.2. Case study

In order to verify the rationality of the technical and economic evaluation model of the factory drilling platform, the author uses data from the Fuling shale gas field. The basic data used in the example include the following: the underground well distance is 600 m, the horizontal section length is 1500 m, the well body structure, borehole track, drilling fluid system, drilling process parameters, as well as the fracturing segment quantity, liquid volume, sand volume, construction parameters and other process parameters are selected to refer to the technical scheme of mature standards in the work room.

1) Reference well selection

The focal X well completed in 2016 (without the use of factory drilling platform technology) was used as the reference for the economic analysis. The well drilling and fracturing are based on the standard design and technology of the work room. The well drilling cycle is 75 days, divided into 18 sections of a single well fracturing project, of which the cost is 70 million yuan, including pre-drilling and land acquisition costs of 5 million yuan, a daily drilling rig fee of 10 million yuan (according to the duration of the 85 day measurement), a drilling fluid cost of 4 million yuan, and a directional well
The service fee of 1.2 million yuan. The casing cost is 4 million yuan, the drilling rig mobile equipment renovation cost is 3.5 million yuan, the fracturing construction cost is 10 million yuan (including fracturing vehicle fees, distribution costs, etc.), and the fracturing test pneumatic demobilization cost is 1 million yuan.

2) Economic evaluation of operation mode of factory drilling platform

According to the drilling day quota, the directional daily fee, casing cost and the construction flow of the industrial drilling platform in Sichuan shale gas field, the increase or decrease of the engineering cost in the factory drilling platform mode is calculated using formula (1), and the results are shown in Table 1.

| No. of platform wells/well | Pre-drilling fee | Drilling day fee | Drilling fluid cost | Casing fee | Orientation fee | Drilling rig renovation fee | Fracturing operation fee | Total fee |
|---------------------------|------------------|------------------|---------------------|------------|----------------|-----------------------------|--------------------------|---------|
| 2                         | 521.97           | 318.00           | 182.28              | 0          | 0              | -143.50                     | 30.87                    | 878.74  |
| 4                         | 705.26           | 322.59           | 273.42              | -24.18     | -15.42         | -71.75                      | 46.31                    | 1189.91 |
| 6                         | 759.54           | 324.89           | 303.80              | -32.22     | -21.22         | -47.83                      | 51.45                    | 1286.95 |
| 8                         | 780.48           | 318.00           | 318.99              | -48.36     | -30.85         | -35.88                      | 54.02                    | 1302.39 |
| 10                        | 787.06           | 312.26           | 328.10              | -58.02     | -36.96         | -28.70                      | 55.57                    | 1303.74 |
| 12                        | 785.40           | 305.37           | 334.18              | -72.54     | -46.27         | -23.92                      | 56.60                    | 1282.22 |
| 14                        | 777.95           | 298.48           | 338.52              | -81.66     | -52.90         | -20.50                      | 57.33                    | 1259.90 |
| 16                        | 765.73           | 289.30           | 341.78              | -90.66     | -57.86         | -17.94                      | 57.88                    | 1230.35 |
| 18                        | 749.09           | 282.41           | 344.31              | -96.66     | -61.73         | -15.94                      | 58.31                    | 1201.47 |
| 20                        | 728.00           | 278.96           | 346.33              | -103.86    | -68.19         | -14.35                      | 58.65                    | 1166.89 |

Note: Positive numbers indicate an increase, and negative numbers a decrease. Costs are in million yuan.

The calculation results show that the average cost of a single well drilling and fracturing project with a four-well type factory drilling platform is 65 million yuan, while the total project cost of the reference well is 78 million yuan. This is a reduction of 13 million yuan. The model calculation value is 11.8989 million yuan, and the relative error is 8.47%. The calculated results are basically in agreement with the actual data in the field, which shows that the evaluation model established by the author is reasonable and reliable. As shown in Table 1, under the operating mode of the factory
drilling platform, when the platform has fewer than 4 wells, the reduction of the total cost of the project increases greatly with increase of the number of platform wells. When the number of platform wells exceeds 6, the increase of the total cost reduction of the project slows down; when the number of platform wells exceeds 8, the reduction of the total cost of the project decreases with increase of the number of platform wells. Therefore, under the current well network conditions and process parameters, the optimal number of platforms for the operation mode of the factory drilling platform in Fuling shale gas field is 4~8.

For economic evaluation of the operation modes of different industrial drilling platforms, there are two platform operating modes for dual drilling rigs in the shale gas field pipeline in Sichuan: i) Type 30 small drilling rig + type 50 large drilling rig factory drilling platform operation mode, and ii) Type 30 small drilling rig + type 70 large drilling rig operation mode. Using formula (1), the savings against the total cost of the project under the operating mode with four kinds of factory drilling platforms are calculated, and the results are shown in Figure 1.

As shown in Figure 1, when the number of wells per platform is less than 6, the working modes of the platform with a single drilling rig and of the platform with a double drilling rig are similar, and the saving on the project cost is more significant than that of the whole towing factory drilling platform operation mode. When the platform has more than 10 well mouths, the operation mode with the double pipeline drilling rig with "type 30 drilling rig + type 70 drilling rig" has outstanding advantages in terms of project cost savings. Therefore, it is suggested to explore and test the operation mode of the double pipeline drilling rig of "type 30 drilling rig + type 70 drilling rig" in the deep shale gas well in the two phases of the Sichuan shale gas field.

C. Conclusion

With the aim of calculating the cost reduction of the average single well project, the technical and economic evaluation model of the shale gas factory drilling platform is established, and analysis and verification of the calculation are carried out using data from the Sichuan shale gas field. The results are in agreement with the field data, which verifies the rationality and reliability of the model.

The calculation results show that the factory drilling platform working mode significantly reduces the cost of the pre-drilling engineering, drilling fluid, and fracturing construction and so on, but increases the cost of casing, directional construction and retrofitting of the drilling rig and fracturing...
equipment. According to this calculation, the optimal number of wells for factory drilling platforms in the Sichuan shale gas field is 4~8, and the optimal operation mode is the platform with a double pipeline drilling rig with "type 30 drilling rig + type 70 drilling rig".

3) The economic evaluation model established does not consider the economic benefit arising from the different production cycles, but can determine the optimal well layout of the factory drilling platform according to the requirements of production operations, the commissioning cycle and so on in practical application on site.

Based on lessons from foreign experience and technology, research on the technology of factory drilling platforms has been carried out in China, mainly through the transformation of conventional land drilling rigs. This initially meets the needs of site construction, and has included pilot applications in individual blocks such as Sichuan, achieving better stage results. However, compared with foreign countries, there is still a clear gap in the technology, which does not fully meet the economic and safety requirements of the factory operation.

V. Main problems and suggested improvements to domestic factory drilling platform technology

A. Main problem

At present, although the domestic industry has a more mature horizontal well drilling technology, preliminary results from the Sulige, Changning-Wei yuan factory drilling platform show it has partly achieved a shortening of the drilling cycle. However, in terms of efficient movement, scale of use, economy and safety, these factory rigs are far from meeting the needs of shale gas and tight oil development.

1) This form of factory drilling platform is still relatively single, and the factory operation flow needs to be further perfected. At present, the use of a single-row single drilling rig or a double-row double drilling rig, a single rig model equipped, has not really achieved factory operations, the relevant equipment transformation has not taken place, and the connection and supporting technical specifications do not fully meet the economic and security requirements for factory operation.

2) In the domestic industry, the number and application of complete sets of customized factory platform rigs is limited. Factory working rigs transformed from conventional land drilling rigs are widely used, but have some disadvantages, such as their large structure, the large number of modules and big footprint.

3) Modified factory rig platforms have a low equipment allocation rate and weak technical level. Drilling speed-up tools are single, mechanical drilling speeds need to be improved, and rotation guidance and other core equipment technology is still lacking. At the same time, the number of fast-moving electric drive rigs suitable for factory drilling is seriously limited, the performance of PDC bits and oil-based drilling fluid needs to be improved, while personalized drill bits and drilling fluids and other personalized technology development capabilities need to be strengthened, as does rotary-oriented drilling technology.

B. Related suggestions

The application of factory drilling platform technology to the development of unconventional oil and gas resources represents a change of production mode in the industry, which is no longer restricted to the traditional construction mode of production. Shale oil and gas development in China's oil and gas industry needs improved construction efficiency, shorter drilling cycles and reduced single well costs. At the same time, the use of advanced factory drilling platform technology can improve single-well production, while optimizing the cost per ton of oil is also an effective way to improve the efficiency. Aiming to overcome the problems of terrain limitation, development cycles and costs holding back shale oil and gas development in China's oil and gas industry, it is suggested to speed up the construction of factory drilling platform technology, enhance the development benefits, learn from successful experiences at home and abroad, carry out testing and mining, and realize platforms for well deployment and factory drilling and fracturing operations.

1) There is a need to strengthen the technology of shale oil and gas development, and popularize the use of factory drilling platforms. Aiming at the development of technology, equipment, management, operational integration and serialization of shale oil and gas, it is beneficial to initiate the large-scale reproduction and popularization of the technology and operations experience of factory drilling platforms, realize their large-scale application, and improve the overall strength and level of
Working teams. A corresponding technical system and specification should be established, forming an intensive, integrated and efficient factory drilling platform management mode.

2) Targeted design of factory drilling platform equipment, with the step-by-point transformation of factory operations, is needed. The development of factory drilling platform facilities suitable for the complex terrain of China's factory drilling platforms should be accelerated, taking account of the poor road transport conditions, small platform area and low number of wells in the platform. The development and use of a set of custom factory operating rigs with small structure sizes and high modularity should also be accelerated. Systematic modification and upgrading of existing drilling equipment will make the drilling equipment of movable value. It is necessary to gradually realize the operation mode of drilling cluster well groups, establishing safe operation of factory drilling platforms along with the relevant standards of environmental protection supporting equipment. Research and development in related technical equipment and well plant technology is needed, to improve the shale oil and gas development level and device level step by step.

3) Standardized management of factory drilling platforms should be realized, together with building a self-owned drilling rig brand. To shorten the delivery time of custom factory drilling platform equipment requires material procurement, unified specifications, improved capital turnover, a reduction in the costs of the procurement of different types of equipment, and moves toward simpler, unified transport and management. Drilling rigs suitable for factory drilling platforms will be developed into the company's own factory drilling rig brand, to realize the personalization and diversification of drilling rig design, to meet the sustainable development needs of enterprises, while further enhancing the company's influence in the design of drilling rigs in petroleum equipment enterprises.

4) Taking account of the influence of the domestic ground conditions and environment, the industrial operation mode of volume transformation is being explored. Multiple water source wells, software tanks and fracturing fluid buffer tanks are designed in the middle of the platform, and the water supply is concentrated to realize continuous mixing of non-storage. By controlling valve regulation, the multiple units on the ground can realize seamless connection between well operations and fracturing construction in the same platform, and improve the construction efficiency. Through platform digging and draining tank, to achieve the pressure after the centralized return of discharge, unified treatment, module capacity matching, the process of close connection, simple and flexible operation, high operating speed, smooth information transmission, the goal is to achieve batch, pipeline type factory operations.

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