New Horizontal Well Completion Technologies and Research Prospects in China

Xu Zhao 1,2,*
1Sinopec Research Institute of Petroleum Engineering, Beijing, 100101, China
2State Key Laboratory of Shale Oil and Gas Enrichment Mechanisms and Effective Development, Beijing, 100101, China

*Corresponding author e-mail: zhaoxu.sripe@sinopec.com

Abstract. Well Completion is an important work in the process of oil and gas well drilling, which is directly related to the development of oil and gas exploration effect and economic benefit. Petroleum Engineers in Foreign country attach great importance on the well completion technology, in recent years, well completion technology has development in the domestic too, especially the horizontal well completion technology had formed many mature technologies, particularly in the special reservoir sand control completion, unconventional reservoir fracturing completion, bottom water reservoir simulation completion, thermal recovery well completion, and smart completion, however, although these completion technology has made some progress, there is still a big gap that compare to completion technology in the foreign countries, that affected the yield and economic benefit of oil and gas wells to a certain extent. In this paper, this paper introduces the present horizontal well completion technology at home and abroad, and analyzing well completion technology difference between the domestic and foreign, discussesing the future research direction of well completion technology.

1. Introduction

Well completion engineering is a relatively independent work linking drilling engineering and production engineering, which combines engineering, geology and exploration. Well completion quality has a decisive effect on the economic benefits of oilfield development and also determines whether well production can reach its expected targets. In recent years, many major oil and gas fields at home and abroad have gradually entered into the deep development stage and many unconventional reservoirs like shale gas also launched large-scale development. Under this background, horizontal well completion at home and abroad has received great attention and achieved rapid development. In order to develop hydrocarbon resources to the maximum extent, many advanced horizontal well completion tools and instruments have been developed successively, forming a series of new completion technologies, such as sand control completion for high-end horizontal wells, multistage fracturing completion, self-adaptive inflow control, and complex thermal recovery well completion. This field has developed into one independent subject. High attention shall be paid to horizontal well completion technology to satisfy oil and gas production demands, protect the reservoir and prolong the life of oil and gas wells as far as possible.
2. Importance and selection basis of horizontal well completion technology

Horizontal well completion technology is the key technology that directly affects the development benefits of oil and gas wells, and it is directly related to the effect and economic benefits of oil and gas exploration and development. Selecting right and suitable completion mode and completion parameters directly determines the future development and production. The practice shows that the completion method and the matching completion technology, which are suitable for the geological conditions and fluid properties of the oil and gas field, can not only significantly improve the production capacity of oil and gas wells and efficiently develop oil and gas fields, but also reduce the direct oil and gas production cost, prolong the life of oil and gas wells, and use low investment to achieve more production. To select an appropriate well completion system, sufficient information about geological characteristics of oil and gas fields, properties of formation fluids, production technologies to be used shall be learnt, and the advanced well completion system design software shall be applied to carry out comprehensive optimization design and propose a suitable and efficient well completion method. In addition, as launching large-scale development of unconventional oil and gas reservoirs represented by shale gas, horizontal well completion technology has increasingly attracted more attention and become a hot spot in the industry. Selection and design of completion methods is the core link in the process of well construction since reservoir, geology, drilling and oil recovery should all be designed and implemented based on the requirements of completion [1].

3. Current situation of horizontal well completion technology

In recent years, for influences from the continuous development of foreign drilling and completion technologies, the rising price of crude oil and the large-scale development of unconventional reservoirs, many advanced horizontal well completion tools and instruments have been developed successively in order to develop hydrocarbon resources to the maximum extent, forming a series of new completion technologies such as sand control completion for high-end horizontal wells, multistage fracturing completion, self-adaptive inflow control, and complex thermal recovery well completion [2-3].

3.1. Sand control completion

Some new technologies have been developed for horizontal well sand control completion in recent years, including “mud cake” cleaning technology, screen top cementing technology, casing-outside gravel packing sand control technology.

3.2. Mud cake cleaning technology in horizontal section

The development of “mud cake” cleaning technology in horizontal section promotes the wide application of screen completion, which has changed the previous practice of conducting casing perforation first and then implementing casing sand control. It has greatly reduced completion cost and development effects.

The horizontal well “mud cake” cleaning is to install a wash-down valve at the bottom of screen, and to insert an intubate with the tubing into the wash-down valve to connect it to the outside of the screen. The acid is replaced into the annulus between the screen and the open hole by inverse well flushing; then the “mud cake” will be dissolved and then returned together with cuttings through from the wash-down valve and the tubing. The formula of acid should be selected according to formation lithology and mud composition. In order to prevent acid from flowing back into the screen, a number of drag devices should be installed on the inner string of the screen to ensure the effect of well cleanup.

3.3. Screen top cementing technology

The screen top cementing technology is to run screen and casing above it into the hole together, and then conduct cementing on casing above the screen. The same inside diameter of the screen and the casing makes it convenient for later operations. Staged collar, external casing packer and blind ram are installed between casing and screen. Firstly, pressurize and set down the external casing packer.
Then, build the pressure to open the staged collar to conduct cementing on upper casings. After cementing, rubber plug is used to close the staged collar. Finally, the rubber plug and the blind ram will be drilled for production.

In recent years, the plug-drilling-free screen top cementing technology has been developed in order to avoid drilling plugs, and fishable tubing plug is used to replace the blind ram. After cement injection, what have to do is to fish out the rubber plug and the fishable tubing plug, and therefore, the casing damage caused by drilling plugs is avoided.

3.4. Casing-outside gravel packing Sand control technology in horizontal wells

Gravel packing has the advantages of good sand control effect and long validity period, but the characteristics of α wave and β wave filling in horizontal well may result in problems of complex process, low packing rate and easy sand plugging. The diverting screen technology developed by Schlumberger can continue to fill through the diverting tube even in sand plugging, and the horizontal well reverse gravel packing sand control technology developed in China in recent years, that is same with cleaning strings in horizontal section, can fill the horizontal section from toe to root through the bottom wash-down valve by direct circulation after removing contaminated mud by acid cleaning in horizontal section. Both technologies are simple and reliable, and can greatly reduce construction risk.

![Figure 1](image1.png)

**Figure 1.** Sketches of new sand control technologies for casing-outside gravel packing

3.5. Fracturing completion

In recent years, along with the large-scale development of low-permeability and difficult-to-produce reserves represented by shale gas in China, it is urgent to improve the production per single horizontal well to further improve the development effect and productivity of horizontal wells. Keeping in step with the rapid development of staged fracturing completion technologies in horizontal wells, at present, the mature staged fracturing processes and supporting tools have been developed at home and abroad for various completion methods such as open hole, screen and casing. Among them, the main technologies mainly include the following five types [4]:

![Figure 2](image2.png)

1. Upper joint  2. Outer cylinder  3. Inner sleeve  4. Ball seat  5. Anti-back snap spring  6. Lower joint

**Figure 2.** Structural diagram of ball-dropping sliding sleeve
3.5.1 Open hole packer + sliding sleeve staged fracturing technology

In recent years, the staged fracturing completion in open hole horizontal wells has been developed most rapidly. At present, a variety of open hole packer + sliding sleeve stage fracturing technologies have been formed. 1) One-ball one-stage open hole packer + sliding sleeve staged fracturing technology. This technology opens one sliding sleeve by dropping one ball, and it adopts open hole packer + sliding sleeve staged fracturing. The main technical features are: ① RIH all fracturing string in one-time, and the fracturing string also serve as the production string; ② open hole differential pressure or expansion packer is used to seal the fracturing section; ③ no string movement; drop the balls from small to large diameter in sequence to open the sliding sleeve and fracture the well stage-by-stage; one ball will open one sliding sleeve; ④ after fracturing, all the stages shall be produced in a commingled way. By applying this technology, the fracturing of 40 stages is successfully realized abroad. At present, the ball gap difference reaches 1/16″. In theory, the 7″×41/2″ tool can fulfill the staged fracturing of 44 stages, the 95/8″×51/2″ tool can realize the staged fracturing of 60 stages, and the packer has the pressure difference of 70.0 MPa, and temperature resistance of 204 °C. Due to simple operation and high reliability of this technology, major domestic oil companies have already initially mastered this technology, but there is still a gap on the number of stages and the supporting capacity of tools. 2) One-ball multi-stage open-hole packer + sliding sleeve staged fracturing technology

In addition to characteristics of the conventional open-hole packer + sliding sleeve staged fracturing technology, this technology is featured by opening a plurality of fracturing sliding sleeves with one ball. The QuickFRAC technology of Packer Plus can open 2-5 sliding sleeves with one ball, and it has achieved 60 stages of fracturing with 15 times of ball injection; each stage is isolated by RockSEAL II packer. Halliburton’s RapidFra fine fracturing technology opens up to six sliding sleeves theoretically for a fine fracturing of 90-point. At present, domestic large oil companies such as PetroChina and Sinopec have already started the research on this technology, and initially carried out field test and application.

3.5.2 Pump down drillable bridge plug staged fracturing technology

Pumping down drillable bridge plug staged fracturing technology is a staged fracturing technique with limitless stages, and is suitable for casing completion. Perforating gun, setting tool and bridge plug are mainly pumped into the well by means of cable. After the bridge plug is set, the perforating gun is picked up to complete the perforation, and the perforating gun is pulled out of hole on cable. All fracturing staged shall be treated in the same way. After the operation is finished, all bridge plugs will be drilled out with milling tools, leaving a smooth wellbore. Its technical features are: ① tool string is pumped into the well; ② fixed-point fracturing; ③ limitless number of stages, and the large flowrate, large-scale fracturing is doable; ④ a smooth wellbore is left after fracturing, which is convenient for the late period management. Foreign companies such as Halliburton, Baker Hughes, Schlumberger, and Weatherford have mastered this technology, and major domestic oilfields and research institutes have also carried out technical research on this technology in recent years, and entered the mature development stage. At the stage, the gap with foreign technology is narrowed. By using this technology, the current record of staged fracturing is 42 stages, the maximum pressure difference of bridge plug is 103.4 MPa, and the maximum temperature is 232 °C. Matching tools have been developed in serial and can meet the needs of staged fracturing in wellbore of 41/2″, 51/2″, 7″, etc. Because this kind of fracturing can realize limitless number of fracturing stages, and the effect of fracturing can be secondarily regulated with clustered perforation technology, this technology is the most commonly used completion method in shale gas horizontal wells.

3.5.3 Intelligent switchable staged fracturing sliding sleeve tool

The technology is to RIH the multi-stage sliding sleeve tool and casing during the process of completion, and the adjacent two sliding sleeves are connected by a pressure control line; once the fracturing on the lower stage is finished, a dart will be casted and landed on the sliding sleeve while displacement. Meanwhile, the pressure is transmitted to the upper sleeve through the control line, and the plunger compression ring is activated to form a dart base, and then dart with the same size will be
injected to fracture all stages successively. Its technical features are: ① the same drift diameter of the fracturing string; ② the number of fracturing stages is limitless; ③ the dart can be dissolved, and it does not affect the drainage; ④ C ring is easy to drill and can be switched using coiled tubing. Currently, it can fracture in 13 stages at most.

3.5.4 Switchable sliding sleeve staged fracturing technology

In order to facilitate the later production management, the staged fracturing technologies with the switchable sliding sleeve have been developed, including the full-bore switchable sliding sleeve staged fracturing technology and the ball injection repeated switchable sliding sleeve staged fracturing technology.

1) Full-bore switchable sliding sleeve staged fracturing technology

The main feature of this technology is that the size (i.e., the drift diameter) of the sliding sleeve is identical to that of the completion string, and special tool shall be used to open the sliding sleeve to conduct fracturing and production management.

2) Ball injection repeated switchable sliding sleeve staged fracturing technology

The main feature of this technology is that the staged fracturing can be realized through dropping a ball to open the sliding sleeve. The ball seat and ball can be milled, and the switching tool can be RIH to switch off the fracturing sleeve against the unwanted pay zone, and realize the fracturing and production management of all stages.

3.5.5 Coiled tubing hydrojet perforation annulus sand fracturing technology

This technology combines the coiled tubing with the hydrojet perforation. It uses the hydraulic jet to carry out sand blasting perforation, and sand fracturing is conducted through the casing-coiled tubing annulus. In the late period of fracturing, a forced screen out is realized to form a sand plug to isolate the fractured stage. Pick up the coiled tubing to carry out sand blasting perforation in the next stage, and then this stage will be fractured through the annulus. Repeat the above steps until all stages are fractured. It is represented by Halliburton's CobraMax H technology, and has been mastered by many domestic and overseas oil companies and research institutes. The technical features are as follows: ① the downhole tool is simple and easy to operate; ② the wear of coiled tubing is small; ③ the number of stages is limitless, and flowrate and sand volume are large; ④ wellbore nearby fracture conductivity is high. This technology has been used successively to conduct 43 stages of fracturing in 4.5" casing with the depth of 9100 ft (MD)/5600ft (TVD) and horizontal section length of 2,900 ft.

3.6. Water control completion

Due to its large oil drainage area and high sweeping coefficient, horizontal well is widely used in the development of edge and bottom water reservoirs, and has achieved some application effects in many oilfields. With increasingly deep development of various oil and gas fields at home and abroad, the horizontal well water control and completion technology has been rapidly developed. At present, several water control and completion technologies have been formed at home and abroad, such as staged variable density perforation, flow adjustment and water control completion technology, mandrel water control and intelligent water seeking/plugging [5-12].

3.6.1 Staged variable density perforating technology

The staged variable density perforation in horizontal well is mainly optimized on the basis of conventional horizontal well staged perforation technology. Aiming at the heterogeneity of reservoirs, it uses variable density perforation and staged process to change the parameters of perforation unit, and dead section will be left to control the edge and bottom water. Its main features are: high design requirements on perforation parameters, adjustment on the inflow pressure drop of wellbore nearby, simple operation, reservoir sealing, and high requirements on cementing quality. Because the staged variable density perforation in horizontal well renders lower requirements on operation conditions and tool matching, this technology has been widely applied at home and abroad. However, since the reservoir adjustment is realized by the optimization of perforation parameters, the adjustment accuracy is poor, and the effect on water control of complex reservoirs is limited.
3.6.2 Flow adjustment and water control completion technology

Horizontal well flow adjustment and water control completion technology is to install the downhole inflow control device to control the inflow of edge and bottom water effectively. According to the fluid inflow control modes, it can be divided into: inflow control device (ICD), inflow control valve (ICV) and adaptive inflow control device (AICD):

1) Inflow control device (ICD)

The inflow control device is a throttling device that creates additional pressure differential when the reservoir fluids flow into the wellbore through this device. By adjusting the type of throttling device to increase the additional production pressure drop of the high-permeability section (reducing the effective production pressure drop) and to reduce the production pressure drop of the low-permeability section (increasing the effective production pressure drop), it is able to eliminate the gas/water coning caused by reservoir heterogeneity and the heel-toe effect, so that the horizontal well production liquid profile is balanced, and the oil-water interface is uniformly raised. Major oil companies at home and abroad have independently developed different types of inflow control devices. According to different throttling methods, they can be divided into three categories: spiral ICD, nozzle ICD and flow path ICD. In addition, the special ICD with spring and slip block has also been proposed, but the application is limited. Because the inflow control device realizes the throttling through adjusting the passage of fluids, it is generally connected with the screen, which is usually called the flow adjustment water control screen. Such screen has been widely used at home and abroad. In recent years, the flow adjustment water control screen completion technology has been widely applied for its low cost, simple operation and good water control effect.

2) Inflow control valve (ICV)

Since reservoir properties and phase (oil, gas and water) saturation change over time, it is desirable to have a downhole flow control technique with post-regulation capability that can be automatically adjusted based on actual inflows. The intelligent well technology that emerged in the 1990s provided a means to solve this problem. One of the key components in intelligent well technology is the inflow control valve (ICV).

The working principle of the ICV is equivalent to one downhole nozzle, and the flow rate of each section is adjusted by downhole throttling, thereby the purposes of adjusting the inflow profile and delaying water breakthrough can be realized. In addition to downhole installed inflow control valve, a complete ICV system shall be equipped with pressure/temperature sensors to monitor and analyze the downhole production status in real time, and then transmit the resulted control information to downhole control unit to adjust the ICV through the control mechanism.

Several major foreign oil companies can offer different types of ICV. The most advanced electronically controlled “infinite” adjustable ICV combined with position sensor can provide valve position control of over 100 opening degrees; the simplest ICV owns the limited discrete valve positions or only two positions of opening and closing. ICV is typically powered by the hydraulic, electric or electro-hydraulic system. At present, the hydraulic control technology is relatively mature, and one hydraulic system can control up to 8 ICV. Compared with ICD, ICV is an “active control” device. After well completion, according to changes on downhole production status, the opening degree of ICV can be adjusted timely through the surface control system to achieve the purpose of real-time production optimization. Compared with other downhole inflow control devices, ICV is more suitable for dealing with the impact of uncertainties from reservoir properties in the production process. It owns more flexible development method, and has good adaptability in low permeability formations. It has strong acidizing/fouling treatment capacity and good water control effect, and is able to realize the optimal production of heterogeneous reservoirs or multi-lateral well. However, ICV is inferior to ICD in terms of long-term reliability and control scope.

3) Adaptive inflow control device (AICD)

The conventional ICD does not have the late period adjustment capacity, but the ICV is expensive, and its long-term reliability and control range are limited, which are only suitable for oil and gas wells with high output and long production cycle. Therefore, it is desirable to develop a kind of water control device that can evenly control the liquid in the early stage, and realize water blocking-oil
recovery in the late period. In order to solve this problem, major oil companies at home and abroad have provided different types of AICD. Technically, by means of materials, spring, sliding block, etc., such devices are able to achieve the high resistance to water/gas and low resistance to oil. The typical AICD devices are RCP valve developed by Statoil, which relies on the “floating disk” to block water and stabilize oil, and the AICD developed by Halliburton, which relies entirely on “flow path conversion” to block water and stabilize oil. Both adaptive fluid control devices have taken a field application, and some effects have been achieved. At present, the adaptive inflow control device is still in the R&D and testing stage. The adaptive, low cost, high intelligence and high reliability will be the development trend of the adaptive inflow control device in the future.

3.6.3 Central tube completion water control technology

Central tube completion is to insert a tubing string (in most cases, with a packer) smaller than the wellbore diameter into the conventional completion wellbore. After the central pipe is inserted, the horizontal section can be divided into several parts according to the liquid production, and the fluid flowing inside the wellbore also changes into three parts, namely: flowing in the annulus, flowing in the wellbore, and flowing inside the central tube. During conventional completion, due to reservoir heterogeneity and wellbore pressure drop along the horizontal section, the inflow profile is severely uneven. The central pipe completion is to reduce the pressure drop of the high permeability section and re-match the inflow pressure drop in the central tube, making the entire inflow profile more uniform. Because the central pipe completion process is simple, cost-saving, convenient, and there is no special requirement on the tools, it is one of the most commonly used secondary completion methods for water control completion at home and abroad. However, the fluid control accuracy of this technology is poor, and the requirement on design accuracy is high; Therefore, its water control effect is limited.

3.6.4 Intelligent multi-layer water seeking/blocking and completion technology

“Intelligent multi-layer water-seeking/blocking technology” is to block various layers of the well with a water-blocking packer, and a set of intelligent switch will be installed against each target zone. The switch can automatically open or close oil layer according to the preset time sequence during water seeking/blocking process. It eliminates the complicated operation on the ground, enables the water seeking/blocking in oil well, and realizes the purpose of selective production and water reducing-oil increasing. The main features of this technology are: ① implement all measures with one trip operation: water seeking, water blocking, testing, production and other processes; ② automatic water seeking/blocking: advanced micro-processing technology is adopted, and the downhole switch is automatically activated according to the predetermined procedure to open and close the layer; ③ multiple-layer adjustment is available: in the normal production, the layers can be adjusted several times according to the production situation of the well, and the only ground operation is to build up the pressure; it eliminates the trip operation of instrument or string operation; ④ it realizes the downhole zonal pressure test: it is able to conduct long-term testing on pressure and temperature changes of the horizon, which has important guiding significance for understanding reservoir properties. At present, the technology has been applied in nearly 10 wells in China.

3.7. Thermal recovery well completion

Because of high temperature and high pressure of the injected steam, the heat loss of the wellbore is obvious, and the damage to the casing and cement ring is severe. During steam injection after well completion, it is necessary to take some wellbore insulation measures to avoid the high-temperature steam contacting with casing directly, but it also brings problems such as large workload and poor insulation reliability. In recent years, the insulated casing completion technology has been developed, which replaces the conventional casing with double-layer vacuum insulation casing during completion, so that the problem of wellbore insulation in the production period is solved effectively. It directly injects steam from the casing, and produces oil from the tubing, which simplifies the thermal recovery process and improves the insulation reliability significantly.
4. Future research direction of horizontal well completion technology

In recent years, horizontal well completion technology in China has made great progress, but still cannot meet the needs of oilfield development. For example, no effective breakthrough has been made in ultra-long horizontal section gravel packing technology, high grade lateral horizontal well completion technology, high-end self-adaptive inflow control completion technology, and intelligent completion technology. The innovative technology is still absent in horizontal well multistage fracturing. The completion cost of thermal recovery wells is still very high, and completion tools for high temperature, high pressure, and high sour oil and gas wells are almost imported ones. Therefore, technical index of horizontal well completion technology needs to be further improved. Furthermore, new completion methods and completion technologies have to be developed in view of the problems existing in the development process, while considering field development demands, so as to reduce the comprehensive development cost and improve the development effect.

1) More attention should be paid to well completion engineering, and the close cooperation among geology, reservoir and engineering should be actively promoted, so that the single completion can be developed into systemized system of drilling, well completion and oil recovery. As for the thinking prospect, our consideration shall extend from individual well completion to long-term benefits, and the well completion design needs to take into account the later oil recovery.

2) For ultra-long horizontal wells in unconsolidated sand reservoirs, such as Sinopec’s heavy oil blocks in Colombia and Venezuela, where the horizontal section has reached 800-1000m long, it is necessary to study gravel packing technology, segmented gravel packing technology and anti-pollution packing technology in ultra-long horizontal wells in view of sand plugging and reservoir pollution.

3) Among horizontal well water control completion technologies, the ICD water control completion, the ICV water control completion, and the central secondary inflow control completion have better application prospects. However, the current horizontal well water control completion technologies are not sophisticated in theory, and the new self-adaptive inflow control completion tool is still in the stage of experimental development. Besides, most completion technologies still stay in a non-intelligent state in field promotion. The future horizontal well water control completion technology will develop towards the direction of intelligent, low cost and highly reliable self-adaptive inflow control, which will make horizontal well water control completion technology enter a new stage.

4) For horizontal well perforation, it is necessary to promote staged perforation with variable parameters in order to prevent bottom water if any and to ensure balanced drainage when there is no bottom water. For the reservoir without bottom water, by implementing well equalizing flowing completion technology, the fluid production efficiency and economic benefits can be improved, and the oil production by water injection in the later stage can be promoted. For the reservoir with bottom water, by implementing well equalizing flowing completion technology, the bottom water coning can be delayed and controlled, and the water free recovery and economic benefits can be improved.

5) In view of the low production of oil and gas wells in China, low cost intelligent completion technology should be developed. By developing the integrated measurement, control and transmission reusable downhole measurement and control valves, the cost of intelligent completion can be greatly reduced, and the development effect and development level can be improved.

6) In the completion technology of horizontal wells for thermal recovery in heavy oil reservoirs, the existing heat insulated casing completion and sand control completion should be integrated, and the main contradiction in the development process should be solved as far as possible. The technologies of horizontal well uniform steam injection completion and offshore thermal recovery completion should be developed according to the characteristics of thermal recovery.

7) For multistage fracturing completion in horizontal wells, while popularizing and improving existing completion technologies, such as pumping bridge plug and multistage ball sliding sleeve, the intelligent switchable staged fracturing slide sleeve tools, large-diameter fracturing sliding sleeves and fracturing pumping bridge plugs should be developed and realize manufacturing in China in short term. At the same time, the innovative research of the horizontal well segregated completion technology
using downhole robot should be strengthened. The function of staged fracturing and water control can be realized by making use of the downhole robot to switch on/off the preset sliding sleeves.

8) In order to further enhance the oil recovery and reduce the development cost of thin oil maturing fields, the technology of layer mining completion can be developed. In order to reduce the cost and improve the reliability, the existing downhole packer is replaced by preset layering tool to realize separate layer recovery, separate flood and separated layer stimulation.

5. Conclusion

As major oil and gas fields have gradually entered into the deep development stage and the large-scale development of unconventional reservoirs represented by shale gas has been launched, the higher requirements have been proposed on horizontal well completion technologies. However, horizontal well completion technologies in China still cannot meet the needs of oilfield development at this stage. Therefore, new suitable horizontal well completion and auxiliary technologies shall be developed. First of all, enough attention should be paid to well completion, and the close cooperation among geology, reservoir and engineering should be actively promoted, so that the single completion can be developed into systemized system of drilling, well completion and oil recovery. The effect of well completion parameter optimization and completion technology optimization on the whole drilling and completion should be attached importance. Besides, we should increase investment in manpower and material resources and strive to break through technical difficulties to innovatively develop a series of staged fracturing and advanced intelligent water control completion tools with independent intellectual property rights, and to form a complete set of supporting application technologies. Thus, the field application of completion tools in China can be changed from “follower” to “leader”. At last, aiming at horizontal wells problems of relatively low production period, relatively short stable production life, and relatively high maintenance cost existing in China, it is suggested that the secondary completion technology with high intelligence, low cost and strong adjustment ability should be studied in depth, and the corresponding completion tools and supporting technologies should be developed as well, especially new completion tools for horizontal wells, such as horizontal well segregated completion robot, self-adaptive inflow control device, intelligent multi-stage sliding sleeve and self-regulating expandable screen, so as to improve the production capacity and the overall economic benefits.

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