Energy Proceedings
Vol 33, 2023
ISSN 2004-2965

Research and application of coiled tubing gas injection completion technology in Changqing Oilfield

WANG Zaiqiang[1,2]，LIU Zhongneng[1,2]，REN Yong[1,2]，WANG Shangwei[1,2]，LUO Yougang[1,2]，LIU Jiangbo[1,2]

1 Oil and Gas Technology Research Institute，Changqing Oilfield Company，Xi'an，Shaanxi 710018，china

2 Engineering Lab of Exploratory and Development in the Low Permeability Oil and Gas Field，Xi'an，Shaanxi 710018，China
(Email: wzaiq_cq@petrochina.com.cn)

ABSTRACT

In view of the common problems of CCUS injection wells, such as casing pressure, difficulty in maintenance and high cost, in order to improve the wellbore integrity of injection wells and reduce comprehensive costs, the research and test of coiled tubing gas injection completion technology were carried out. By optimizing the stainless steel coiled tubing for well completion, the string can resist the corrosion of downhole long-term acidic environment, the leakage point is minimized, and the whole well completion under pressure can be conducted. A special gastight packer has been developed, which adopts a double rubber cylinder sealing structure. The gastight pressure bearing is 50MPa, and the unsealing tonnage is controlled below 8.0t, providing a means to solve the tripping problem caused by the low tensile strength of coiled tubing. Large diameter coiled tubing hanger, metal auxiliary sealing device, dual function safety release and gas seal connector are designed to meet the comprehensive requirements of the overall sealing performance of the gas injection string and the later operation under pressure. On this basis, a new process test was carried out for the first well of coiled tubing gas injection in Changqing Oilfield. It only takes 2.5 hours to lower the tubing string to the design depth. The testing of the large diameter coiled tubing hanger and metal auxiliary sealing device at the wellhead was normal, and the setting and verification of the gas seal packer were successful once. The success of this test provides a new solution for the completion of CCUS injection wells, which is of great significance in improving the integrity of injection wells, realizing safe gas injection throughout the life cycle of injection wells, and building Changqing Oilfield into the largest CCUS industrial base in China. It has a very broad application prospect.

Keywords: Coiled tubing gas injection,wellbore integrity,gas injection string,gas seal packer,large diameter coiled tubing hanger

NONMENCLATURE

Abbreviations	
CCUS	Carbon Capture Utilization and Storage

1. INTRODUCTION

In recent years, Changqing Oilfield has actively promoted the coordinated development of carbon dioxide emission reduction and efficient oilfield development, vigorously tackled the key CCUS technology, and exploredthe road of green and low-carbon development of low permeability reservoir. In November 2018, the experimental scale of "9 Injection and 37 Mining" was completed, and in December 2020, the national CCUS demonstration project was completed. With the continuous injection of CO_2, casing pressure of gas injection Wells becomes increasingly prominent, and problems such as high pressure, corrosion and perforation of the old shaft, casing damage control need to be solved. Meanwhile, pressure relief is difficult in late maintenance of gas injection Wells, and pressure operation is difficult and costly, which is recognized as a technical problem in the field of enhanced oil recovery at home and abroad. Facing the severe technical challenge, the research and test of continuous pipe gas injection completion technology are carried out.

This is a paper for International CCUS Conference 2023 (ICCUSC2023), April 14-15, 2023, Beijing, China.

2. RESEARCH WORK CARRIED OUT

2.1 *Material selection of continuous pipe*

A new gas injection process for continuous pipe was proposed in view of the problems such as multiple wire connections, high leakage rate, high gas seal detection cost, and difficulty in drilling with pressure in the early stage of well completion. The 2205 stainless steel continuous pipe was selected as the completion pipe, which met the requirements of long-term downhole corrosion environment, reduced the leakage point to a maximum extent, and made it convenient and quick to run and complete the well with pressure. It provides the overall gas sealing performance and service life of the tool; In order to deal with the characteristics of weak tensile strength of continuous pipe, the distribution position of anchoring and sealing mechanism is carefully designed to optimize the force of central pipe and the size of pin, and reduce the unsealing tonnage to the greatest extent.

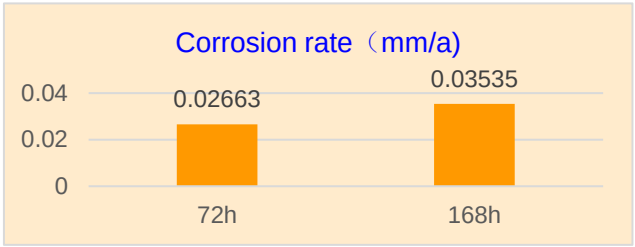

Fig.1. Corrosion rate test results of 72h and 168h

Fig.2. Shematic diagram of gas seal packer for continuous pipe

The gas sealing performance and unsealing performance laboratory tests were carried out around the gas seal packer.

Test conditions: gas seal test system, gas cylinder, data acquisition and monitoring system, as shown in FIG. 3, FIG. 4, FIG. 5.

Test pressure: Sealing pressure 50MPa, and unsealing tonnage test, as shown in Figure 6.

Test medium: compressed nitrogen.

Barometric test standard: API Spec 6A wellhead and tree test specification.

parameter	Yield strength （MPa）	tensile strength （MPa）	elongation （%）	yield load （t）	internal yield pressure （MPa）	torsional yield strength （N m）
2205 stainless steel continuous pipe	610	782	36.3	31.219	81.5	3875.1
80Ksi steel grade r equirements	⩾552	⩾620	⩾25	/	/	/

TBL.1.The mechanical property parameters of 2205 continuous pipe

temperature ℃	total pressure Mpa	CO_2 partial pressure Mpa	flow rate m/s	test time h
95	20	20	1.5	72、168

TBL.2.CO_2 injection operation 2205 continuous pipe simulated corrosion test

technical guarantee for improving wellbore integrity and extending string life of gas injection well. TBL.1 shows the mechanical property parameters of 2205 continuous pipe. TBL.2 and FIG.1 show the simulated corrosion test results of 2205 continuous pipe during CO_2 injection.

2.2 Research and development of key tools

A gas seal packer for continuous pipe was developed (FIG. 2), and bidirectional anchoring enhanced the creep resistance of the string. 13Cr material is preferred for rigid body to ensure the anti-corrosion effect. The external design of two sets of rubber cylinder, the use of "three rubber cylinder combination + expansion ring + copper bowl protection" structure, the internal use of "metal + rubber" composite sealing way, greatly improve

Laboratory tests show that the maximum atmospheric sealing capacity of the packer is 53.91MPa and the unsealed tonnage is 6.99t, which meets the technical requirements of the design.

Fig.3. Gas seal test system

Fig.4. Gas cylinder

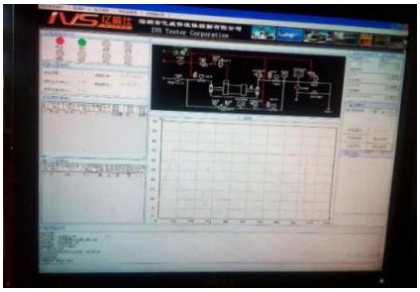

Fig.5. Data acquisition and monitoring system

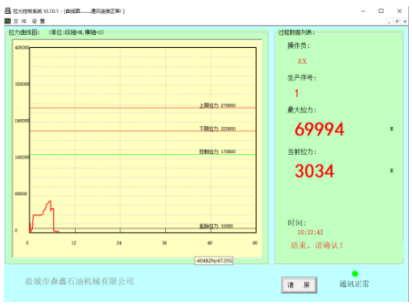

Fig.6. Unsealing tonnage test

2.3 Wellhead device and other supporting equipment

In order to cooperate with the field application of continuous pipe gas injection string in injection Wells, a large-diameter continuous pipe hanger and a metal-assisted sealing device (as shown in FIG. 7 and FIG. 8) were developed, and tools such as gas seal connectors and dual-function safety release were designed to optimize the length of tool string and meet the overall sealing performance of coiled tubing gas injection string and the comprehensive requirements of late pressure operation.

2.4 Field test

The test well was a renewal injection well in the Yellow 3 area with a three-way structure. The completed formation length was 8 and the drilling depth was 2,870m. Construction procedure: through-well - wash - pressure test - perforation - lower fracturing drilling - acidizing - shut-in, blowout and drainage - drilling - lower continuous pipe gas injection string - completion and injection. Perforating interval: 2800.00-2813.00m, 2819.5-2826.0m; Measures: compound perforation + acidizing, acid content: 35m^3.

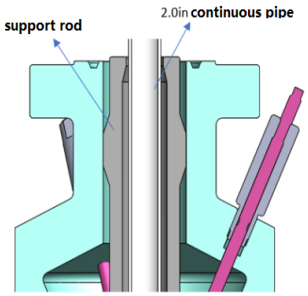

Fig.7. Large diameter continuous pipe hanger

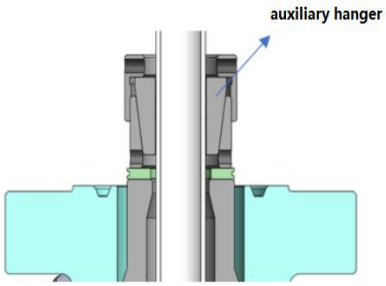

Fig.8. Metal auxiliary sealing device

Completion: Complete the ball-through test, test pressure, and install continuous pipe connectors to connect downhole tool strings through the press and straightener. The string combination is: bell + shear ball seat + gas seal packer + dual-function safety release + connector +2205 continuous pipe. The completion string is lowered to the intended position, 2775 m packer position. The string was placed in the well for 2.5 hours, 35m3 of annulus protective fluid was injected, 28mm steel ball was injected, packer setting pressure was 24MPa, ball seat shear pressure was 30MPa, annulus pressure was 10MPa, pressure was stabilized for 15min, there was no pressure drop, seal test was normal, and the packer was successfully set and sealed once. The well head large-diameter continuous pipe hanger and metal-assisted seal were tested correctly, demonstrating the technical advantages of the continuous pipe and the good sealing performance of the overall string. Gas was injected normally. FIG. 9 shows the construction site of continuous pipe gas injection, FIG. 10 shows the 2205 continuous pipe used in construction, and FIG. 11 shows the completion wellhead of continuous pipe gas injection test well.

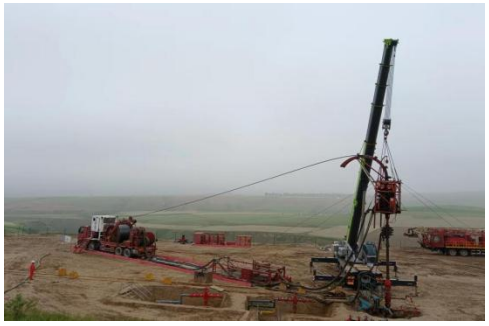

Fig.9. Continuous pipe gas injection construction site

Fig.10. 2205 continuous tube

Fig.11. Test well completion wellhead

3. CONCLUSIONS

(1) The stainless steel continuous pipe is preferred for injection well completion to meet the requirements of long-term downhole corrosion environment, minimize the leakage point, and can be killed throughout the well completion operation.

(2) Developed supporting tools such as gas seal packers for continuous tubing, large-diameter continuous tubing hanger, metal auxiliary sealing device, etc., to meet the overall sealing performance of coiled tubing gas injection string and the comprehensive requirements of late pressure operation.

(3) Continuous tube gas injection completion technology provides a new solution for CCUS injection well completion, which is of great significance for improving wellbore integrity and realizing safe gas injection throughout the life cycle of the injection well.

DECLARATION OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. All authors read and approved the final manuscript.

REFERENCE

[1] ZHENG Wei. Analysis of main failure forms and cause s of coiled Tubing [J]. Science and Technology Innovatio n, 2019(11):32-33.

[2] LV Zhanchun. Application of coiled tubing technolog y in downhole operation [J]. Petrochemical Technology, 2019, 26(2): 42,64.

[3] Xian Ning, Zhang Ping, Rong Ming, et al. Research pr ogress on fatigue life of coiled tubing in acid environme nt J]. Natural Gas & Oil, 2019，37 (1) : 63-67.

[4] WANG Jianjie. Coiled tubing technology in oilfield do wnhole operation under new situation [J]. Shandong Ind ustrial Technology, 2019(3):90.

[5] XU Xueli, WANG Tao, YU Han, et al. Friction and Wea r Properties of CT80 Tubing at Low Friction Velocity [J]. L ubrication Engineering, 2019, 44(2):66-71.