Application Research on Liner Tube without Variable Diameter of Shale Gas Plunger Gas Lift Wellhead

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Abstract. Given that there is variable diameter in the shale gas plunger gas lift wellhead, which causes that the plunger cannot run up and down the gas well wellhead, affects the effect of plunger drainage gas production, the paper carries out research on liner tube without variable diameter of the shale gas plunger gas lift wellhead and installation methods, makes the diameter of the gas well wellhead consistent with that of the oil pipe, ensure that the plunger can be open up and down the wellhead of the Christmas tree, facilitate the periodic inspection and replacement operation of the plunger, and reduces the cost of plunger salvage operations. The successful application of the process plan in the shale gas well ** has achieved good drainage gas production effect, truly solved the variable diameter problem of shale gas plunger gas lift wellhead, and achieved the goal of once and for all.

Keywords: Plunger drainage gas production; shale gas; liner tube.

1. State of Shale Gas Plunger Gas Lift Wellhead Process

For shale gas development, the key technology is factory fracturing, and shale gas wells need to be fractured to transform the reservoir before they are put into production. In order to simplify the construction process and save investment costs OF gas well, well completion usually adopts fractured wellheads, namely fractured wellheads are used below the 1# main valve and will not be replaced, while conventional wellheads are replaced above the 1# valve, as a result, there is clash between the production tubular column and the gas wellhead diameter at the Christmas tress wellhead.

Shale gas** well adopts KQ180/78-105EE class gas production wellhead (big cross, 1#, 4# main valve: 105MPa, main diameter 180mm; small cross 105MPa, 78mm diameter; big and small cross connect in the middle by 78-105 to 180-105 conversion flange). The structure of production pipe column from bottom to top: one φ88.9mm sieve pipe (has bell mouth) x2.95m + one φ93mm rupture disk x one 0.24m + φ88.9mm 2 7/8 "EU-P x 2 7/8 "NU-B variable buckle 1 x 0.20m + one φ88.9mm plunger working cylinder x 0.31m + four hundred and thirty-three 2 7/8 "NU chamfered oil pipe x 4136.41m.

The well adopts 2 7/8" oil pipe, and the gas production wellhead adopts Christmas tree with 180mm main diameter, there is variable diameter at the wellhead. For this type of shale gas well, the existing plunger gas lift process usually only considers whether the plunger can be successfully dropped into the wellbore without considering whether the plunger can reach the blowout prevention tube, thus affecting the drainage gas production effect of plunger, make the plunger cannot run up and down at the wellhead, which is not conducive to periodic inspection and replacement of the plunger, and once the plunger is stuck or is replaced or inspected, wireline work must be carried out to salvage the plunger, which increase the cost of construction operations.

2. Design of Liner Tube without Variable Diameter

In order to ensure that the plunger can be open up and down the wellhead of the Christmas tree, facilitate the periodic inspection and replacement operation of the plunger, ensure the drainage gas production effect of plunger, and truly solve the technical difficulties of variable diameter of shale gas plunger gas lift wellhead. The gas production wellhead experts of our company carried out technology study and designed a liner tube without variable diameter of shale gas plunger gas lift wellhead and installation process, completely solve the variable diameter problem of shale gas plunger gas lift wellhead and achieve the goal of once and for all.

2.1 Design of Liner Tube

In order to adapt to the diverse working structure of the Christmas tree, the liner pipe is designed as straight liner pipe I, perforated liner pipe II, straight liner pipe III and

bell mouth liner pipe IV, under the condition of ensuring the normal work of the Christmas tree, four sections of liner pipes are installed in the corresponding positions of the Christmas tree, as shown in Fig.1. The liner pipe is installed inside the channel of Christmas tree, achieve the same inner diameter of the production pipe column and the channel of Christmas tree, prevent the plunger from jamming when running up and down the wellhead, because the diameter of Christmas tress is much larger than the maximum outside diameter of the plunger, affecting gas well production.

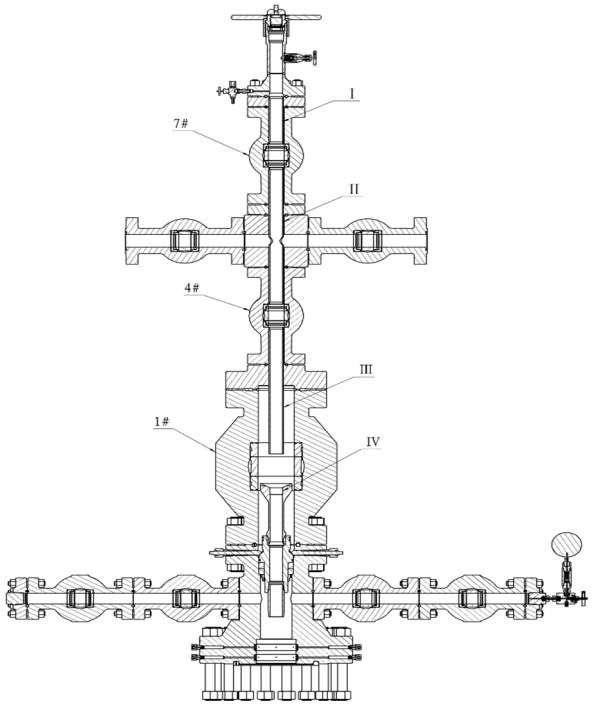

Fig.1 design diagram of the liner tube with variable diameter

The inner diameter of the production tubular column of the gas well is 62mm, and the maximum outer diameter of the plunger is 59.5mm, in order to achieve the same inner diameter of the production tubular column and the Christmas tree channel, and ensure the smooth work of the plunger up and down the wellhead, the inner diameter of liner is designed to be 62mm. In order to install the liner tube into the Christmas tree and ensure the strength of the liner tube, the outer diameter of the liner tube is 72 mm. For ease of installation and disassembly, each liner tube is installed on the threaded flange among valve bodies by threaded connection mode. When installing the liner, a certain distance is kept between the liner tube and the brake board to prevent the liner tube from affecting the normal use of the valve. Without affecting the normal work of the valve, the design length of the liner tube should be taken as round as possible in order to improve production efficiency.

The ends of liner pipe I, liner pipe II and liner pipe III are designed with 60° chamfer. The slight tilt will occur when the plunger moves up and down the wellhead, the ends of the liner tube are designed with 60° chamfer, when the plunger passes through the valve body, the plunger can smoothly enter the next liner by using the chamfer.

2.1.1. Design of Straight Liner Tube /

Straight liner pipe I is designed with a total length of 290mm and is installed to the upper flange of the 7# valve to the upper part of the valve plate. The inner diameter of the blowout prevention device is smaller than the inner diameter of the valve, in order not to affect the normal work of the blowout prevention device, the threaded flange is installed between the blowout prevention device and the 7# valve, and the installation thread of the liner pipe I is designed at the end. In order not to affect the normal on-off work of the 7# valve board, and ensure that the plunger can smoothly pass the valve, it is appropriate to minimize the distance between the liner I and liner II, the design spacing is 147.3mm. As shown in Fig.2, the liner tube I is installed in the threaded flange through the end thread, and the other end does not affect the normal work of the brake board.

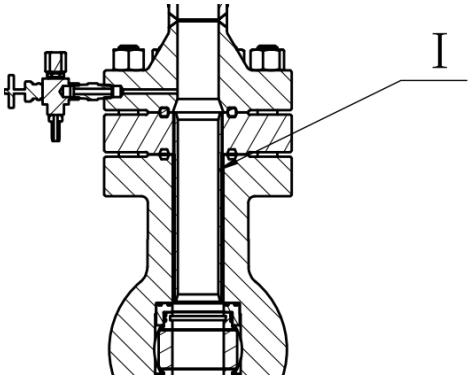

Fig.2 installation diagram of liner tube I

2.1.2. Design of Perforated Liner Tube II

The perforated liner II is installed from the lower part of valve seat 7 # to the upper part of valve seat 4 #. The liner tube II should not affect the normal on-off of the 7# valve board and the 4 # valve board, and the liner II should ensure that the plunger can pass through the valve smoothly, the spacing between liner tube II and liner tube I and liner tube III should be reduced as much as possible, the total design length of liner II is 835mm. For ease of the installation of liner II, the threaded flange is installed between the small cross and 7 # valve, and the installation thread of liner tube II is designed to be 225mm away from the upper end of liner II. Since the small cross channel is 449mm away from the upper end of liner tube II, a hole with diameter of 50mm is designed at 225mm away from the upper end of liner tube II to ensure that the produced fluid from the gas well can pass through the small cross channel smoothly. As shown in Fig.3, the installation position of liner tube II does not affect the normal work of valve 7 # and valve 4 #, and the small cross channel is opened to ensure that the liquid carried by the plunger can be sent out normally.

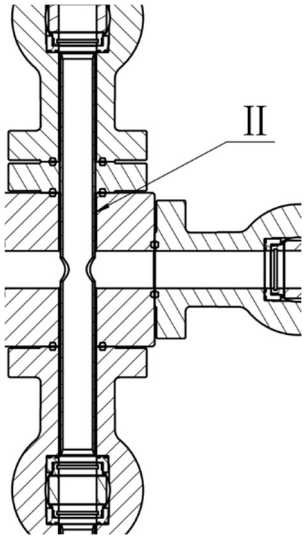

Fig.3 installation diagram of liner tube II

2.1.3. Design of Straight Liner Tube III

Straight liner III is installed from the lower part of valve seat 4 # to the upper part of valve seat 1 #. After liner tube III was installed, the normal on-off of 4 # board valve and 1 # board valve will not be affected, and liner tube III needs to ensure that the plunger can pass through the valve smoothly, the distance between liner III and liner II and liner IV should be reduced as much as possible, the total design length of liner III is 775mm. For ease of the installation of liner tube III, liner tube and thread are designed in the transformer flange, which is installed between 4 # valve and 1 # valve, the installation thread of liner tube III is designed to be 230mm away from the upper end of liner tube II. As shown in Fig. 4, the installation position of liner III does not affect the normal operation of valve 4 # and valve 1 #.

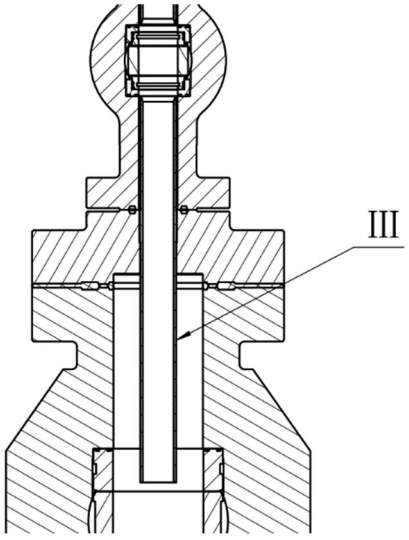

Fig.4 installation diagram of liner tube III

2.1.4. Design of bell mouth Liner Tube IV

The bell mouth liner tube IV is installed under the valve seat of 1 # valve to the oil pipe hanger. The lower end of liner IV is designed with tubing joint NU/EU thread to facilitate the connection of tubing hanger, and the position of liner IV should not affect the normal on-off of 1# valve ram, the total design length of liner tube IV is 379mm. Since the valve seat of 1# valve seat is larger than that of other valves, the installation space between liner tube IV and liner tube III is larger than that of other liner tubes, therefore, liner tube IV is designed to be bell mouth, so that the plunger can be reset in the inclined state by using the liner tube IV bell mouth slope, prevent the plunger from flying out of the liner tube due to inclination and getting stuck in 1 # valve, and ensure that the plunger can enter liner tube IV smoothly. Since the inner diameter of 1# valve channel is 89.5mm, the maximum outer diameter of the bell mouth is designed to be 80mm, while facilitating the installation of liner tube IV in 1 # valve, it ensures that the plunger can reach the bell mouth of liner tube IV even if it is tilted to the maximum angle, and it can be reset smoothly to enter to liner tube IV. The external part of bell mouth and the middle part of the liner tube are designed to be 60° chamfer, which reduces the weight of liner tube IV and weakens the stress concentration of liner tube IV, and the design is beautiful, the strength of liner tube IV is improved. The inner diameter of the bell mouth end of liner tube IV is designed with threads to facilitate the direct installation of liner tube IV at the tubing hanger by using the wellhead pickup device. As shown in Fig.5, the installation position of liner IV does not affect the normal work of valve 1 #, and can be installed on the tubing hanger.

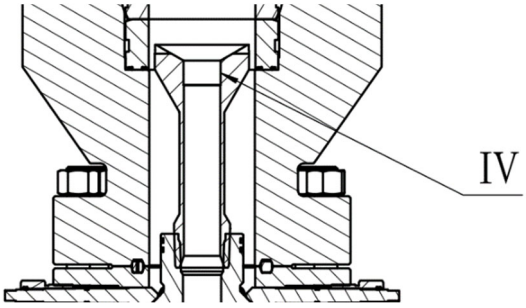

Fig.5 installation diagram of liner tube IV

2.2 Installation Method

According to the design of liner tube without variable diameter, combining the tool device of Christmas tree, the installation method of liner tube IV and other three sections of liner tubes with the pick-up device is designed. This installation process method needs to be implemented by team with corresponding qualification for pressure operation, and nonprofessional teams are strictly prohibited from construction.

(1) Shut in the well, close 1 # main valve and relieve pressure;

(2) Dismantle the wellhead process, namely the part above 1 # main valve;

(3) Install the liner tube IV to the lower end of the pressurized pick-up device, connect the flange, test the pressure of clean water at 30 MPa, and maintain the pressure for 15 minutes, there is no leakage outside the equipment, and the wellhead pressure drop should not be higher than 0.5 MPa;
(4) Open 1 # main valve, lower liner tube IV to hanger position, connect with hanger
(5) Remove the pick-up head and exit the pick-up head to the upper position of 1 # valve plate;
(6) Close 1 # main valve and open the pressure relief device and relieve the residual pressure at the wellhead;
(7) Remove the pressure pick-up device;
(8) Install the connecting flanges of 1 # and 4 # valves at the wellhead, replace the connecting lifting short joint (built-in liner III), and install 4 # valve and small cross;
(9) Install the small cross and 7 # valve to connect lifting flange (built-in liner tube II), and install 7 # valve;
(10) Install the upper part of 7# valve and connect lifting flange(built-in liner tube I);
(11) Close pressure test of 7 # valve, test pressure at 30MPa, no pressure drop and external leakage are qualified.

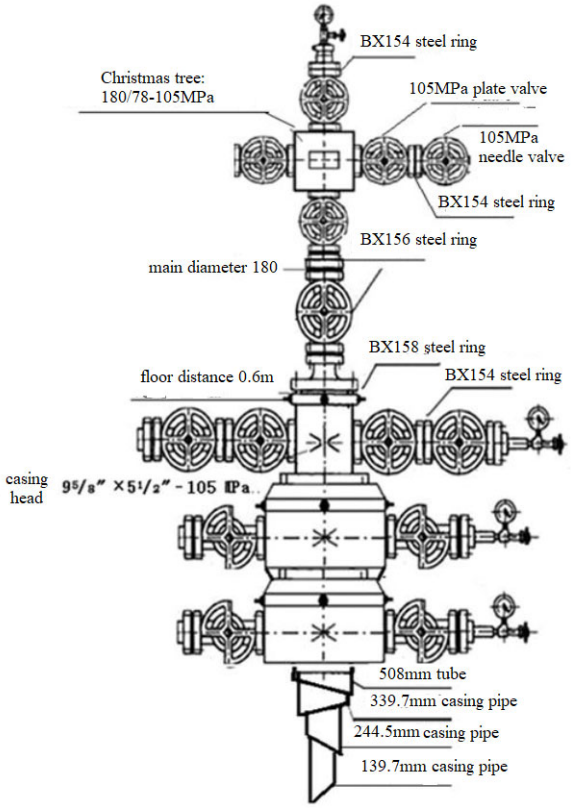

Fig. 6 schematic diagram of gas production wellhead equipment

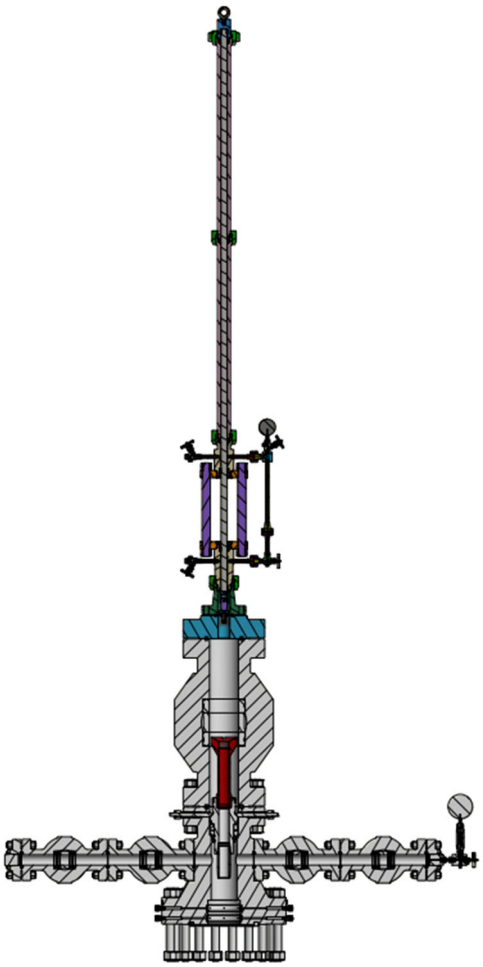

Fig.7 installation diagram of pick-up device under pressure and liner tube IV

3. Application Effect

Shale gas well ** is a shale gas development evaluation well/horizontal well deployed in the syncline structure of Fangjiagou of the southern Sichuan low fold belt in the Sichuan Basin, the well depth of drilled well is 5627m, the layer of drilled well is $S1_l$, and the well completion method is casing completion. It is put into production in April 2018, the early daily gas production is $6.17\times10^4m^3/d$, daily water production is $8.1m^3$, casing pressure is 48MPa. By the beginning of 2022, the cumulative gas production is $2907\times10^4m^3$, the accumulated water production is $10013m^3$.
In January 2022, the adjacent well was fractured before the plunger is put into operation, in order to avoid fracturing channel, the well was shut. As a result, the gas well was drowned, and it was difficult to resume production, intermittent well opening and liquid drainage into the air were adopted to maintain the gas well production, The daily output was $2.7707\times10^4m^3\downarrow0.5478\times104m^3$.
In May 2022, the well was transformed by the plunger drainage gas production process, the plunger wellhead process of liner tube without variable diameter was adopted, which completely solved the variable diameter

problem of the shale gas plunger gas lift wellhead, ensured that the plunger stably reached the wellhead blowout prevention tube, facilitated the periodic inspection and replacement of the plunger, and saved the salvage cost of plunger.

After the plunger is put into operation, the gas well has been running stably for more than 100 days, the plunger reaches the wellhead stably, reaching the detection rate is 100%, the gas well realizes automatic liquid drainage, the pressure difference of the oil jacket is 6.1↓1.3MPa, and the annular liquid level depth is 3363↓3643m, which effectively reduce the liquid accumulation in the gas well, the average daily gas production is 10000m^3, production increases by 80%, the efficiency of drainage gas production is greatly improved, effectively reduce the cost of human management in the well station, and realize automatic drainage gas production in the gas well, green and environment-friendly production.

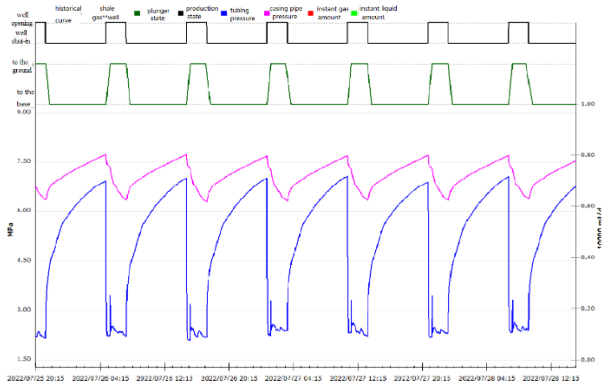

Fig.8 operation curve of plunger in shale gas well**

4. Conclusion and Recommendation

4.1 The liner tube device without variable diameter of shale gas plunger gas lift wellhead and its installation process completely solves the technical challenge: variable diameter of shale gas well plunger gas lift wellhead affects the drainage gas production effect of plunger;

4.2 The liner tube device without variable diameter of shale gas plunger gas lift wellhead and its installation process can ensure that the plunger reaches the ground blowout prevention pipe stably, facilitate the periodic inspection and replacement of the plunger, and save the salvage cost of plunger;

4.3 The plunger can run up and down periodically in the wellbore of shale gas well, which is the premise for plunger gas lift well to achieve better drainage gas production effect.

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