IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 2 ISSUE : 5 Print / Issue Publication Date: 11-Aug-2017

ISSN : 2455-2143

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

editor@ijeast.com

International Journal of Engineering Applied Sciences and Technology, 2017
Vol. 2, Issue 5, ISSN No. 2455-2143, Pages 81-84
Published Online March-April 2017 in IJEAST (http://www.ijeast.com)

DESIGN AND APPLICATION OF SAND FILLING TOOL FOR VERTICAL WELL

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Abstract— **In the development of unconsolidated sandstone vertical wells, because of the high content of mud, easy to form, difficult to control, the sand control method of single suspension sand filter tube is easy to cause the sand filter tube to be blocked, which affects the oil well productivity. In order to extend the effective period of the oil well exploitation, and achieve a good comprehensive sand control effect, on the basis of the theory of extrusion filling, this paper has carried out the research on the technology of gravel filling in vertical wells, and developed a sand filling and control server for vertical wells to ensure the normal production of oil wells. The sand control tool is mainly composed of a sealing mechanism, a filling mechanism, a well washing mechanism and a well retaining mechanism, which can realize the filling of the stratum and the annular space between the sieve tube and the casing. The tool is reasonable in structure, compact connection between components, with good effect, can improve the success rate of filling.**

Keywords—**Squeeze pack; Sand control tool; Structure design; Experimental study**

I. INTRODUCTION

Sand control is always a problem to be solved during the exploitation of unconsolidated sandstone reservoir [1]. The unconsolidated sandstone reservoir is characterized by poor cementation, shallow reservoir burial and poor formation lithology, and with the exploitation of formation fluid, sand production is becoming more and more serious. Existing wells filling tool using the leather bowl type, which will be squeezed by filling liquid to achieve the purpose of filling the liquid from the gap between the cup and the casing into the sieve tube and the casing annulus. After many times of extrusion, the seal of the leather bowl is poor and the service life is short. In addition, the existing common filling tools have small inner diameter, and the sand bridge and the sand plug can be easily formed during the filling process of large sand ratio, and the construction success rate is reduced. Secondly, using a single flow valve structure, it is difficult to wash well, easy to produce sand column to release the situation, leading to failure of sand control [2,3]. With the further development of the oilfield, the method has gradually exposed its limitations, and cannot fully meet the needs of the production of unconsolidated sandstone reservoir.

In this paper, combined with the sand control problems in the process of oil well development and engineering practice, the paper analyzes and researches on the sand control technology of filling, and designs a new type of vertical well filling sand control tool. The indoor simulation experiment proves the rationality and reliability of design.

II. STRUCTURE AND CHARACTERISTICS

A. Design requirement–

According to the requirements of the site operation, the design requirements of the filling and sand control server for vertical wells should include the following points [4-6]:

(1) With setting, anchor, packer, sand, and other functions.

(2) It can be used to complete the formation extrusion and annulus filling operation at the same time.

(3) In order to avoid the sand pipe to move up and down, the server should have a strong anchoring capacity.

(4) The performance of the rubber tube should be satisfied: high thermal stability, good sealing performance, good chemical stability, low friction coefficient and good self-lubrication.

(5) In order to make the construction safer and more reliable, it is necessary to realize the sand removal in the backwash well by the nonmoving string.

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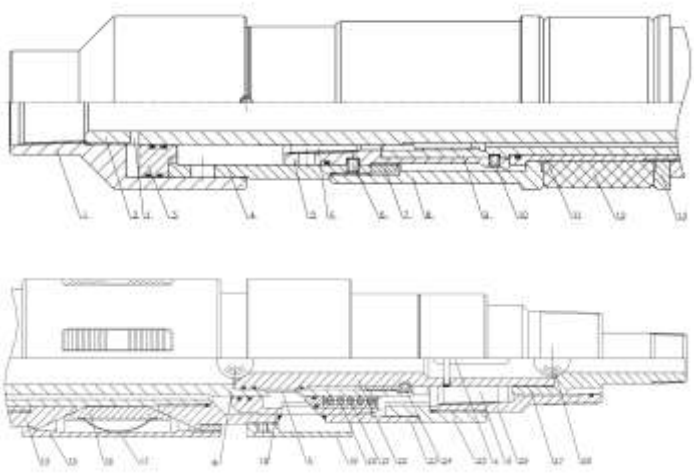
(6) The buckle to ensure clear signal.

B. Structure–

The server is mainly composed of slip hanging device, releasing device, sealing device and extrusion filling and flushing device [4]. Specific structure shown in Figure 1.



1-top connector;2-Central tube; 3-piston; 4-force transmission sleeve; 5-de-archive joint; 6-setting pin; 7-lock ring ; 8-compression tube; 9-long tube; 10-de-archive pin; 11-outer tube; 12-compressive packer rubber; 13-limit ring; 14-upper cone; 15- slip sleeve; 16-slip; 17-spring piece; 18-inner pipe for filling; 19- protective sleeve;20-valve;21-spring; 22-sliding sleeve;23- outer pipe for filling;24-sliding pin; 25- reversing joint; 26-lower connector; 27-tail pipe; 28-check valve; a-ball; b-inner hole; c-first through hole; d-passageway; e-second through hole; f-third through hole;

Fig. 1 Schematic diagram of sand filling tool for straight well

The sealing mechanism is composed of a cone, spring pieces, slips, a slip sleeve, etc. The slip is embedded into the wall of the casing to a certain depth and acts as a suspension tool. The locking mechanism comprises a spring claw, a locking ring, releasing pin, center long tube. C ring under normal circumstances was in the lock to ensure that the packer is always in a sealed state, lift the spring claw, C ring was forced to open, unlock. The sealing mechanism is composed of a compressive rubber cylinder, limit ring and a compression tube. The rubber tube plays the role of sealing, and the sealing mechanism acts as a downhole packer. The filling mechanism, whose function is to transfer the sand carrying fluid from the tubing to the annulus of the sieve tube and casing to fill the formation and the annular space and the liquid is transferred to the oil sleeve ring of the upper part of the rubber cylinder through the transfer channel, and finally returns to the ground, is composed of an inner pipe, an outer pipe for filling, a sliding sleeve and a check valve (steel ball).The filling hole closing system consists of closing valve, springs and filling pipe. Its role is to prevent the formation of gravel from the mouth of the filling into the tool even at the bottom of the hole, the impact of oil production. Releasing and the center of the column is proposed, closing valve under the action of the spring force automatically shut down and seal filling port. The backwashing mechanism consists of backwashing holes and backwash channel, a check valve, a tail pipe.

C. Design requirement–

This tool has the following characteristics:
(1) The filling tool and the packer are integrated into a whole, which not only shortens the operation period, but also saves the cost;
(2) The inner diameter of the filling tool is relatively large, and it is difficult to form the sand bridge and the sand blocking phenomenon in the process of filling the large sand ratio, which can improve the success rate.
(3) A bridge type channel is formed between the lower joint, the inverted joint, the filling outer pipe and the filling inner pipe, namely, the gravel filling liquid and the returned liquid are respectively passed through the valve, and can not influence each other.
(4) Backwashing is simple operation, reduce sand control string not releasing the situation.

III. WORKING PRINCIPLE AND MAIN TECHNICAL PARAMETERS

A. Working principle-

The working principle of sand control tool includes the following steps[7-9] :

1) Seated anchorage

Apply hydraulic pressure to the tool the liquid passes through the hole of the upper end of the central pipe to enter the piston cavity between the upper joint and the piston, under the action of pressure then the piston and force transmission sleeve move in the axial direction, which will cause the dowel pins to be sheared. Compressive packer rubber and upper cone move in the axial direction, which causes the slips to expand axially and anchor to the casing. Under the continuous action of the liquid pressure, the rubber cylinder is compressed and expanded, and then the oil sleeve ring is sealed, so as to realize the sealing and anchoring function of the tool.

2) Filling sand

Continue to increase pressure when the pressure reaches a certain value, the sliding sleeve pin is cut under the action of shearing force and the axial movement of the sliding sleeve is carried out, at this time, the inner hole of the central pipe is

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opened with the inner pipe, the outer pipe and the sleeve. A certain viscosity of the liquid carrying gravel movement to the oil layer of the sieve tube and casing, and gravel in the sieve ring to form a sand barrier, at the same time the liquid enters the tool through the tailpipe, which enters the lower joint, the reverse joint, the bridge between the outer pipe and the inner pipe through the bar hole on the sliding sleeve, and finally returns to the casing.

3) releasing

When the filling construction is completed, the tubing string is rotated in the positive direction so that the left thread of the long pipe and the central pipe is detached. Lift up the pipe column, the upper joint, the central pipe, the piston, the steel ball, the sliding sleeve and the tail pipe and so on are raised at the same time, the others remain in the well.

4) de-archive

When the need for releasing operation of tools, the special tool is connected with the de-archive joint, lift the pipe, the de-archive pin is cut off, and the lock ring is opened, the compressive packer rubber, upper cone and slip return to the initial position, de-archive is completed.

B. Main technical parameters-

The main technical parameters of the tool, as shown in Table 1.

Table -1 The Main Technical Parameters

The technique target.	The parameter
The maximum overall diameter	150mm
The minimum internal diameter	28mm
The minimum inner diameter after release	68mm
Total length	1230mm
Temperature resistance	-20℃~270℃
setting pressure	15MPa
Bearing capacity	35MPa
hanging capacity	900KN
The inner diameter of casing	157~162.36 mm

IV. SIMULATED EXPERIMENT RESEARCH

A simulated experiment research was carried out with a 7 inch vertical sand filling server tool, the main test steps are as follows:

(1) Inspect the system of test wells comprehensively;

(2) Place the filling sand control server in the specified location;

(3) Put the steel ball with a diameter of 35mm into the tool;

(4) When pressure is applied to 4.6Mpa, the pressure fluctuates obviously, at this time, the sealing pin is cut and the sealing is started;

(5) Continue to pressure to 12.2Mpa, the system shows significant pressure fluctuations, determine the server tool to complete the seal, the anchor has been anchored, the compressive packer rubber has been sealed;

(6) Continue to pressure to 19.4Mpa, the system shows severe pressure fluctuations, the wellhead can hear a loud sound, determine the sliding sleeve pin is cut, sand filled channel is open;

(7) Apply pressure with large displacement pump. With the displacement of 70L/min piston pump pressure, the throttle pressure difference of 0.8 ~ 0.9Mpa.

(8) Anchoring test. Lift the column, the tool does not slide

(9) Releasing. The column is positive rotation 20 laps, terminate the connection, the pipe column is lifted, the success.

(10) DE blocking. Lifting force is 1.5T, releasing pin is cut off, continue to increase, the rally reached 2.7t, successfully remove lock, pull out of the sand control string.

The simulation test is successful, according to the design parameters of sand control operation can successfully complete the various processes. The tool can realize the functions of pressure, setting, anchoring, extrusion filling, releasing. The flow path is smooth, the throttling pressure difference is small, and the large displacement filling can be carried out. The experimental results are shown in table 2.

Table -2 Simulation test Results of sand Filling Tool for Vertical wells

Test items	Parameters	Experimental result	Conclusion
setting pin shear pressure	< 5MPa	4.2 MPa	qualified
setting pressure	12MPa	12.2 MPa	qualified
anchoring capacity	900KN	900 KN	qualified
de-archive pin shear pressure	22MPa	19.4 MPa	qualified
Filling channel conversion	flexible	flexible	qualified
packing sand rate	3 ton	2.7 ton	qualified

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V. CONCLUSION

Vertical squeeze packing sand control tool into a trip column complete setting, anchoring, formation of extrusion and annular packing, backwashing, and other functions, and it can be widely used in oil field production and solve the problem of sand production of oil wells. After completing setting, rubber tube seal stability, slip anchored firmly. The formation filling and annulus filling can be completed at the same time, which ensures the reliability of filling sand barrier, at the same time, it does not need to rotate the string when the well is washed, sand blocking can be prevented during construction. The releasing operation is simple, clear signal, when the tool failure, releasing tool is simple, easy to salvage. The whole process is reliable and adaptable.

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