The Field Application of Direct Reading Efficient Measurement and Adjustment Process

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Abstract. The direct reading high-efficiency measuring instrument adopts a combination of dual flow and non-current collecting and measuring methods, that is, a flow tester is arranged at both ends of the water distribution device, and the flow changes above and below the water distributor are tested. The calculated difference flow rate is the actual water injection amount of the interval, and the flow adjustment based on this is highly targeted and accurate. At the same time, the cable is used to transmit signals, and the working condition of the plug adjusting device can be visually monitored through the notebook computer. The application of the PC measurement and adjustment software can calculate the water volume of the mixing layer and facilitate on-site operation. In this paper, the test situation of the dual flow non-current collecting direct reading high-efficiency measurement and adjustment process in the eccentric injection well stratification test site is summarized, and the practicability of the process on site is demonstrated. A detailed summary and argumentation were made for the advantages, problems and operational points that the process showed in the stratified test work.

Key words: dual flow, non-current, high efficiency, adjustment, edgemeasurement, occlusion.

1. Foreword
According to the needs of oilfield water injection development, all injection wells should complete the three-year adjustment and adjustment tasks, to improve the water injection qualification rate, maximize the capacity of the existing test team, and must improve the existing test process to improve the test efficiency. For a long time, the testing work has been carried out by means of tentative adjustment of the faucet. The test work has high labor intensity and low accuracy. In the process of repeated adjustment, it is easy to cause the plugging device to fly, causing the falling object of the well. With the successful development of dual-flow non-collector direct-reading high-efficiency measurement and control technology, the test process has reached a new level since it was put into field application.

2. The Comparison of the Current Test Process
At present, the test processes applied in the test site mainly include non-collecting ultrasonic flow meter, side-measurement side-adjusting flow meter and dual-flow non-collector direct-reading high-efficiency measuring instrument. The advantages and disadvantages are compared as shown in the following table.
Table 1. Comparison of current test procedures

| Non-collecting ultrasonic flow meter | Direct reading and high efficiency measuring instrument |
|-------------------------------------|------------------------------------------------------|
| advantage                           | The measurement and adjustment process is intuitive and can accurately reflect the true water absorption of the formation in real time. The operation is simple, and the labor intensity of the tester is fundamentally reduced. |
| disadvantage                        | The instrument adopts advanced ultrasonic principle and has high test accuracy. Because the instrument does not have any movable mechanical parts. It is easy to install and has high reliability. |
| advantage                           | The test adjustment mouth needs repeated fishing, and the test worker has high labor intensity. |
| disadvantage                        | Cannot be applied to small diameter columns. At present, there are many problems with instrument accessories. |

3. The Working principle of dual flow non-current collecting and the direct reading high-efficiency measuring instrument

The instrument consists of three parts: PC measurement and adjustment software, ground measurement and control instrument and down-hole measurement instrument. The single-core cable and adjustable plug-in are used as auxiliary equipment. When measuring and adjusting the eccentric water injection well, we should connect the cable to the instrument and enter the predetermined level. The PC measurement and control software controls the instrument to discharge the discharge machine through the cable on the ground, so that the water nozzle adjustment arm is opened, and the guiding device is used to complete and block and the docking of the adjustment mechanism. Then, click the “test” command of the PC measurement and adjustment software, and the down-hole instrument will automatically calculate the actual test value of the current layer by displaying the actual test value of the upper and lower flow-meters through the software. According to the program's matching requirements, clicking the “Intelligent Adjustment” command of the PC measurement and adjustment software to change the opening degree of the adjustable plugging nozzle by adjusting the motor to drive the adjustment arm, thereby changing the actual water injection amount of the layer until the geological plan is met. After the adjustment is completed, clicking the “receive arm” command of the PC measurement and adjustment software to retract the adjustment arm into the instrument, lift it up or down to other layers, and continue to complete the measurement and adjustment work as required.
4. Analysis of test results

4.1. The significantly improving of the efficiency of measurement and adjustment

| Convention | Direct Reading |
|------------|---------------|
| Riser      | Riser         |
| Time cost of investing and measuring the edge of the plug | Time cost of investing and measuring the edge of the plug |
| Lower regulator | Cable down-hole time |
| Lower flow meter | Rough adjustment (including settling time) |
| Adjusting the faucets of each layer for the first time according to the dispense | Fine adjustment (including settling time) |
| Lower flow meter | Two buck cards |
| The second time according to the dispensing adjustment of each layer of the nozzle | Cable |
| Stable schedule | 1 hour and 20 minutes |
| Lower flow meter | 1 hour and 20 minutes |
| Two buck cards | 3 hours |
| Start wire | 20 minutes |
| Total | Total |
| 14 hours and 50 minutes | 10 hours and 30 minutes |

This well uses the original test method, usually resulting in less than 4 to 8 times. In this test, the plugging was only carried out 4 times, and the adjustment work was completed down-hole, which greatly reduced the labor intensity of the test workers and improved the work efficiency.

4.2. The improving of the accuracy of debugging

The dual-flow non-collector direct-reading high-efficiency measurement and adjustment process is equipped with a tamper adjustment device. It can be used together with the ground measurement and control instrument, notebook computer and PC measurement and adjustment software to monitor the adjustment process of the occlude, so that it can be visually observed. The water volume increase and decrease of the stratification section further improves the test pass rate.

In the conventional method test, the water volume of the 3-layer section is difficult to control. When the nozzle is repeatedly condensed, the water volume of the daily injection is 26m$^3$, and when the water is injected into the 2.4mm nozzle, the daily water injection amount is 36m$^3$, and the input is 2.6. When the mm nozzle is used, the daily water injection amount is 40m$^3$. Input the edge measurement and adjust the plug, directly adjust the bias 3 expected value of 50m$^3$, and measure 50m$^3$. The number of fishing times is reduced by 4-5 times, the time of measurement and adjustment is greatly shortened, and the
amount of water is also more reasonable. At the same time, the water volume and oil pressure coincidence rate with the wellhead water meter will reach to 100%.

4.3. Reducing the occurrence of falling objects
A common cause of the falling object is that the plug is thrown in the process of repeated fishing and the trap is caught in the column. The application of the dual-flow non-collector direct-reading high-efficiency measurement and control process can reduce the number of clogging devices and greatly reduce the chance of working wells due to falling objects. Avoid working 3 wells due to falling objects during use.

5. Problems and solutions in the test

5.1. The friction is large and the winter cable icing seriously affects the efficiency of measurement and adjustment
Experiments show that under the same conditions (winter), the completion of one well test direct reading instrument is one hour and 30 minutes less than the edge measurement instrument. From the comparison of various test links, the adjustment time of the direct reading instrument (cable) is reduced by 4 hours compared with the side measuring instrument (wire). However, the cable operation during the down-hole and lifting process of the instrument is increased by nearly 3 hours compared to the wire operation. According to the analysis of the actual situation on site, there are two main reasons:

(1) The instrument has a large friction between the spring plate and the well wall, which makes the instrument slow down. The first 200 meters of the operation requires manual boosting of the well.

(2) In winter, the cable is seriously frozen, and the load increases when the well is lowered. When the lifting is carried out, the cable is aligned and the cable is easily deformed.

Solution:

(1) Communicate with the technical personnel of the manufacturer to reduce the arc of the instrument spring body to reduce the friction with the well wall when the well is down, reduce the load, and improve the down-hole speed of the instrument.

(2) When the equipment is running in winter, we should install a heating device on the head of the cable drum to melt the thin ice on the outer wall of the cable to prevent the alignment from being uneven, and to increase the starting speed.

5.2. The outer diameter of the day pulley is different from the center hole of the test plug, and the fixed coupling does not bear the force.
During the test, the cable is rubbed against the center hole of the plug when it goes down, so that the outer wall of the cable protects the wall of the steel pipe from thinning. The strength of the cable is easily damaged, causing damage to the cable. Because the fixed coupling of the sky pulley does not bear the weight, the pulley is affected by the pulley. The force is deformed, causing the cable to break and causing the test to fall.

Solution:

Re-customize the day pulley and adjust the verticality of the pulley so that it is concentric with the test plug. We can change the pulley fixing coupling to a dead end to avoid deformation of the sky pulley.

5.3. The cable head is not tapped, and the cable is broken after encountering the resistance.
The pull-off tension of the double-flow high-efficiency measuring instrument cable head is 150 kg. When the instrument is lifted, the tension reaches 275 kg and the pressure is 12.00 MPa. The cable head is not disconnected, causing the 900 m cable to fall out of the well.

Solution:

By contacting the manufacturer to change the gasket in the cable head from 6cm to 4cm, it can reduce the compression of the locking spring, and reduce the tension of the cable to 100-110 kg to avoid the phenomenon that the cable head does not tap.
5.4. The cable is not easy to line at the two ends of the drum

When the cable is cabled, the cable is prone to large seams when it receives the two sides of the roller, so that the cable cannot be aligned and affects the service life of the cable. When the instrument is lifted, it is necessary for the tester to press the cable by hand to align, which results in prolonged test time and increases the risk of the worker's operation.

Solution:
The vehicle is returned to the factory to adjust the parts of the cable drum to make the drum work optimally. Re-align the bottom layer of the cable to lay the foundation for the upper cable.

6. A few points of understanding

Dual-flow non-collector direct-reading high-efficiency measurement and adjustment process is suitable for normal pipe column and bridge eccentric pipe column. It is not suitable for layered water injection wells with small diameter pipe columns and casings.

We should know about the data such as water nozzle before demodulation and water injection in each layer. According to the test results and the water absorption of each layer, we should determine the adjustment sequence, input the layer to be adjusted and set the desired value of each layer adjustment.

The application of dual-flow non-current collecting direct-reading high-efficiency measurement and adjustment technology avoids repeated fishing. It is intuitive and simple to adjust the plugging devices in each interval, which improves the efficiency of measurement and adjustment. The average single well saves more than 40% of the time.

During the process of using the process, the test water quantity and the water meter water quantity can match the rate of 100%, and the test pass rate is also higher than before.

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