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The reason and prevention measures for the rod and tubing wear of the pumping unit in the Bei 301 operation area

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Abstract. In order to study the effective prevention measures to improve the regulation effect of the anti-deflecting measure in Bei 301 operation area and prolong the pump cycle of the oil well. The calculation of the historical data of the eccentric wear well and the analysis of eccentric wear prevention effect show that eccentric wear condition in Bei 301 operation area of hailaer oilfield is relatively serious and the operating wells' ratio of rod breakage and tube leakage increases year by year due to eccentric wear [1,2]. In 2014, the proportion of rod breakage and tube leakage in the operating wells of the operation area was 19.4% and 45.2% respectively, and the average pump inspection cycle was around 400 days. The reasons for the serious wear of the rod pipe in Bei 301 operation area are the improper production parameters, the submergence depth, high water content and well fluid properties according to the detailed data analysis of the pump operation. Active eccentric wear prevention measures have some effect, and next research direction for preventing eccentric wear is put forward in this paper: the paraffin-removing technology, bi-directional protected box coupling and low friction pump combined with the problems faced by the operating area.

1. Introduction

According to the statistics on the operation of testing pumps in Bei 301 operation area of hailaer oilfield from 2012 to 2014, the sucker rod and tubing are seriously damaged caused by working long hours. Rod broken and tube leakage wells (figures 1 and 2) increases year by year, the proportion of these wells to the total tested pumps is about 50%.



Figure 1. The wells of rod broken.



Figure 2. The wells of tube leakage.



In the all 2014 annual inspection pump well, due to the partial grinding of the operating area, the shaft shut-in 6 well, accounting for 19.4% of the total number of pump wells; As a result of partial grinding, the pipe drain well is 14 times, accounting for 45.2% of the total number of pump wells. And for three consecutive years, the proportion of wells that have caused the leakage of pipe leakage has increased year by year. Therefore, researching on the rules of eccentric wear, analyzing the reasons of rod and tubing wear and taking effective measures of preventing eccentric wear will have important significance to reduce eccentric wear well and extend the oil well pump inspection cycle in Bei 301 operation area.

Table 1 shows the statistical situation of rod broken and tube leakage wells in the three-year testing pump wells of the Bei 301 operating area.

Table 1. Statistics of rod broken and tube leakage wells in the three-year inspection pump well of the Bei 301 operating area.

Year	The wells' number of testing pumps	The wells' number of rod broken	The wells' proportion of rod broken%	The wells' number of tube leakage	The wells' proportion of tube leakage %	The wells' number of rod broken and tube leakage	The wells' proportion of rod broken and tube leakage %	The average pump inspection cycle, day
2012	38	12	31.6	5	13.2	17	44.7	504
2013	48	12	25.0	15	31.3	27	56.3	399
2014	31	6	19.4	14	45.2	20	64.5	404

2. Analysis of the reasons for the rod and tubing wear of the operation area

When the pumping unit is running normally, the sucker rod is always in tension during the upstroke, and there is usually no bias; In the down stroke, in addition to its own downward gravity, the sucker rod is affected by the upward resistance including the buoyancy of well fluid, so that the neutral point appears on the sucker rod. The compression stress below the neutral point can lead to the buckling of the sucker rod, which leads to the eccentric wear of rod pipe. So the rod eccentric wear problem is inevitable due to the working characteristics of pumping unit itself, but the various factors such as properties of produced fluid and the parameters of production will aggravate the degree of eccentric wear of rod pipe [3-5].

2.1. The production parameters

When oil well goes into production, it is generally necessary to select a certain stroke to meet the demand of liquid production. In the statistical operation area, the average rate of pump is 4.6/min, and the maximum is 7.5/min, which causes a great resistance when the fluid passes through the plunger at the bottom of the sucker rod and the descent velocity of part of the sucker rod lag. Figure 3 shows the proportion of oil wells under different impulse times and pump inspection cycle.

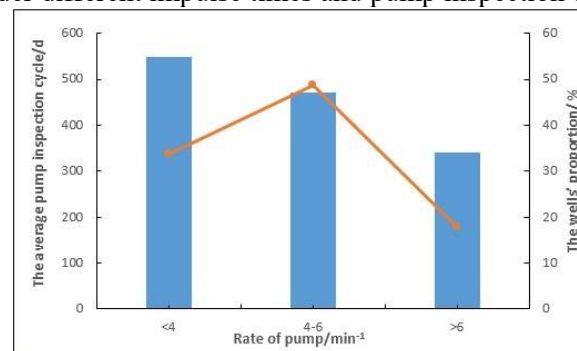


Figure 3. The wells' average pump inspection cycle and proportion of different rates.

Great resistance will appear when the fluid passes through the bottom plunger of the sucker rod, which is caused by the larger rate of pump. And the speed of partial sucker rod is lagging. Therefore, the sucker rod below the neutral point is badly compressed and the bending failure stability accrues which causes the sucker rod to increase the bending degree. At the same time the frequency of rod tube wear increases and aggravates eccentric wear eventually.

2.2. *The submergence depth*

The wells' average submergence is 80m in the operation area. The low sinking degree causes the fluid to be unable to fill the pump barrel in time and the well supply is insufficient. As a result, the pump piston hits the liquid surface during the downward stroke, and the "liquid strike" phenomenon occurs, increasing downward resistance; And the higher the submergence depth, the greater the submergence pressure, increasing the upward pressure of the plunger.

2.3. *The water content*

The type of well fluid is changed from water in oil type (W/O) to oil in water type (O/W) when the water content of the well is more than 74%. The frictional lubricant between the rod strings and tubes is changed from crude oil to water. Loss of lubrication and protection of oil film, the pipe is directly exposed to the water, and the wear speed of sucker rod and tubing is accelerated.

At present, the average moisture content of eccentric wear wells is about 70.0%.

2.4. *The properties of produced fluid*

In the production process, the wellbore will appear with wax. Oil well's scale and paraffin will reduce the annular space area of tubing and rod column and the gap between piston and liner in the pump barrel, increasing the downward resistance of the sucker rod and piston. If the wax scale is serious in the tubing, the friction resistance will increase during the descending process of the sucker rod. In this way, the sucker rod at the end of the paraffin well is bent by compression.

In addition, the well fluid can corrode the column, which causes the friction of the contact surface of the rod to increase, and aggravates the grinding degree of the rod tube. And the eccentric wear will destroy the protective film on the pipe and increase the corrosion degree of the well fluid to the pipe.

The effect of each well fluid property on the operating wells of the operation area is shown in table 2.

Table 2. The effect of well fluid properties.

The operating well times	The proportion of wax deposition,%	The proportion of scaling,%	The proportion of sand production,%	The proportion of corrosion,%
108	15.74	2.78	0.93	7.41

3. Measures for anti-deviation in the Bei 301 operation area

In view of the reasons for the eccentric wear in the operating area, the following prevention and control measures are adopted.

3.1. *Sucker rod centralizer*

The sucker rod centralizer is the main anti-deflecting measure for the field application of each oil field. The sucker rod centralizer is mainly divided into two types: torsional type and coupling type:

- The centralizer of torsional type: It is installed in sucker rod body with a repeated utilization ratio, which can effectively prevent rod body wear. However, it is easy to appear the channeling and centralizer scraping phenomenon in the process of using.
- The centralizer of coupling type (figure 4): It is installed on the sucker rod collar, with uniform abrasion and tight fastening, which can effectively prevent collar wear. However, when the eccentric wear is serious, it is easy to break off and cause the rod to be removed.



Figure 4. The centralizer of coupling type.

The wear ratio of partial offset well centralizer is low, and it is not effective to prevent the eccentric wear of the rod tube, combining with the record of pump operation in the operation area. In addition, the application effect of the coupling type centralizer is better than that of the torsional type, and the pump cycle is extended by 101.7 days compared with the torsional type centralizer according to the field test.

3.2. The synthetic protector

The sucker rod rotate slowly, which is driven by the energy of the load difference resulted from sucker rod up and down reciprocating motion process. Due to the difference of polished rod load, the sucker rod can rotate 3~5 turns a day. Changing the fixed point wear of the pipe originally to uniform wear, the synthetic protector can reduce the situation of rod breakage or tube leakage due to unilateral eccentric wear, achieving the purpose of extending the eccentric wear cycle.

The comprehensive protection device of sucker rod is used in the severe eccentrically worn wells of the operation area. Tracking analysis for the effect of 18 oil wells, the average speed of the sucker rod is 3.2 laps/d after installation and the maintenance-free period is extended 177 days, and the effective rate is 91.0%.

3.3. Optimizing production parameters

In order to reduce the frictional resistance of the oil well effectively, the oil pump with large gap and small leakage is preferred. For the formation of adequate fluid and good pump efficiency of the deflection well. In order to reduce the probability of the pipe deviation under the premise of ensuring the production volume, it is necessary to carry out the pump upgrade, reduce the flush or lift the shallow pump. In the case of low formation energy or low pump efficiency, carry out the pump demotion or reduce the rate of pump, reducing the phenomenon of "piston liquid strike" and improving the stress condition of sucker rod, will reduce the degree of eccentric wear of the rod tube.

Optimizing the parameters of 18 wells in the operating area, the average rate of pump is reduced by 1.47/min, and the average stroke is reduced by 0.92 m. The average maintenance-free period of the oil well is extended 87 days.

3.4. Reasonable intermittent pumping system

According to the law of stripper well's production fluid, the continuous production system is adjusted to the reasonable intermittent pumping system, which can reduce the degree of eccentric wear of the pipe effectively.

In the operation area, the intermittent pumping system is carried out for some stripper wells, which 12 wells' production remained stable after the pumping, and the average maintenance-free period of the oil well is extended 267 days.

4. The next research direction on prevention measure

Certain achievements has been made in the rod tube eccentric wear prevention measures for Bei 301 operation area, but there are still some problems: 1) parts of oil wells' displacement method of the area

turns into polymer flooding from water flooding, fluid viscosity and other properties change; 2) Some of the oil wells are seriously waxed, and the installation of the centralizer will increase the operating load of the sucker rod. This is a higher requirement for the selection of the field anti-bias grinding measures.

- The paraffin-removing technology [6,7]

The paraffin deposition in production wells is relatively serious in the operation area and the major step is hot washing, which the Paraffin wax removal method is single and cannot effectively reduce the effect of the wax on the eccentric wear of the rod tube.

Therefore: 1) It is necessary to do well the daily work of paraffin removal and control and make a reasonable wax cycle according to the law of the oil well. 2) Study the applicable chemical paraffin inhibitor. according to the properties of the oil well in the operating area. 3) For these oil wells that are hard to manage, high efficiency anti-wax scale installation can be installed in the downhole.

- The bi-directional protected box coupling [8,9]

In view of the severe collar wear phenomenon in hailar oilfield, it is recommended to use the bi-directional protected box coupling. Under the harsh conditions, the collar has a strong wear resistance, which can reduce the load of the sucker rod, protecting the collar and tubing, and reducing the wear between the pipe rods. It can increase 20 times, compared with the normal collars' life, reduce the friction resistance 15-23%, and effectively extend the maintenance-free period of oil wells. Figure 5 shows a bi-directional protected box coupling object.



Figure 5. Bi-directional protected box coupling.

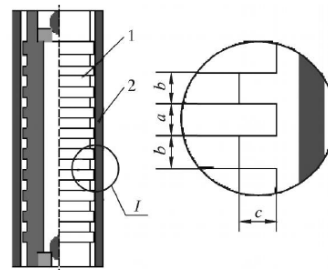


Figure 6. The schematic diagram of low friction pump.

- The low friction pump [10,11]

The low friction pump is a technical measure to reduce the friction between the plunger and pump cylinder, which is specially designed for the high viscosity of the production fluid, the high water content in the late stage of development and severe eccentrically worn wells below the neutral point.

Using the ring grooves (as shown in figure 6) instead of traditional tubular pump plunger, the low friction pump can effectively reduce leakage to guarantee the pump efficiency, and can shorten effective length of contact to reduce the friction between the pump cylinder and plunger.

5. Conclusions

- The proportion of rod breakage and pipe leakage wells caused by rod and tubing wear is increasing year by year in Bei 301 operation area of hailar oilfield, which causes that the average pump cycle of production wells is shorter, averaging about 400 days. Frequent operations affect the normal production of oil wells in the operating area seriously.
- There are the main factors to aggravate the eccentric wear of the rod tube in Bei 301 operation area that the high rate of pump, unreasonable submergence depth, high water cut and sand production of well fluid.
- The measures used at present in Bei 301 operation area have certain anti-deflecting effect. On the basis of this, the first is to prevent oil wax to reduce the effect of wax on the eccentric wear of the rod tube. The second is to use the bi-directional protected box coupling to improve wear

resistance of the collar. The third is to use the low friction pump to reduce the frictional resistance and further improve the management level of the eccentric wear of the rod pipe.

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