

Research on the Structure Improvement of New Collar and Eye Grinding Shoes

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Abstract: *There are about 200 shut-in wells and inefficient wells in Bohai area, which cause a large number of idle assets and seriously affect the production and economic benefits of oilfields. It is one of the effective means to use shut-in wells or low-efficiency wells to arrange adjustment wells by sidetracking. A new type of pilot hole grinding shoe is designed and tested in the field, and the penetration rate is as high as 2m/H, and the application effect is good.*

Keywords: Collar-eye shoe mill, Research, Field application.

1. Preface

After nearly 50 years of exploration and development in Bohai Oilfield [1-2], some major oilfields have entered the high water cut stage, with a comprehensive water cut of about 80%, as shown in Table 1. The produced water treatment cost is high, which does not meet the requirements of energy saving and emission reduction, and eventually leads to the shutdown of oil and gas wells; According to incomplete statistics, there are about 200 shut-down wells and inefficient wells in Bohai area, resulting in a large number of idle assets, seriously affecting oilfield production and economic benefits. How to tap the potential of remaining reservoirs in old blocks has become an urgent problem to be solved in various oilfields [3-5]; and the use of shut-in wells or low-efficiency wells to arrange adjustment wells by sidetracking has become one of the effective means. Compared with new drilling wells, it has the following advantages: 1) Surface wellbore and downhole tools are reused to reduce engineering investment; 2) Recycle the notch, reduce the engineering facilities such as external hanging, and reduce the investment in engineering construction; 3) Tap the remaining oil around the old wells and improve the recovery rate.

In the preparation operation of processing each layer of casing to meet the requirements of large hole sidetracking, the conventional cutting and washover process can meet the requirements of processing single layer casing or processing multiple layers of casing. However, due to the restriction of well conditions, the existing washover tools may cause problems such as backing pressure, casing splitting, casing leakage, conductor leakage, and severe wellhead vibration. In the case of complex well conditions, it can only be milled by multi-blade collar grinding shoes. At present, the milling efficiency of the commonly used multi-blade collar-eye grinding shoe is low, and the service life of a single tool is short. In this context, it is particularly necessary to put forward the research on the shoe grinding tool.

1.1 Research Status at Home and Abroad

No case of multi-layer casing processing is found in onshore and offshore oilfields in China. For single-layer casing processing, forging and milling are common in onshore oilfields, but the efficiency is low, the blade material is limited, and the forging and milling distance is unstable. We have been exploring the process of sleeve milling and milling since 2013, and the aging and safety are uncontrollable at present. There are many problems, such as milling support pressure, split, leakage, slow milling footage, short working time of a single grinding shoe and so on.

Internationally, this kind of problem is mainly dealt with by milling, with a single mill shoe milling 80-100m, provided that the eccentricity is not serious. In view of the serious eccentricity, it is regarded as a difficult operation to avoid as far as possible, and there is no complete technical system and standard for casing milling and milling.

1.2 Research Technical Route

In this study, a combination of theoretical analysis and experimental methods and lines are used. Research methods: First, according to the needs of the scene, the structure of the tool is designed, and then the tool size of each part of the tool is determined by mechanical analysis, and the processing drawings are drawn, and finally the product processing is completed. Test method: firstly conduct indoor test, then conduct field test in the test well, and finally further verify the performance of the tool through field application, and further optimize it according to the test and field application results. Technical idea: technical/market research — establishment of working principle and research scheme — expert guidance — engineering drawing — prototype trial production — function test — result feedback — improvement — retest — result output. The research technology roadmap is as follows:

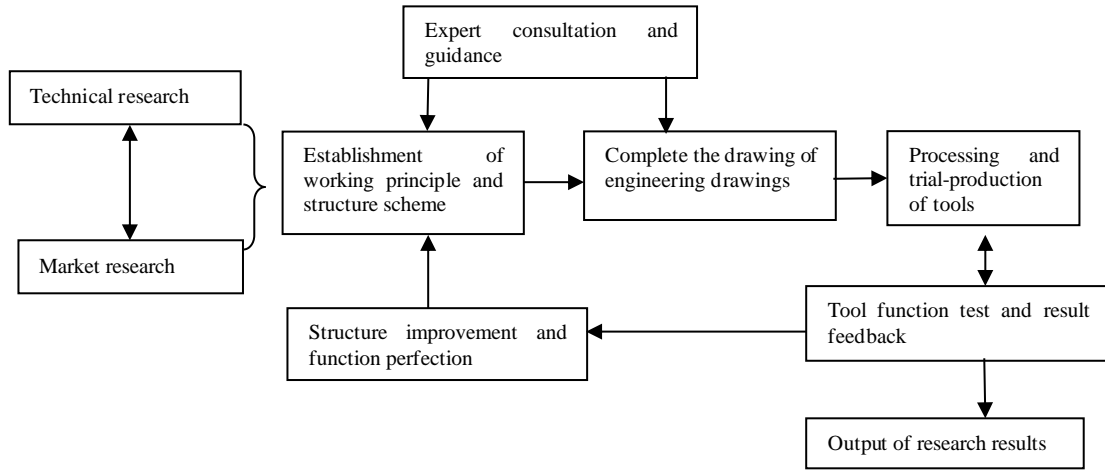


Figure 1: Project Research Technology Roadmap

1.3 Tool Structure Design

The novel collar eye grinding shoe is mainly composed of a female button, a body, a spiral knife wing, a righting wing, an inner hole, a male button, an alloy block and alloy particles;

the tool structure is shown in Figure 2, the A-A sectional view of the collar eye grinding shoe is shown in Figure 3, and the B-B sectional view of the collar eye polishing shoe is shown in Figure 4.

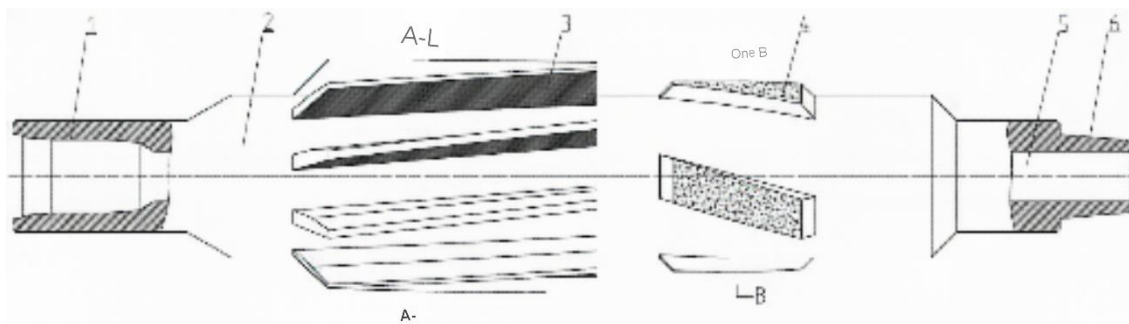


Figure 2: Schematic Diagram of the Structure of the New Collar and Eye Grinding Shoe

Notes: 1. Female buckle, 2. Body, 3. Spiral blade, 4. Righting wing, 5. Bore, 6. Male buckle, 7. Alloy block, 8. Welds, 9. Alloy particles

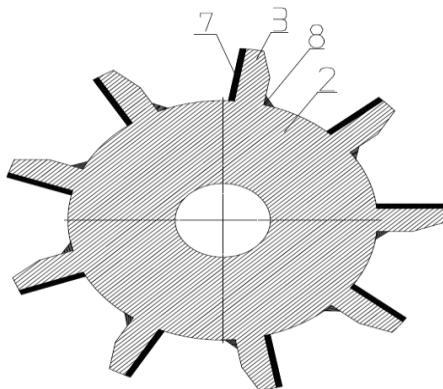


Figure 3: Section A-A

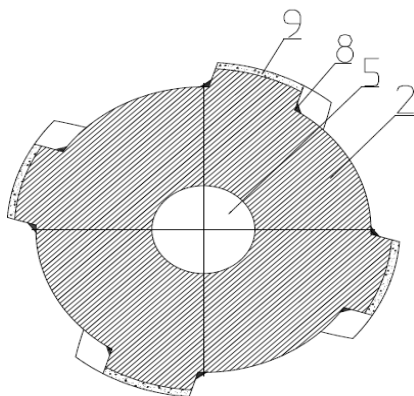


Figure 4: Section B-B

The female/male buckle is a special buckle for petroleum, and different types of buckles can be selected according to customer requirements to meet different purposes; the spiral blades are welded on the body, and the body can be reused on the premise of ensuring the strength, so that the production cost is reduced; the number of the spiral blades is odd, and is similar to a triangular stability principle, so that the stability in the milling process is improved; An alloy block is welded on one side of that spiral blade wing and is used for milling the casing; the righting we is also welded on the main body, so that the main body can be reused conveniently; and hard alloy particles are welded on the surface of the righting wing, so that the wear resistance of the casing is improved. In the field operation process, when the casing is not centered, the efficiency of casing milling/grinding is very low. The new leading hole grinding shoe uses cutting instead of grinding, which greatly improves the operation efficiency and shortens the construction period of the adjustment well project, so as to achieve the purpose of reducing cost and increasing efficiency.

As shown in Figure 2, Figure 3 and Figure 4, the novel collar eye grinding shoe is mainly composed of a female button (1), a body (2), a spiral blade (3), an aligning blade (4), an inner hole (5), a male button (6), alloy blocks (7) and alloy particles (8); The female buckle (1)/male buckle (6) are special buckles for petroleum, and different buckle types can be selected according to customer requirements to meet different

purposes; the spiral blade (3) is welded on the body (2), and the body (2) can be reused on the premise of ensuring the strength, thereby reducing the production cost; The num of that spiral blade wings (3) is odd, which is similar to a triangular stable principle so as to improve the stability in the mil process; the alloy blocks (7) are welded on one side of the spiral blade wing (3) and are used for milling the casing; the righting wings (4) are also welded on the body so as to facilitate the reuse of the body; And hard alloy particle (8) are coated and weld on that surface of the righting wing (4) so as to improve the wear resistance of the righting we. In the field operation process, when the casing is not centered, the efficiency of casing milling/grinding is very low. The new leading hole grinding shoe uses cutting instead of grinding, which greatly improves the operation efficiency and shortens the construction period of the adjustment well project, so as to achieve the purpose of reducing cost and increasing efficiency. Meanwhile, the tool is integrated, and the spiral cutter wings and the righting wings are welded on the body, so that the tool is simple to process and convenient to maintain; the spiral cutter wings are in a spiral shape, so that the deformation in the use process is reduced; the number of spiral cutter wings is odd, and is similar to a triangular stability principle, so as to improve the stability in the milling process; and the tool has strong universality and wide adaptability.

1.4 Field Application

1.4.1 Basic information of a well

A shut-in well in Suizhong 36 Oilfield is located in Liaodong Bay of Bohai Sea. The drilled formations are Pingyuan Formation, Minghuazhen Formation, Guantao Formation, Dongying Formation and Shahejie Formation from top to bottom. The wellbore structure is three spudding, namely $\text{Ø}609.6\text{mm} + \text{Ø}406.4\text{mm} + \text{Ø}311.15\text{mm}$; Due to the high water content of the well, it is designed to sidetrack from 130m of the well, and the new well follows the surface riser of the old well; the new well is a horizontal well with a design depth of 2358 m, and the wellbore structure is four spuddings, i.e. $609.6\text{mm} + 406.4\text{mm} + 311.15\text{mm} + 215.9\text{mm}$. The wellbore structure is shown in Figure 5.

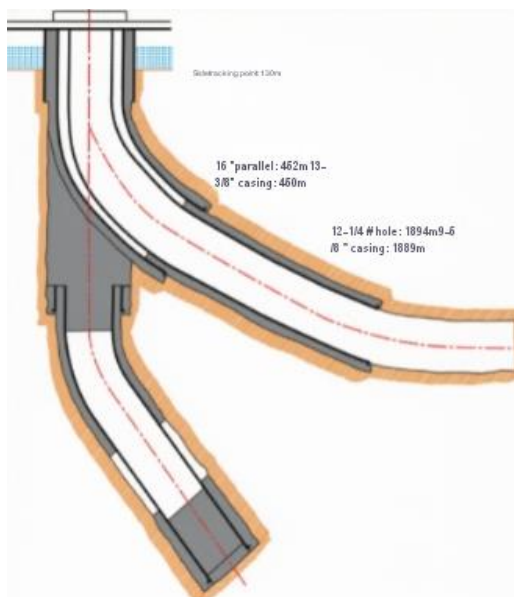


Figure 5: Wellbore Structure of New Well

1.4.2 Analysis of test results

No matter the milling shoe with wave bottom teeth or the milling shoe with Great Wall bottom teeth is used, the penetration rate cannot be effectively improved; meanwhile, if the casing has been split, it means that the casing is not centered; Therefore, it is proposed to try to use the cutting process to treat the remaining 13-3/8" casing. The cutting string combination is: 5" drill pipe + 13-3/8" pilot hole grinding shoe tool (see Figure 6) + 6-1/2" DC + 5" heavy weight drill pipe; the cutting process parameters are: bit pressure 3 ~ 4 T, rotating speed 60r/min, torque 8 ~ 10 K N. M; The cutting effect is obvious, the average penetration rate reaches 2m/H, and the return of iron filings is also obvious. In order to keep the borehole clean and avoid the accumulation of iron filings in the annulus to stop the top drive, the thick slurry (5 cubic meters) is swept every 2 hours during cutting; The blade of the collar eye grinding shoe is worn by 34 cm in total, and each blade is worn evenly, which belongs to normal wear, as shown in Figure 7. The final treatment is 13-3/8" casing to 141.5m.

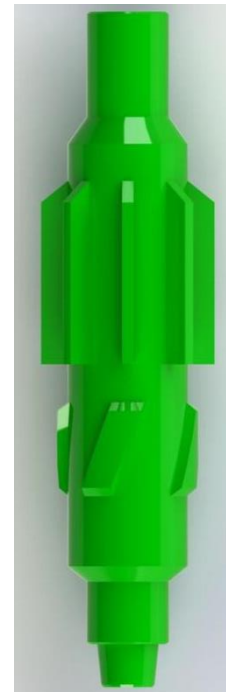


Figure 6: Shoe Grinding Tool for Collar Hole



Figure 7: Shoe Grinding for Collar Hole Out of Well

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