International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Study on Fatigue Life and Contact Stress of Valve Plate of 9-5 / 8 "Mechanical Casing Valve

Xiaodong Zhang, Youwei Gao

School of Mechatronic Engineering, Southwest Petroleum University, Chengdu, 610500, China

Abstract: ***The casing valve is working during the process, the fatigue life and sealing performance of the valve plate are the two most important factors affecting the whole valve body work. In this paper, ANSYS Workbench is used to analyze the fatigue life of the valve plate and the contact stress of the valve plate and the valve seat. Under the premise of ensuring the strength of the valve plate, the valve plate with different parameters is studied and the optimal parameters of the valve plate are obtained.***

Keywords: mechanical casing valve; valve plate parameter; fatigue life; contact stress

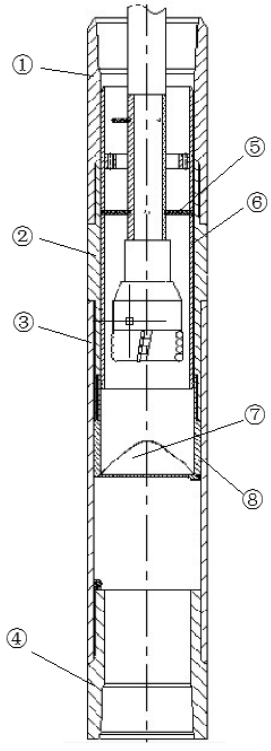
1. Preface

At present, underbalanced drilling technology in the domestic and foreign oil drilling market has developed rapidly, it has the ability to effectively protect oil and gas reservoirs, improve drilling speed, to avoid leakage, reduce the pressure difference card drill and many other advantages, has been widely used in the world Large oil and gas field development projects. The core of the whole process of underbalanced drilling technology is not killing operation, with the underground isolation technology - the promotion and application of casing valve, can better ensure that the construction of the operating conditions of the underbalanced state, to achieve the whole process underbalanced Drilling technology [1].

Downhole mechanical casing valve is installed on the casing of the cut-off valve, through the form of mechanical control to achieve the valve plate to open and close, in order to meet the requirements of underbalanced drilling. At present, there are hydraulic casing valve in the underbalanced drilling under the conditions of the strength of its valve plate analysis [2], this paper is considered in the gas underbalanced drilling, and in ANSYS Workbench gas-solid coupling, through the The fatigue life of the valve plate with different parameters and the contact stress of the valve plate and the valve seat are discussed. The influence of the valve plate with different parameters on the sealing performance is discussed. Finally, the optimal thickness of the valve plate is obtained parameter.

2. The composition and working principle of mechanical casing valve

The mechanical casing valve is shown in Fig. 1, which includes a valve body, a spool and a switch sleeve for opening the valve plate. Both ends of the valve body are connected to the casing by thread. In the process of underbalanced drilling, when the switch sleeve is lowered into the casing valve, the switch sleeve is subjected to a downward force on the drill, so as to open the valve plate, when the shear screw When the external force increases to a certain extent, it can be cut, the sleeve is detached from the drill string and fixed inside the valve body, so that the valve plate is open and protect the spool, the drill can continue to work down. In the process of drilling, when the drill will be mentioned on the valve plate will pull the switch slip sleeve out of the valve body, The valve plate under the action of the torsion spring closed, isolated from the bottom of the reservoir pressure, at this time on the drill string on the top of the force also will disappear, according to conventional methods drilling [3].



①—Upper connector ②—Middle connector ③—Connecting sleeve ④—Lower connector⑤—shear screw ⑥—switch slip sleeve, ⑦—valve plate ⑧—valve seat

Figure 1: Schematic diagram of mechanical casing valve

Mechanical casing valves have the following advantages in underbalanced drilling:

① To achieve don't kill well Underbalanced operation of the column, the reservoir can be effectively protected.
② Compared with the hydraulic casing valve, the

mechanical pipe valve control form does not require the ground hydraulic system, pipeline and joint protection device, greatly simplifies the equipment.

③ Can quickly achieve drilling, improve drilling time, reduce the drilling process from the risk of drilling.

④ Compared with the forced drilling device, the installation is simple, easy to operate, while saving costs and improve efficiency.

3. Spool valve design and modeling

In the premise of ensuring the strength of the valve plate, should be as much as possible to reduce the quality of the valve plate, the lighter the quality of the valve plate, torsion spring to overcome the smaller torque, help to improve the sealing capacity and casing valve life. In this paper, the structure of the hydraulic casing valve, the spool with double torsion spring design [4-5], connected with the valve body, in the UG to establish 9-5 / 8 "mechanical casing valve seat and valve plate The model is shown in the figure:

Figure 2: spool valve diagram

Further use UG based on 9-5 / 8 "mechanical casing valve to establish the valve plate thickness of 10 to 15 a total of six groups of three-dimensional model, the three-dimensional model into the ANSYS Workbench, the use of gas-solid coupling of different thickness of the valve plate Fatigue analysis and contact stress analysis, the overall simplified model as shown:

Figure 3: Integral simplified model of spool valve

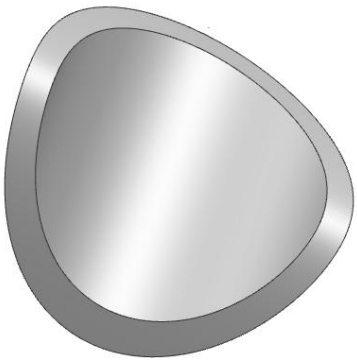


Figure 4: three-dimensional model of the valve plate

4. Fatigue life and contact stress analysis of valve plate

Valve plate and valve seat material selected 45CrNiMoVA, elastic modulus of 206GPa, Poisson's ratio of 0.3; gas medium selected N2, density 7.114484kg/m^3, viscosity 0.0170755kg/m-s. According to the actual conditions, the use of gas - solid coupling, in the seat end of the application of fixed constraints, the thickness of the valve plate to make life and sealing effect analysis, as shown in Figure 5, Figure 6 shows.

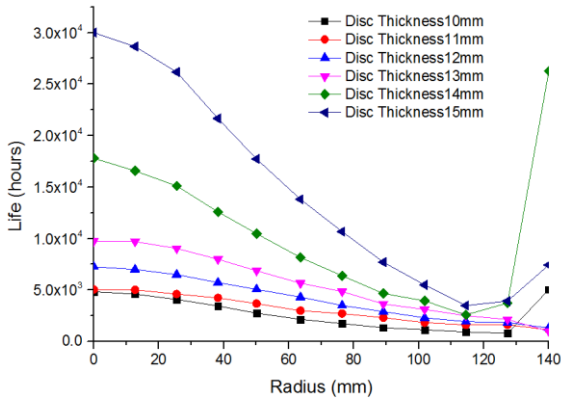


Figure 5: Valve plate thickness – life relationship

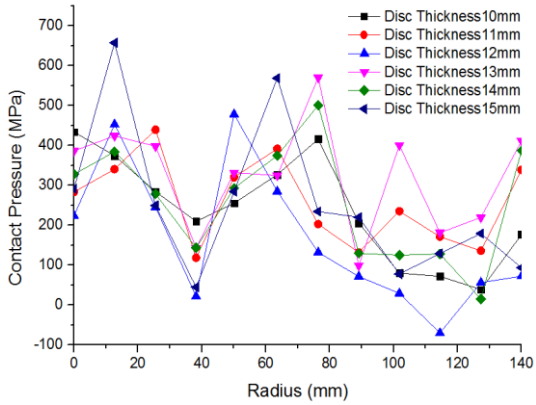


Figure 6: Valve plate thickness - contact stress relationship

As can be seen from Figure 5, the life of the valve plate increases as the thickness of the valve plate increases, and the life of the outside diameter of valve plate decreases due to the direct contact with the valve seat.

It can be seen from Figure 6, the valve plate thickness of

12mm, the valve plate and the valve seat contact process in the valve plate at the edge of the contact stress -70MPa, then seal failure. Valve plate thickness of 10mm, 11mm, 15mm, although there is no contact stress for the negative seal failure, but the contact stress curve fluctuations, likely to cause damage to the sealing surface. Valve plate thickness of 13mm, 14mm, the contact stress does not appear negative, the curve is relatively smooth, and in the life curve, the valve plate life tends to intermediate state. In ensuring the strength and life of the valve plate under the premise of the valve plate should be as much as possible to reduce the quality, so the analysis can be seen that the optimal thickness of the valve plate should be between 13mm-14mm. The following to take the plate thickness of 13.5mm for further analysis.

5. Optimal Results

Through the analysis of the gas-solid coupling of the valve plate thickness of 13.5mm, it can be seen from Figure 7 that the maximum value of the fatigue life value and the minimum point are very few, the life of the whole valve plate is basically between 2184 and 30149 and the distribution is more uniform.

It can be concluded from Figure 8, the valve plate and the valve seat in contact with the middle area does not appear stress value of less than 35Mpa situation, indicating good sealing performance. The minimum value of the contact stress appears in the outermost layer of the contact area, indicating that the contact stress may be less than 35 MPa in the edge area where the valve plate is in contact with the valve seat under the action of the gas pressure, so the design can be considered to add rubber seals make the sealing performance is more good.

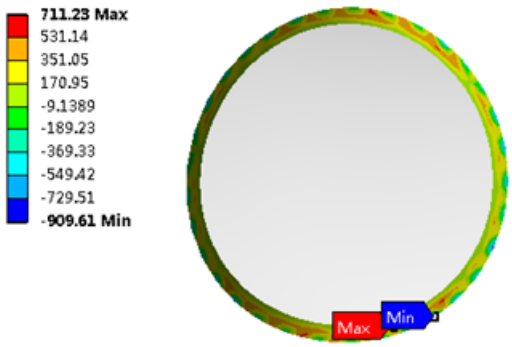


Figure 7 valve plate fatigue life diagram Figure

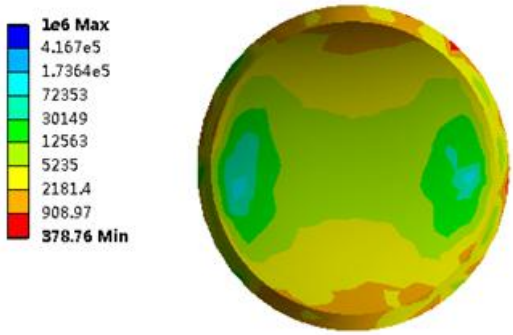


Figure 8: Valve plate and valve seat contact stress cloud

6. Conclusion

(1) Fatigue life analysis of valve plates with different thickness is analyzed by gas-solid coupling. The analysis shows that the life of the valve plate increases with the increase of the thickness of the valve plate. Considering the effect of the sealing performance between the valve plate and the valve cover, the optimum thickness of the valve plate of casing valve is between 13mm and 14mm.

(2) When the thickness of the valve plate is 13.5mm, the life chart of the valve plate is obvious and the gradient of the contact pressure cloud is obvious. Minimum contact pressure greater than 35MPa, to meet the sealing requirements and the best life.

(3) The life of the outer diameter of the valve plate and the contact pressure are relatively small, which proves that the outer diameter of the valve plate has the greatest influence on the overall sealing performance.

References

[1] Fan Haiyang. Liaohe Oilfield 7 "casing valve technology research [D]. Northeast Petroleum University, 2015.
[2] Li Bin, Shen Xuefeng. Improvement and optimization of underground casing valve underbalanced drilling [J]. Petroleum Mine Machinery, 2010, (09): 33-37.
[3] Zhang Baogui, envy Wei Wei, Chen Kexu, Luo Maona. Mechanical downhole casing valve [P]. Chinese patent, 2012, 11, 05.
[4] JIA Li, JIANG Bai-shun, XIE Cong-hui, et al. Development of DQ-9-5 / 8 "Casing Valve [J]. Western Exploration Engineering, 2010, 22 (8): 81-82.
[5] Development of Underground Control Valve for Underbalanced Operation [J]. Petroleum Mine Machinery, 2009, (01): 78-81.
[6] XIE Cong-hui, JIANG Bai-shun, JIA Li, BAI Xiao-jie.Study on Downhole Sealing Spool of Casing Valve [J]. Western Exploration Engineering, 2010, (10): 120-121 + 124.
[7] Li Linzhen, Guo Yongqi, Li Shici. Application of underground casing valve [J]. China Western Technology, 2015, (02): 32-33