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The Impact of Casing Damage Critical Condition on Marker Bed With Differential Internal and External Pressure in Daqing Oilfield

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Abstract

During long-term development of Daqing oilfield of marker bed has been affected sliding between layers, causing a large area of casing damage. The marker bed casing damage mechanism has been basically clear at present, but the influencing factors of casing damage are not yet consummate. There is fluid impact of pressure on the casing on the marker bed, and fluid pressure on the critical conditions of casing damage has not yet been carried out in research. To research the critical conditions, taking into account the mechanics characteristics of the formation and elastic-plastic the finite element model has been established, and different sets of pressure differential as critical condition impact on casing damage were studied in this paper. The results showed that the internal and external casing liquid pressure difference has little effect on the formation of critical slippage. High internal casing pressure wells, with small casing damage critical slippage, are more likely to damage.

Key words: Daqing oilfield; Casing damage; Marker bed; Finite element; Internal and external casing pressure differential

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INTRODUCTION

Marker bed, with the presence of weak surface level on, is the upper reservoir in Daqing Oilfield. With the long-term development of the block, marker bed has been broken in some areas, horizontal crack appeared. Under the influence of the geologic function, the marker bed has slipped, causing a large area of casing damage, which seriously affects oil production. Currently, casing pressure of wells has heightened in the concentrated area where plenty of casing damage has happened on the marker bed. The increasing of casing pressure causes the imbalance of internal and external casing pressure. Inside and outside casing pressure difference, as the critical condition of casing damage, affect stress of casing and strain in the casing damage process. For this, finite element model with different sets of critical conditions on internal and external casing pressure differential would be carrying out.

1. RESEARCH IN CASING DAMAGE CRITICAL CONDITION

Casing damage mechanism in marker bed is entirely different with conventional casing damage mechanism. Conventional casing damage is compression deformation because of the deformation of formation. Because enhancing casing strength can prevent the formation of large plastic deformation, casing by formation extrusion pressure and casing strength are yardstick to judge the casing damage. A large area of formation slip induced the casing damage in marker bed. The big scale of formation slip can damage casing easily owing to the casing strength is incomparably less than the force of formation slip. To the other words, casing's hardiness can not resist the slip of formation. It is sagacious to measure the slippage of formation as the casing damage's critical conditions, not to analyze the strength of casing.

The pressure of internal and external casing impacts the stress of casing and formation on the marker bed in the process of casing damage during stress. Considering the pressure's balance between internal and external casing, defined as internal and external casing pressure differential on casing, the fluid pressure between internal and external casing is symbolized by D*P*, and D*P* = *P* internal -*P* external. Using the method of finite element simulation to analyze internal and external pressure casing slip effect on the formation, the impact can be analyzed by the impact of formation on casing and the slippage of casing shear failure.

2. THE INFLUENCE OF INTERNAL AND EXTERNAL PRESSURE DIFFERENTIAL ON THE FORMATION STRESS

Casing damage of Nen2 bottom marker bed is mainly shearing failure result from the slipping of formation. During the slipping, casing will produce a reaction force to balance the shear stress to the casing. So the internal and external pressure casing reaction forces should be study.

When the simulation, the casing and external pressure from -5 MPa increased to 18 MPa. Figure 1 shows the different internal and external pressure casing reaction force.

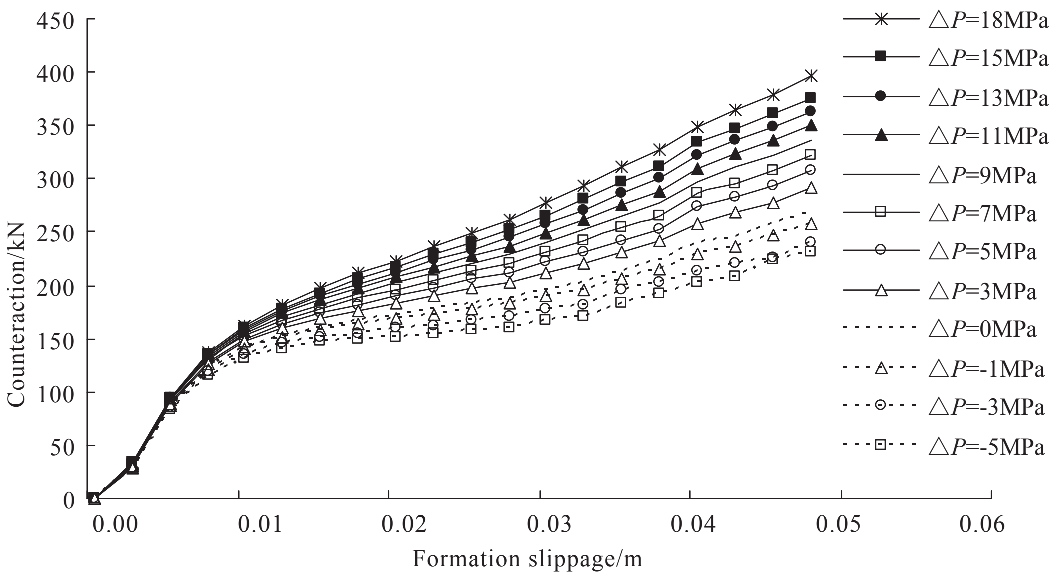

Figure 1
The Counteraction in Different Sets of Internal and External Casing Pressure Differential

As can be seen from Figure 1, with the increasing in pressure inside and outside the casing reaction force is tended to increase. Internal and external casing pressure differential from -5 MPa increased to 18 MPa, and the maximum increase in the reaction force has added to 43%, the maximum reaction force of 3.95×10^3 MPa, which shows the influence of internal and external casing pressure differential on slip of formation.

The shear slip of formation between the layers overcome the friction of about 8.76×10^6 kN, which is more than 2,000 times of ground reaction force. The force of formations slip casing should be more than equal to the reacting force value. Comparing the two values, the formation of the overall force is much larger than the reaction force of casing impact on the formation. Therefore when the slippage of the formation shearing casing, the changes between external and internal casing pressure can be ignored.

3. THE INFLUENCE OF INTERNAL AND EXTERNAL CASING PRESSURE DIFFERENTIAL ON TENSILE STRAIN OF CASING

When the formation of shear slip casing, the maximum tensile strain is critical to the damage of casing, it can be variable as the casing of the main parameters determining the casing is damaged. Simulation get the trends of casing maximum strain values under different external pressure, shown in Figure 2. As can be seen from Figure 2, with increasing internal and external casing pressure differential, the casing maximum strain value change slightly. When the slippage of formation is less than the amount of slip 20.00 mm, maximum strain of casing are coincident. To the other words, there is no significant influence of internal and external casing pressure differential on casing maximum tensile strain rate. When the layer slippage is between 20.00 mm and

40.00 mm, layer slippage between 20.00 mm and 40.00 mm, which the casing and external pressure increases from -5 MPa to 18 MPa. As the maximum strain of the casing to the critical value (0.24 casing strain at failure), the slippage that the casing damages decrease from 36.00 mm to 35.50 mm, which illustrates increasing internal and external casing pressure differential will reduce the slippage that the casing can sustain. When the slippage is greater than 40.00 mm, the maximum strain of casing tends to coincide. In conclusion, the change of internal and external casing pressure differential impact on the slippage of formation slightly.

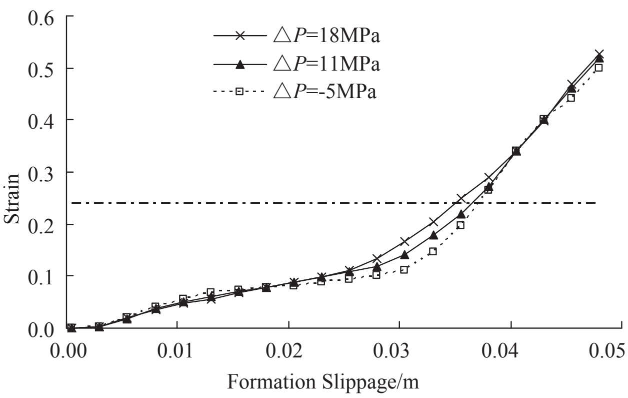

Figure 2
The Maximum Strain in Different Sets of Internal and External Casing Pressure Differential

With the increase of internal and external casing pressure differential, the critical formation slippage that the casing damages trends downwards. When the internal and external casing pressure differential is -5 MPa, the critical formation slippage that the casing damages is 35.00 mm; and when increase of internal and external casing pressure differential is increased to 18 MPa, the critical formation slippage that the casing damages becomes 37.14 mm. It shows that the casings with larger internal and external casing pressure differential are likely to damage in the conditions that casing is impacted on the same slippage of formation, and the differential 23 MPa affect only 5.76%, which can be negligible.

Through the above analysis, to prevent the casing damage on marker bed, being focus on reduce the slippage of formation which has impact on casing instead of decreasing the internal and external casing pressure differential which delays the casing damage is efficacious.

According to results of finite element analysis in this paper, it shows that the change of internal and external casing pressure differential impact on the slippage of formation slightly. So the internal and external casing pressure dedicate to delaying the slip of formation slightly.

CONCLUSION

(a) The larger reactive force which is affected by the larger fluid pressure in the internal casing resists the slip of formation. In fact, the effect of the reactive force can not resist the slip of formation, so the resistance to the slip of formation can be negligible.

(b) The casings with larger internal casing pressure is likely to damage when the slippage of formation is small, and the differential 23 MPa affect only 5.76%, which can be negligible.

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