Study on the cause classification and prevention methods of casing damage

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Abstract: The casing damage wells in non oil layers are mainly distributed in the N2 and SI-SII oil shale interlayer, and the casing damage types are mainly deformation and dislocation. The main reason is that the injected water enters into the oil shale, the cementing quality is poor, and it is easy to form an invasion water area after invading along the channeling channel, which reduces the stability of the formation. Under the effect of geostress, the force generated by the formation sliding along the weak surface is directly applied to the casing, causing shear casing damage; The casing damage in the oil reservoir is mainly concentrated in SII1-5 layers, which is analyzed as a result of high pressure water injection and large difference in plane and interlayer pressure; The casing damage on the fault plane is mainly caused by slip caused by water softening on the fault plane and fault activity caused by excessive difference in pore pressure of oil layers on both sides of the fault. This paper expounds the measures taken in daily management from the aspect of casing damage prevention, which provides a basis for the prevention and control of casing damage wells in the future.

Key words: cause of casing damage well; Prevention and control of casing damage well.

1. General situation of casing damage

Since its production and development in 1970, Block A can be roughly divided into three stages, namely, water injection and flowing production stage, flowing to pumping stage, and formation subdivision and infilling adjustment stage. In the layer system subdivision and adjustment stage, it is divided into primary encryption adjustment, secondary encryption adjustment and tertiary encryption adjustment. From the change curve of the number of wells with damaged casing over the years, it can be seen that from 1978 to 1981, the number of wells with damaged casing increased year by year. From 1982 to 1986, the number of wells with damaged casing was stable at about 10. From 1986 to 1990, the number of wells with damaged casing decreased from 8 in 1986 to 3 in 1990. Therefore, before 1990, the basic well pattern went through the production stage of flowing, flowing, pumping and overall pumping, while the casing damaged well has gone through the process of rising, stabilizing and falling since it was discovered in 1978. Since 1990, infilling adjustment has been started. After infilling adjustment, with the increase of the number of wells with damaged casing in primary wells, secondary wells and tertiary wells, the number of wells with damaged casing is generally on the rise.

2. Causes of casing damage

2.1 Analysis of casing damage well in non oil layer

The casing damage in non oil layer is mainly concentrated in N2 and SI-SII interbeds. It is believed that water inflow from oil shale is the main factor causing casing damage.

1) Water ingress into the oil shale of N2 causes casing damage around the well

The lithology of the marker bed at the bottom of N2 is mainly dark grey, grey black and black grey massive mudstone and mud shale with weak sound. The rock contains rich ostracods and phyllopoda fossils, which are mostly distributed along the layers, but most of them are unevenly distributed. Some layers are densely distributed, while some almost do not contain fossils. The phyllopoda fossils are also enriched into layers locally. There are few fossils in the shale, the foliation is developed, the inner layer is flat, and sporadic fish fragment fossils can be found locally. Silt is contained locally in mudstone, horizontal bedding is mostly developed, rock section is also relatively neat, and lithology of the whole section is characterized by weak hard lithology.

The study shows that there is a weak lithologic interface in the fossil belt corresponding to the third peak of the electrical logging curve at the bottom of N2 Member. After the injected water is immersed along the channeling

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channel, it is easy to form an immersion area, which reduces the stability of the formation. Under the action of in-situ stress, the force generated by the formation sliding along the weak surface is directly applied to the casing, causing shear casing damage.

A total of 67 casing damage wells were found in the standard layer of N2, accounting for 21.27% of the non oil layer. In the first half of 2013, two casing damage wells were found in the standard layer of N2: Well A is a well in Block A. During the overhaul in April 2013, 861.3m casing was found to be broken. The casing damage layer is N2, with a minimum diameter of 92mm. At present, water is injected after the overhaul. In order to verify whether there is water inflow into the standard layer of N2, the water injection wells around the well block have been investigated to determine the water immersion range of N2. A total of 5 wells have been inspected; Well B is an oil well in Block A. During profile control in January 2013, it was found that the casing at 717.53m was broken. The casing damage layer was at Section N2, with a minimum diameter of 104mm. The well was not overhauled successfully and is now to be scrapped.

2) The injected water channeled to the interlayer oil shale of SI-SII along the bedding, resulting in casing damage

Horizontally, there are two or three obvious peaks in the SI-SII interlayer, which is an oil shale with high abundance of ostracoda, phyllopoda and other fossils, brittle texture and developed bedding. The analysis shows that the main reason is the casing damage of oil and water wells in the oil shale after water inflow along the bedding. The causes of water ingress may include:

(1) The cementing quality is poor, and the casing is damaged due to the external immersion of injected water. According to statistics, there are 158 wells with casing damage in SI-SII interlayer, 61 wells with good cementing quality, accounting for 38.6%, and 97 wells with poor cementing quality, accounting for 61.4%.

(2) Fracturing of SII1 layer may cause injected water to move up along the longitudinal fracture, causing casing damage of SI-SII interlayer.

(3) The casing damage of adjacent wells is caused by water inflow at the interlayer of Well SI-SII.

Therefore, it is believed that the main reasons for casing damage of SI-SII interlayer are the poor quality of water well fracturing and cementing of SII1 interlayer.

2.2 Analysis of casing damage wells in oil layers

1) High pressure water injection easily leads to casing damage

Long term high-pressure water injection in water injection wells is the main cause of casing damage in oil layers. From the perspective of the two blocks that have experienced high pressure water injection, the casing damage ratio is relatively high, while the casing damage ratio of the blocks that have been put into development at the same time and have low water injection pressure is very low. It can be seen that high pressure water injection is an important cause of casing damage, and the well pressure drop of top fracture pressure water injection is an important means to reduce casing damage.

2) Uneven plane pressure distribution and large interlayer pressure difference easily lead to casing damage

Due to the influence of development well pattern, production method and development strata, the development block forms a high and low pressure area on the plane, which makes the distribution of formation pressure uneven on the plane and between layers. Due to the change of the maximum and minimum horizontal principal stress distribution, the circumferential stress distribution of the casing is uneven. When the change of this force exceeds the anti extrusion or anti shear strength of the casing, the casing is damaged.

With the continuous deepening of oilfield development, the conditions of the adjusted target oil layer become worse, and the shale content in the oil layer increases. In the oil field developed by water injection, it is easy to cause the pore plugging of the oil layer, which reduces the water injection volume. High pressure injection is required to meet the needs of oilfield development. With the continuous increase of water injection pressure, the pressure difference between different sub layers is increasing, and the difference of formation pressure is an important reason for casing damage.

3. Study on Prevention and Treatment of Casing Damage Wells

3.1 Prevention and treatment methods for N2 and SI-SII interbeds in non oil bearing section

(1) For the water injection wells around the newly added N2 bottom casing damaged wells, water injection shall be controlled or stopped immediately, and then the well condition shall be investigated. For the casing damaged wells, water injection must be resumed after major repair. The casing damage at this position brings the greatest harm to oilfield development, which is the most important part of casing damage prevention and control work, and also the focus of casing damage analysis.

(2) For the casing damage at the oil shale of N2 and the interlayer between SI-SII, if the casing protection packer is not sealed, the first stage packer shall be installed at the casing damage position to prevent casing damage at the same position of the surrounding oil and water wells. Investigation was made on the casing damage of the packer in N2 Member and SI-SII Sandwich. The investigation results show that 21 of the 54 wells have been scrapped due to multi-point casing damage and serious dislocation. The remaining 33 wells were fully investigated and found to be overhauled. According to horizon analysis, there are 5 wells in N2 and 28 wells in SI-SII interlayer. There are 26 wells with eccentric passing and 7 wells with smooth tube passing. In view of the actual situation, for the wells that currently use packers, put dead nozzles, and the last operation time is before June 2012, all the wells have been re sealed, with a total of 20 wells.

(3) Investigate the scrapping method of scrapped wells for casing damage at non oil layer N2 oil shale and SI-SII interlayer, and scrap the well used micro expansive cement scrapped with heavy mud.
(4) When new wells are arranged in the casing damage area of the standard layer of N2 and the SI-SII interlayer, p110 casing is run in the standard layer of N2 and the SI-SII interlayer to improve the casing shear strength and prevent casing damage.
(5) To prevent casing damage caused by water entering the standard layer in the free section of N2 section. During the completion of new wells, a part of the cement return height is selected to be higher than the standard layer of N2 for future comparison and analysis.
(6) In order to prevent casing damage caused by mud water inflow expansion, anti expansion agent is added to newly injected water injection wells to reduce mud water immersion expansion.

3.2 Prevention and treatment methods for oil layers

1) Reduce water injection pressure
High pressure water injection is an important cause of casing damage, and the well pressure drop of top fracture pressure water injection is an important means to reduce casing damage.
2) Adjust the high and low pressure blocks to reduce the plane and interlayer pressure difference
In order to avoid casing damage of oil layer caused by abnormal pressure, the monitoring data, oil and water well dynamic and static data, etc. are used to comprehensively analyze the injection and production status of single sand layer and determine the abnormal pressure well layer. In 2013, we will focus on the adjustment of water injection scheme and periodic water injection to control the water injection of SII1- SII5 and SII9-SII11 layers with relatively high formation pressure, appropriately increase the water injection volume of the main oil layers and some main thin sand layers of PI Formation, and strive to balance the plane pressure between layers. At the same time, the newly discovered casing damage wells in oil layers are analyzed and treated. In view of the actual situation that the pressure difference between layers and planes is large, it is planned to reduce water in the high-pressure layer.

4. Conclusion

(1) At the bottom of N2 in Block A, casing damage is easy to occur at the position with high fossil content and the highest apparent resistivity. The positions where casing damage is easy to occur in oil layers are mainly concentrated in the positions where lithology changes. The casing damage is the result of mechanical shearing, and the casing damage type is mainly shear casing damage and there is casing damage shear band.
(2) Water injection with excessive reasonable pressure can lead to casing damage of water injection wells in the overpressure water injection well section, and the greater the overpressure amplitude, the faster the casing damage of oil and water wells. Considering the influence of various factors, the reasonable water injection pressure limit of the oil layer should be controlled within 0.5MPa lower than the overlying rock pressure of the oil layer.
(3) The genetic type of abnormal high pressure layer is mainly caused by the imperfect injection production relationship of single sand body. With the continuous infilling and adjustment of the well pattern, the mining object gradually becomes worse, and the distribution of high-pressure layer also changes with the change of the adjusted target layer.
(4) The prevention and control measures for casing damage at the bottom of N2 in Block A should mainly focus on improving the cementing quality of new wells and the key prevention measures in key areas.
(5) The formation pressure on both sides of the fault shall be controlled reasonably and monitored in time to prevent casing damage caused by excessive differential pressure on both sides exceeding the critical value.
(6) For abnormal water injection wells near the fault, timely test and adjust. If the adjustment is not successful, shut in the well in time for operation to prevent the injected water from entering the fault to further expand the immersion area and aggravate casing damage.
(7) For casing damage wells that have been at the breakpoint, pay close attention to other wells with the same breakpoint on this fault, and reduce the formation pressure difference in time to prevent casing damage in pieces.

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