

Influences of Downhole Fracturing on Drilling Construction and Corresponding Measures

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Abstract

With the continuous development of shale gas exploration, infilling wells and adjustment wells in the same block have increased, and adjacent wells have fractured or are fracturing, which has a serious impact on drilling operation. By analyzing the influence of downhole fracturing on formation and drilling operation, this paper adopts three recommended methods for fracturing wells and two recommended methods for fractured wells. Through comprehensive analysis of formation, wellbore safety and well control equipment, practical technical measures are put forward to provide a good construction environment for drilling wellbore safety.

Keywords

shale gas; infill well; fracturing; drilling; Recommended Practice.

1. Preface

With the deepening of Fuling shale gas exploration, more wells are laid out in the same block, and the problem of anti-collision is more prominent. At the same time, the fracturing operation of adjacent wells has brought serious adverse effects on the construction of positive drilling, and even threatened the quality and safety of drilling construction. Because of the accelerated pace of productivity construction, it is impossible to drill all wells in the same area before fracturing. Therefore, it is necessary to analyze the influencing factors of adjacent wells fracturing on forward drilling and drilling, and to study the management, technology and safety in view of the simultaneous drilling and fracturing in the same area or the formation that has been fractured. By taking corresponding measures, it is necessary to minimize the interference and influence of downhole fracturing on drilling construction and ensure construction safety. Problems to be solved.

2. Analysis of the Influences of Downhole Fracturing on Formation

Usually the amount of downhole fracturing fluid used in a single well is more than 50,000 square meters. During fracturing operation, the wellhead construction pressure can reach 60-90 MPa, and the amount of backflow after fracturing is less than 10%. Most of the fracturing fluid is left in the formation. The impact is mainly reflected in the following aspects:

- (1) Fracturing construction results in destruction of geological structure of target formation and deterioration of formation stability;
- (2) The fracturing fluid remains in the formation, and the immersion of the formation will further affect the formation stability.
- (3) Fracturing fluid will pollute drilling fluid and change its performance.
- (4) Fracturing operation changes the original state of formation pressure coefficient and forms abnormal high pressure in local area.

- (5) Fracturing creates a complex fracture network in the formation, forming new leakage channels and cavities;
- (6) Fracture network formed by fracturing provides conditions for gas migration and accumulation in formation, which is also the ultimate goal of downhole fracturing operation.
- (7) The impact of fracturing may reach hundreds of meters or more.

3. Influences of Downhole Fracturing on Drilling Construction

For drilling operation, there will be downhole safety problems and well control safety problems when adjacent wells are fractured during drilling or when they are drilled in the strata that have been fractured.

3.1. Underground Safety

- (1) After the adjacent well fracturing fluid enters the wellbore, the drilling fluid is polluted and its performance changes greatly, which may easily lead to well collapse and downhole sand sinking, and sticking in serious cases.
- (2) Fracturing construction leads to the destruction of geological structure and the deterioration of formation stability, which can easily lead to well collapse and downhole sand sinking, and even sticking when serious.
- (3) The immersion of fracturing fluid in formation will further affect formation stability, which may lead to well collapse and sticking in slight cases, and in severe cases may lead to drilling construction can not be carried out;
- (4) Fracturing operations in adjacent wells will affect the stability of drilled holes and cause drilling resistance. If long-distance drilling is carried out, the risk of new holes will increase.
- (5) If the formation has been fractured and immersed in fracturing fluid, there is not only the risk of well collapse and sticking, but also the possibility of serious leakage.

3.2. Well Control Safety

- (1) The fracturing fluid from adjacent wells enters the wellbore of normal drilling, which leads to the direct overflow of normal drilling.
- (2) The fracturing fluid from adjacent wells drives formation gas into the wellbore of the drilling well, which results in the occurrence of hydrocarbon value increase and wellhead spillover and other well control hazards.
- (3) The abnormal high pressure formed by formation after fracturing will lead to high hydrocarbon value in the drilling process, or the continuous flow of pumping wellhead, endangering the safety of well control.
- (4) Fracture network formed by fracturing provides conditions for gas migration and accumulation in formation. During drilling, formation gas will rapidly accumulate in wellbore to form gas column, which will lead to blowout.
- (5) After fracturing, the gas reservoir becomes active. It is difficult to stabilize by simply increasing the density of drilling fluid. A large amount of combustible gas is carried out when circulating drilling fluid, which makes drilling construction impossible.
- (6) Fracture network formed by fracturing also increases the possibility of lost circulation. The "same layer of leakage" in drilling increases the complexity of the problem and the difficulty of processing.

4. Measures and Recommended Practices for Ongoing Adjacent Well Fracturing

Since the fracturing operation in adjacent wells has brought serious adverse effects on the construction of positive drilling, corresponding measures should be taken from the aspects of management, technology and safety to minimize the interference and influence of downhole fracturing on drilling construction and ensure the construction safety.

4.1. Establish Multi-party Early Warning Mechanism and Emergency Disposal Mechanism to Effectively Control Risks.

- (1) The project department organizes specialized companies to establish information exchange platform and emergency disposal platform with Party A.
- (2) Drilling companies should do well in trajectory prediction, anti-collision scanning, calculation of the nearest well spacing with fractured wells in advance, and make pre-construction submissions in advance.
- (3) Before fracturing, the downhole testing company should confirm whether there is positive drilling around the fracturing section, and the positive drilling within 1000 meters around the fracturing section should be taken into account.
- (4) In fracturing operations, hotlines should be established in fracturing wells and adjacent drilling wells to ensure the smooth flow of information.
- (5) Two hours before the start of fracturing, the downhole test fracturing team shall give a briefing to the adjacent drilling team, including information on the start and end time of the operation, the estimated fluid volume and the estimated construction pressure, so that the drilling team can respond.
- (6) The downhole test fracturing team can not carry out fracturing operation until it receives the information that the drilling team is ready.
- (7) The drilling company and the drilling team should be aware of the fracturing operation performance of the adjacent wells around the well being drilled.
- (8) During the fracturing operation of adjacent wells, the drilling team should pay close attention to the situation of the well and inform the downhole test fracturing team immediately if abnormal conditions occur.
- (9) After the completion of the fracturing operation, the downhole test fracturing team shall confirm whether the operation has an impact on the surrounding positive drilling, as well as the scope and magnitude of the impact.

4.2. Fracturing Operation with Adjacent Wells

The drilling stops temporarily, starts drilling into the casing, closes the well for observation, and resumes production after fracturing operation and pressure relief. The main measures taken are as follows:

- (1) Through information exchange platform and emergency disposal platform, the drilling team strengthens communication with downhole operations, assigns a cadre to establish contact with downhole test and fracturing team, and grasps the dynamics of fracturing wells at any time.
- (2) After receiving the fracturing notification from adjacent wells, the drilling team must start drilling into the technical casing in time to prevent sticking.
- (3) The drilling team should close the blowout preventer and close the well for observation in order to control the entry of fracturing fluid into the wellbore to the greatest extent.
- (4) During the fracturing operation of adjacent wells, the drilling team should send special personnel to observe the change of wellhead pressure in order to assess the impact of fracturing of adjacent wells on the well in time.

(5) If adjacent well fracturing results in the wellhead pressure approaching the limit casing pressure, the downhole test fracturing team shall be immediately notified to stop operation. To prevent construction pressure from endangering drilling wellhead safety when normal drilling and fracturing wells are fully connected.

(6) If fracturing operations in adjacent wells have resulted in an increase in wellhead pressure, after fracturing, the drilling team shall liaise with the downhole test fracturing team to determine that the fracturing well shall first relieve pressure.

(7) During the process of releasing pressure from fractured wells, the drilling team should record the pressure drop of the wells. After confirming that the pressure of the fractured wells has been released, the pressure of the wells can be relieved by throttling manifolds in order to control the fracturing fluid entering the wellbore to the greatest extent.

(8) The drilling team should pay attention to the following conditions when relieving pressure through throttle valve:

①. When relieving pressure at wellhead, drilling fluid can be recovered through a liquid-gas separator and a long open fire can be ignited at the exhaust port in order to observe whether combustible gas enters the wellbore.

②. The pressure relief process should be as smooth as possible.

③. If the pressure drops rapidly during pressure relief, it means that the main fluid enters the wellbore. After pressure relief, downhole drilling and circulating sewage should be opened as soon as possible to prevent well collapse and sticking.

④. If the pressure drops slowly or the pressure does not decrease and rises, it indicates that there is gas entering the wellbore, and the pressure can not be relieved any more at this time, the "driller method" should be adopted to throttle and circulate sewage. After the gas is circulated out of the wellbore, the casing pressure is observed to be zero.

(9) Downhole drilling can only be carried out when casing pressure is 0. Otherwise, the pressure relief of fractured wells should be confirmed.

(10) In the process of drilling, subsection circulation should be adopted. Fracturing may cause wellbore instability and prevent sticking failure.

(11) during tripping circulation, strengthen the measurement of drilling fluid performance and timely adjust and recover the polluted drilling fluid.

4.3. Uncertainty of Adjacent Wells

If the drilling team has not obtained the information about the possible fracturing of adjacent wells, or has insufficient knowledge of the impact of fracturing operations on normal drilling, and has not taken the corresponding measures mentioned above in advance, the following points should be done:

(1) Careful daily inspection of well control, key well control parts such as blowout preventer, control system and gate waiting condition should be inspected to ensure that the hardware facilities are in place.

(2) In the process of drilling construction, we should strengthen monitoring, implement the system of sitting observation and cadre follow-up, monitor well the changes of drilling fluid performance and total hydrocarbon value, and ensure that the drilling crew sitting on guard can find the overflow in time to ensure that formation fluid enters the wellbore as little as possible.

(3) Strengthen well control field management, especially well control equipment inspection, blowout control exercises, etc. We must ensure that the emergency situation is not chaotic, and that the well must be shut down at the first time after spillover is found, so as to ensure that the wellhead can be controlled and the downhole situation can be avoided to deteriorate.

(4) Monitor wellhead pressure after shutdown and report to drilling company, Technical Department of engineering company and Party A to verify whether the overflow was caused by fracturing of adjacent wells. We must not blindly throttle circulation killing, otherwise oil-based mud will be seriously polluted by fracturing fluid, and even may lead to sticking. Therefore, in view of this abnormal high pressure can not be solved by conventional killing methods, we must pay great attention to it.

(5) Once it is determined that there are fracturing wells around overflow wells, emergency disposal mechanism will be initiated to relieve pressure through fracturing wells.

(6) Once the oil-based mud is polluted, it is necessary to timely discharge sewage or add additives to adjust, and the well team reserves sufficient diesel oil, emulsifiers and other key materials to prevent the mud performance fluctuations leading to downhole failure or complex occurrence.

5. Drilling Safety Measures and Recommended Practices for Fractured Formations

During drilling in fractured formations, because the fracture network formed by fracturing provides conditions for gas migration and accumulation in formations and may also form local abnormal high pressure, formation gas will rapidly accumulate in wellbore to form gas column during drilling. Well control risk is different from that of conventional shale gas wells, but has the well control risk of high-pressure natural gas wells. Features. Therefore, we must implement the corresponding construction plan and technical safety measures.

5.1. Ready

Sufficient material, material, technology and safety preparations should be made before construction to provide necessary guarantee for construction safety. It mainly includes the following contents:

(1) The well control device in the well site should be in a reliable state, and the driller can shut down the well quickly on the drilling platform.

(2) Every drilling tool should be equipped with an internal blowout preventer. Floating valves are recommended. The internal blowout preventive tool should be immediately followed by the drill bit. When using the downhole power drill tool, the internal blowout preventive tool should be installed between the screw and the directional joint. Internal blowout preventer with snap on device shall be provided on the drill floor.

(3) In the third stage of using oil-based drilling fluid, the standby working condition of throttle manifold should be set to implement "hard shut-in", and the valves entering the liquid-gas separator and the valves entering the nozzle line should be closed.

(4) The exhaust and exhaust nozzles of the liquid-gas separator ignite the long open flame.

(5) The drilling crew should perform the practice of "hard shut-in" with the driller's operating platform (not the usual "47" action) to ensure that abnormal shut-in is found directly and quickly, and each drilling crew should be skilled in it.

(6) 80 cubic meters of oil-based drilling fluid, 180 tons of barite and 16 tons of plugging material are reserved in the field, ensuring at least 2 times of plugging. The above materials are supplemented with use.

(7) There should be enough exhaust fans on the drilling platform, the wellhead, the shaker screen and the circulating tank surface to keep running. Prevent the accumulation of combustible gases on the ground.

(8) The well site is equipped with fracturing trucks and the pipelines are connected to the well killing pipelines. If necessary, the well killing is pushed horizontally from the annulus.

(9) Make preparations for installation of rotary control head at wellhead, and use rotary control head to implement simple pressure control drilling when necessary.

5.2. Well Control Technology

The fracture network formed by fracturing not only connects the gas reservoir, but also increases the possibility of well leakage. In this case, the pressure window is narrowed or even not, so special well control technical measures need to be taken.

(1) The upper limit control of drilling fluid density should ensure that no leakage or acceptable degree of leakage occurs during circulation. Otherwise, the excessive consumption of oil-based drilling fluid will not only increase the cost, but also be unsustainable.

(2) in the process of drilling circulation, the hydrocarbon value will be higher, so the drilling shall be stopped in the middle of the drilling process, and the circulating blowdown shall be carried out through the choke manifold and liquid gas separator. Prevent gas from forming large gas column in wellbore.

(3) After stopping circulation in the middle, gas will accumulate to form gas column in the well. The well should be closed and discharged through throttling circulation of liquid-gas separator before drilling resumes.

(4) If leakage occurs, the circulating displacement can be reduced. The use of plugging agent may solve the problem, but the precondition is not to cause blockage of water hole in drilling tools.

(5) Sitting at mud outlet is the main work during drilling. If abnormal increase of wellhead return flow occurs, the driller should be notified to shut down the well hard immediately. After closing the well, it can throttle and circulate sewage through the liquid-gas separator, and then resume drilling.

(6) After drilling out of the horizontal section, shut down, throttle and circulate sewage for one week, and then continue drilling. If the requirement of safe start-up is not satisfied, the method of drilling a heavy slurry cap at the top of gas reservoir should be adopted to ensure the safety of start-up.

(7) Close the well immediately in case of danger in the process of drilling. Generally speaking, throttling and circulating sewage discharge. If the drill bit is too far away from the gas reservoir and the throttling and sewage discharge are ineffective, the wellhead horizontal push killing can be used to pressure the overflow back to the formation.

(8) If the liquid level is not at the wellhead during the drilling process, the method of "lifting irrigation" should be adopted. If it can be equipped with annulus liquid level monitoring device, it can not only save a lot of oil-based drilling fluid, but also ensure the safety of work.

(9) In the process of drilling, it is necessary to cut off the well in stages and circulate the sewage through the liquid-gas separator after shutting down, and then resume drilling.

(10) In this case, consideration should be given to abandoning completion logging. Direct production casing cementing. If electric measurement is necessary, on the one hand, it is necessary to increase the density to the state of micro leakage, while lifting irrigation while electrical measurement. On the other hand, the cable bypass valve should be used at the wellhead and the emergency joint should be prepared so as to shut down the drilling tool quickly in case of danger.

(11) It is not suitable to circulate sewage in stages during casing running. It is recommended that drilling fluid be pushed horizontally from the wellhead after shutdown to ensure casing running safety.

(12) In the case that the above measures can not meet the construction safety, it is recommended to install rotary control device and implement simple pressure control drilling.

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