

Investigation on Sand Production Problems and its Mechanisms

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Abstract

Sand production is a common complex problem during oil and gas exploration and it's one of the principal challenges in different steps of field expansion planning including wellbore stability during the drilling. Sand production leads to several damages and disadvantage such as surface and down hole equipment erosion, wellbore damage, equipment failure, small maintenance-free periods and obstruction of valves is typically suffering for this in the form of erosive damage for oil and gas explorers especially companies producing from unconsolidated formations. One of the main tasks of exploration in the oil and gas industry is strengthening and stabilization of production. However, the main problem for arriving at this purpose is that most of the formations around the gas and oil wells, especially reservoir formations consist of highly unconsolidated sand grains and the other problem is the rock failure during wellbore drilling and perforation as well as hydrocarbon production. Therefore, production is complicated due to entering of sand to the wellbore because of several reasons such as stress concentration around the borehole, increasing of water production levels, production flow increasing, drawdown pressure increasing and passing of this pressure from a critical level and etc. Accordingly, there is great interest to estimate the critical conditions that the rock failure occurs and sand migration is beginning. In fact, rock failure and sand production prediction can be done by using of petro physical logs such as sonic logs, tectonic stresses information and geodynamics data. The estimation advantage of rock elastic parameters, pressure and stress properties and rock mechanical properties to calculate the rock strength and sand production prediction from existing logs is recognized as the real and original condition of the measurements.

Introduction

The problems that are existing during the drilling of oil and gas wells are divided into two general categories: 1- Avoid considerable instability in oil and gas wellbore during the drilling and limited breaking of surrounding

formations of well during the production. 2- The second problem is often referred as the sand production (or the production of solid particles), is a result of formation significant breaking during the hydrocarbon production. Sand production is one of the important challenges in

upstream oil and gas industry which is causing operational and safety problems.

Failure Criterion

Therefore, selecting an appropriate failure criterion is obligatory in sand production prediction analysis. There are various failure criteria for use in the sand production studies. The most used one is the Mohr- Coulomb failure criteria, although, in sand production studies, it has been discussed with caution because the impact of the main intermediate principal stress is not considered [1]. However, provided calibration data are available, three-dimensional failure criterion such as Mogi-Coulomb and Modified Lade failure criterion can also be used [2].

Problems due Sand Production

Sand production can lead to many of problems which can have irrecoverable costs for oil companies and investment companies. These problems may include corrosion and erosion of surface and downhole equipment such as valves, pumps, pipelines, sand accumulation in separators, blocking a part of the well and decreasing of well flow pressure and not production of the oil, requirement more workforce to replace and repair the equipment, decreasing permeability of the formation and as a result decreasing the reservoir resumption efficiency.

Factors Affecting on the Sand Production

The solids produced from wells are divided into two categories: 1- Very small particles that are not part of a sandstone skeleton. 2- The particles that constitute the sandstone skeletons. In practice, cannot be prevented from producing very tiny particles. In fact, it is better to remove these particles instead of blocking of the formation or gravel pack. When we are talking about sand production problem the purpose is the particles that constitute sandstone skeleton. The factors affecting the sand production include reduction of stiffness or hardness of formation because of the production, reduction inside-fluid pressure because of production and reservoir pressure decreasing that leads to increasing of compaction force and destroy sand grains cement, production rate, reservoir fluid viscosity, increasing of water production or due to reduction of capillarity forces, the creation of movement forces by movable fluid (if the fluid velocity and it's viscosity increase, sand production also increases), reduction of relative permeability of oil due to increasing water saturation degree that leads to more pressure drop.

Stresses and Pressures around the Borehole

Drilling a well through the formations specially reservoirs formations leads to stress concentration around the borehole and it leads to formation failure. The magnitudes of the greatest, intermediate, and least principal stress at depth (S_1 , S_2 , and S_3) can be expressed as S_v , S_{Hmax} and S_{Hmin} in the manner originally proposed by E. M. Anderson. The vertical stress (S_v) is the maximum principal stress (S_1) in normal faulting regimes, the intermediate principal stress (S_2) in strike-slip regimes and the least principal stress (S_3) in reverse faulting regimes [3]. In sand production prediction studies, that is important to obtain the orientation and magnitude the *in-situ* stresses around the borehole, but there are so many methods to determine these parameters [1]. These methods include hydraulic fracturing technique, stress-induced wellbore breakouts technique, drilling-induced tensile fractures, earthquake focal mechanisms, geologic stress indicators such as the orientations of igneous dikes or cinder cone alignments and fault slip data, regional stress patterns, leak off test, extended leak off test, mini fracture test, microfracture test and etc. the best one for production condition is using linear poroelasticity equations [4-10].

Determination of Formation Parameters

For prediction of sand production, that's necessary to calculate the required parameters. These parameters are divided into three general categories: 1- Formation mechanical parameters such as P and S waves transit time, P and S waves velocity, Poisson ratio, elastic modulus like Young modulus, Shear modulus and Bulk modulus, uniaxial compressive strength (UCS), pore pressure and rock cohesion strength [11]. 2- Formation physical parameters such as internal friction angle, porosity and density and finally 3- Stress and pressure parameters such as orientation and magnitude of vertical stress and maximum and minimum horizontal stresses and tectonic strain.

Mechanism of Sand Production

Sand production occurs when the well has crossed from the drilling stage and it has arrived at the hydrocarbon production stage when oil and gas from the reservoir rock will enter to the well. The main reason of the hydrocarbon production and its entering to the well is the pressure difference between the reservoir pressure (formation pressure) and the drawdown pressure that leads to migrating and transferring of hydrocarbon from the reservoir to the well. Therefore, the main factor of oil and gas production and it's transferring from the

reservoir to the well is drawdown pressure, because the reservoir pressure is almost constant. Oil and gas wells are considered as a pressure discharge environment and it causes the hydrocarbon enter automatically from the reservoir with high pressure into the well with zero pressure. But engineers will increase the drawdown pressure until the pressure difference between the reservoir pressure and the drawdown pressure do not be high. But during increasing of drawdown pressure, this pressure may pass from a specific amount which at that time, hydrocarbon production will be with the sand production. This critical point is named "Collapse Pressure". So, collapse pressure is a critical point of sand production. If the amount of drawdown pressure exceeds the amount of collapse pressure, hydrocarbon production will be with the sand production and the high pressure of drawdown will lead to detaching of the sand grains from the reservoir rock and it's moving toward the oil well with hydrocarbon.

Discussion and Conclusion

Sand production and sand control in different oil and gas field with different stress regime, is generally an expensive enterprise for an oil and gas operator and prediction of sand production will be a great study to decreasing the costs of sand production and therefore, study of sand production in relation to tectonic stresses, formation and fluid properties is one of the most important and most needed issues of the huge oil and gas companies.

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