Oil Well Sand Production Control

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Abstract

In formations where the sand is porous, permeable and well cemented together, large volumes of hydrocarbons which can flow easily through the sand and into production wells are produced through perforations into the well. These produced fluids may carry entrained therein sand, particularly when the subsurface formation is an unconsolidated formation. Produced sand is undesirable for many reasons. When it reaches the surface, sand can damage equipment such as valves, pipelines, pumps and separators and must be removed from the produced fluids at the surface. Further, the produced sand may partially or completely clog the well, substantially lead to poor performance in wells and, ultimately, inhibiting production, thereby making necessary an expensive work-over. In addition, the sand flowing from the subsurface formation may leave therein a cavity which may result in caving of the formation and collapse of the casing.

Sand entering production wells is one of the oldest problems faced by oil companies and one of the toughest to solve. Production of sand during oil production causes severe operational problem for oil producers. Several techniques have been used for sand production control in sandstone reservoirs. These techniques are divided into four groups including; standard rig operation with retrievable packer; tubing-conveyed string; coiled tubing and long zone/selective treatment. Several consolidating materials, such as, crude oil coke and nickel plating, have been used in the past by researchers. At present, the chemical binders, such as; phenol resin, phenol–formaldehyde, epoxy, and furan or phenol–furfural provides cementation. In this paper, we discuss sand control method for an oil well.

Introduction

Most of the world oil and gas reserves are contained in sandstone reservoirs where sand production is likely to become a problem at some point during the life of the field. Sand production occurs during the hydrocarbon production from a well when the reservoir sandstone is weak enough to fail under the in situ stress conditions and the imposed stress changes due to the hydrocarbon production. The oil or gas flow transports the failed rock causing a variety of problems ranging from erosion of the surface facilities, to well integrity, and sand disposal. On the other hand, limited sand production has been proven to increase the productivity of a well and when tolerated it may eliminate altogether the need for sand control.

Some of oil and gas fields are faced with sand production problem worldwide. Many of the world's oil and gas wells produce from unconsolidated sandstones that produce formation sand with reservoir fluids. Some reservoirs can produce several tons of sand in a day and it can be so severe that operators often choose to install down-hole sand control in all sand-prone wells. The standard, historical way of sand prediction, is to accept that if you get down to a particular pressure regime and rock strength, you will probably produce sand at some time during the life of the well. That pushes you towards a very conservative approach, where you go for installing lots of expensive up-front equipment as a precautionary default option.

In sand-prone areas, we have a wide range of sand control options to choose from, including a variety of different down-hole sand screens and gravel packs which can be installed in production wells. But installing sand control hardware carries its own risks, so it is important to determine the correct sand control well completion option in each particular situation. Choosing the best method, lies in gaining an understanding of the underlying physics behind the flow of sand and liquid hydrocarbons. For this purpose, we must know different aspects of the fundamental physics of sand transport in multiphase flow - that is, flow containing liquids, gas and solids to be able to develop a sand control model. The model takes advantage of equations that describe the dynamics of fluid flow, and also draws on data about the way the rock behaves under different pressure regimes, to provide us with objective advice about the sand control options available to them and the best type of sand control completion to choose for production wells.

The modeling work is also helping us to understand the effect of sand ingress into water injection wells and how best to deal with it. This can involve changing the design of the well, or adopting different well management procedures on injection wells. It can also involve taking advantage of sand control hardware such as expandable sand screens or other novel completion equipment. But the usefulness of the model is just as applicable to injection wells - wells used to pump water into a reservoir to maintain pressure and drive oil towards production wells.

Without knowledge of sand control methods, the wells may have experienced excessive sanding and may have to be taken out of production earlier. The experiences results among other things that when it comes to managing production wells in sand-prone areas, we must go slow and steady. It's a bit like training to run a marathon. You begin training by starting slowly then you gradually build up your strength so you can run the marathon without injury. We take a similar approach to producing from sand-prone wells. By building up production in measured steps we are often able to improve the behavior of the sand by the way we produce from the well. In some cases, the best solution can be just to accept that some sand will be produced, and learn to live with it.

Sand may pose a severe problem in offshore and onshore and also in gas fields. Problems that are associated with sand production include plugging of perforation tunnels, sanding up of the production interval, accumulation in surface separators and potential failure of down-hole and surface equipment from erosion. These problems can pose serious economic and safety risks. Although in one field, wells may all completed using a variety of standalone sand screen types, roughly half may producing sand and there may be consequent production losses, sanding may so severe that the well had to be shut in. We must have some information about the factors leading to sanding, enabling the field operators to modify activities that contributed to sand production. By managing those activities they were able to stop sanding in the wells altogether.

In reservoirs such as heavy oil, tar sands and high temperature/high pressure reservoirs, controlling sand becomes even more difficult. In tar sand areas or when producing from reservoirs containing heavy oil, conventional sand control measures such as gravel packs and sand screens can form a barrier in front of the well-bore that blocks the flow of these highly viscous hydrocarbons, thus preventing the use of conventional sand control solutions.

Gravel Packing

Knowing the nature of the sand, which is best learned by examining cores, is an essential first step to control sand production from a well. Monitoring sand concentration in produced fluids can help identify "quick sands" (high and relatively constant sand concentration), "partially consolidated" sands (concentration fluctuates widely), and "friable" sands (taper off to nearly zero after a well has been on production for awhile).

In order to limit sand production, various techniques have been employed for preventing formation sands from entering the production stream. One such technique, commonly termed "gravel packing", involves the forming of a gravel pack in the well adjacent the entire portion of the formation exposed to the well to form a gravel filter. In a cased perforated well, the gravel may be placed inside the casing adjacent the perforations to form an inside-the-casing gravel pack or may be placed outside the casing and adjacent the formation or may be placed both inside and outside the casing.

Because of the nature of oil-field sands, slotted liners or screens by themselves (without gravel) are rarely effective in controlling sand production. For a successful gravel pack, it is necessary to: (1) size the gravel to stop movement of formation sand, (2) place gravel in a tight pack that has a radius as large as possible, and (3) maximize productivity while minimizing formation damage. Open hole gravel packing is common in vertical wells because it is easiest and usually less expensive than other options, although hole stability, screen plugging, and thief zones can be a problem. This method is generally limited to a bottom interval in multiple zone completions.

The size of gravel pack sand that should be used depends on size of the formation sand. This is determined from sieve analysis, preferably from core samples (bailed samples tend to be large, produced samples tend to be small). Gravel pack sand is normally sized to achieve a suitable grain size ratio. There is a trend towards using larger sizes. Screen or slotted liner openings should be no larger than the smallest gravel pack sand diameter. Pre-packed screens and liners must be appropriately sized. Three basic tools are used in gravel packing operations: (1) packer/crossover tool assembly, (2) over-top tool assembly, and (3), in some cases, port collars. Some are completion tools that remain in the well after the gravel pack is complete. On the other hand, service tools are used while placing the gravel pack but then are removed.

There are three basic gravel pack processes: (1) High Rate Water Pack, (2) Fracture Pack, and (3) Horizontal Gravel Pack. Fracture Packs are a combination of a fracture treatment and an annular gravel pack. A successful Fracture Pack must not only stop sand movement, but must create a wide fracture that is held open by a high permeability extending through the near well-bore zone, importantly not making contact with nearby zones that contain unwanted fluids. A High Rate Water Pack, which pumps water and sand at high rates creating short fractures, maximizes gravel placement in the perforations. Treating pressures may or may not exceed fracture pressure. High Rate Water Packs are typically used where the completion is near water or gas contacts and there is a shallow radius of near well-bore damage combined with relatively uniform sand quality and permeability. In contrast, Fracture Packs, which create much longer fractures, are used where sands are laminated, where fines migration potential exists, or where deep formation damage is known or suspected.

In high angle and horizontal well-bores, any formation that will not collapse while drilling a long horizontal, should be strong enough to not produce sand. This is also true with removing the drilling equipment and running a liner/screen. Sand problems occur with excess water production, too much pressure reduction, or with high drawdown (high production from short intervals). Just as with vertical wells, slotted liners or wire wrapped screens should be used in conjunction with gravel packing. Un-gelled brine is typically used. Special pre-packed screens and down-hole filters, which are sometimes used in horizontal wells, can be susceptible to plugging and collapse. Before installing pre-packed screens or liners, it is important to apply a thin coat of acid soluble materials, waxes, or wax-polymer blend to them to reduce screen/liner plugging.

When designing horizontal gravel packs, it is important to define the allowable pump operating ranges. Pump rate must be high enough to exceed the rate of fluid loss and to push dunes of gravel to the end of the screen. This system uses small diameter tubes strapped along the outside of the screen that allow gravel to be pumped at high velocities. A controlled viscosity fluid is used to suspend gravel and aid its transport.

Oil Well Sand Control Screen Pipe

Composite grading sand control screen adopts peculiar grading sand control design and organic combination of surface filtering and deep filtering to realize double precision of single screen. It is a new design breach in mechanical sand control field. In the meanwhile, it has characteristics such as high penetrability, high strength, high deformability, high reliability and strong corrosion resistance, so it is the most effective sand control product at present.

External protective sleeve with bridge side discharge orifice (optional). It can protect grading sand control filtering layer excellently during transportation of product and case-off process and prevent influence to actual anti-sand effect caused by puncture and damage of anti-sand filtering layer. It can effectively avoid direct erosion damage of flow to grading sand control filtering layer during production process of oil and gas well and extend service life of screen. Central tube of screen shall adopt standard oil tube and casing. Central tube adopts helical perforation form to reduce opening area of cross section and retain strength of central tube as much as possible on basis of guarantee of integral area of passage. Sand is blocked out of screen and oil, gas or water in stratum can pass aperture of filtering layer and orifice on central tube to enter into screen to realize the purpose of sand control.

Permeable Solid Barrier

A method for treating a sand formation adjacent to a bore hole forms a permeable solid barrier which restrains the movement of sand particles while maintaining the permeability of the formation. The method includes the step of forming a consolidation fluid containing an asphaltene and a hydrocarbon solvent such as naphtha. The consolidation fluid is injected into the sand formation to saturate the sand in a zone around the bore hole. This is followed by injecting an oxygen-containing gas for a period of time. In one embodiment of the invention, the oxygen concentration of the effluent gas is monitored and the injection of oxygen-containing gas is continued until the oxygen concentration of the effluent gas is equal to the oxygen concentration of the injected gas.

Results

We must adopt new production practices for managing sand. These involved maintaining hydrocarbons production at a level that is set over the long term to avoid reservoir damage, rather than pushing the wells to the point where sanding occurred followed by a break in production. As a result of adopting these recommendations, oil production has improved and sand production has been greatly reduced. While it is important to effectively prevent sand production, it is equally important to do so in a way that does not hinder a well's productivity. This dual goal requires specialized sand control completion practices to allow hydrocarbons to be produced without formation sand.

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