REMOVAL OF SCALE AND OTHER PERFORATION DAMAGE UTILIZING LOW FREQUENCY OSCILLATIONS FOR INCREASING PRODUCTION/INJECTION

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Abstract

This paper will discuss a method for the successful removal of scale deposits and perforation damage that inhibit the productivity/injectability of a well by the usage of a downhole tool that creates low frequency (16-40 Hz) oscillations in the wellbore fluid. Other methods for addressing the problem of scale and perforation damage will be discussed with a comparison of how and why this method proves to be more effective.

Introduction

A pulsating stimulation device (referred to hereafter as PSD) was developed primarily as a method to remove hard scale deposits in oil and gas wells that are formed by minerals dropping out of the water that is often produced with oil and gas. These minerals (such as calcium carbonate, iron sulfide, barium sulphate, etc.) bind together generally at the perforations where the oil and gas is being produced from; forming a "build up". This scale "build up" forms a natural "choke" that inhibits the ability of the hydrocarbon bearing formation to communicate with the wellbore, thereby causing production loss. Many of the stimulations traditionally used to attempt to correct this problem (such as acidizing, scale converters, etc.) all share the same problem: they fail to effectively remove the scale/damage present. The innovation of the PSD is the ability to pulverize the scale problem with powerful, low frequency oscillations that treat the entire perforation tunnel; thereby exposing more surface area to allow increased fluid entry or injection.

Pulsating Stimulation Device

The PSD operates on the basic physical principle known as "water hammer". The PSD has a proprietary internal mechanism which causes fluid that is injected into the device to be rapidly accelerated out of three seperate outlet ports in a successive manner (see Figure 1). This rapid fluid acceleration creates a compression wave, or water hammer in the wellbore fluid. As this is occurring 16-40 times per second, a low frequency oscillation is created within the wellbore fluid. The low frequency oscillation within the wellbore fluid literally "hammers" upon the scale or damage present, leading to the fatigue of scale/damage; pulverizing it into fine particles (Figure 2). The PSD is used by lowering it into the wellbore on a tubing string or coiled tubing to the perforated or open hole interval. Fluid (i.e. 2% KCL water) is then pumped down thru

the device while the device is slowly reciprocated across the perforated interval to ensure that all the perforations are treated.

Other Stimulation Methods

There are many different methods currently being used to try and correct the problem of scaling and other perforation damage. Acidizing operations using ball sealers, diverting agents, pin point injection type tools, jetting tools, etc. are all examples. The problem associated with these methods is this: these methods, though somewhat effective, fail to treat the entire perforation tunnel (Figure 3). Even when fluid is injected into a perforation it doesn't necessarily mean the entire surface area of the tunnel is being treated as the fluid injected will travel the path of least resistance. Another problem associated with these methods is communicating perforations by breaking down the cement behind the casing. These problems lead to a less effective treatment; leading to less production or injection.

Stimulation with the Pulsating Stimulation Device

The PSD allows for the entire surface area of the perforation tunnel to be treated as the oscillations travel throughout the perforation; even in some instances back into the formation (Figure 4). The build up and damage is removed from the entire surface area, unlike aforementioned methods that require the treatment fluid to be in direct contact with the damage. Removal of scale and jet charge damage using the PSD allows a well to not only give up fluid better, it also allows for better fluid injection, such as water injection wells and disposal wells. It also helps in further stimulation operations such as fracturing by helping to keep fractures in zone and allowing superior zone coverage during the fracturing operation.

Paraffins and Asphaltenes

The PSD is not effective on paraffin/asphaltenes without the usage of some form of solvent or dispersant; due to the fact that paraffin cannot be mechanically broken down. The usage of the PSD with a paraffin solvent is a good combination as the paraffin solvent will work more effectively with the agitating motion of the fluid oscillation; also, any scale present in conjunction with the paraffin will be broken up by the oscillations.

Case Histories

Oil Producers (workover)
Ward Co. Texas - Operator has a well that had been consistently producing 35-40 BOPD for several years which declined over several months to 15-20 BOPD. Testing concluded a severe calcium sulphate scale problem. Operator treated this 50 feet of perforated interval with the PSD and produced water at 4-5 BPM while reciprocating the PSD across the interval. Returns revealed pulverized scale. The well stabilized one month later at 40-45 BOPD; with no other treatment performed.

Howard Co. Texas Operator utilized the PSD on a producer to first clean the perforations with 2% KCL water, then acidize with 1500 gallons of 15% HCL NEFE. Operator stated that most of the wells in the field would see a 3-5 BBL oil increase after an acid job. Results of the PSD: From 3 BOPD to 28 BOPD.

Lea Co. NM Operator had a well that dropped to 0 production after a casing and tubing leak dumped mud on formation. Production before this happened was 45 BOPD 160 BWPD. Operator repaired leaks and acidized the interval with an acid/ball job using 4000 gallons of 15% HCL NEFE acid. The operator attempted to swab but could obtain no fluid entry. The operator decided to apply the PSD to this problem. The perforated interval was precleaned with 2% KCL water at 4 BPM and acidized with 4000 gallons 15% NEFE utilizing the PSD. Swab testing revealed fluid entry. One week after the treatment, the well produced 139 BOPD 240 BWPD. Two months after the treatment the production was stabilized at 110 BOPD 225 BWPD.
The operator performed another treatment on an offsetting well that increased to a sustained production from 40 BOPD to 92 BOPD.

Injection wells
Winkler Co. Texas Operator has an injection well he had never been able to inject fluid into since he purchased the property; even after several attempts to stimulate it by running a bit and scraper and attempting to acidize. The operator used the PSD to clean iron sulfide scale out of the perforations and several hundred #s of iron sulfide scale was circulated out. 500 gallons of 15% HCL acid was spotted out and the well was put back on injection. 30 days post treatment the injection had stabilized at 175 bbls water/day @ 1100 psi; a normal field injection rate and pressure.

Lea Co. NM Operator had 3 injectors to work over using coiled tubing. After attempting to acidize the wells with acid using a "jet" tool clean out and unable to acidize, the PSD was utilized. The intervals were precleaned with water and 3000 gallons of 15% NEFE HCL was injected. All 3 wells went on a vacuum during treatment. After being returned to injection the operator did not have enough produced water available to continually inject into these 3 wells.

New Well Completions
Gaines Co. Texas Operator was using pin point injection tools to try to open every perforation in these 200 ft + intervals. Unfortunately, the operator found that most of the time he was communicating the perforations at breakdown pressures of 2800 psi +. These jobs also took up to 2 days to complete as they would pressure up on a perforation for as long as an hour before it would finally break. The operator decided to apply the PSD to this problem by using the PSD to preclean the new perforations with brine water only before the pin point injection job. Operator reported that the perforations broke almost instantaneously with no communication at pressures from 600 psi to 1200 psi.
One of the engineeering group took a keen interest in determining whether or not the PSD was what caused this phenomenal change. He attempted to pin point inject a well allowing an 1800 psi maximum

pressure. None of the perforations broke down. He then treated the perforations with the PSD utilizing brine water only @ 4-5 BPM. He then once again used a pin point injection tool to attempt to break down the perforations as before with the same 1800 psi maximum pressure. All of the perforations broke down @ 500-600 psi with zero communication. This operator has continued to use the PSD in this fashion for over 2 1/2 years.

Chavez Co. NM Operator had 14 horizontal wells to be completed. The wells had anywhere from 900-1400 ft of horizontal open hole zone. The first well the operator treated using traditional stimulation with no obtainable production. The PSD was utilized to preclean the intervals and acidize. All 14 wells treated had good oil production; however the operator had a large acid program planned to try to further stimulate the wells. After performing 3 of these large acid jobs and noticing no increase in production, the operator cancelled the remaining 11 stimulations, thereby making the PSD and acid the only stimulation these wells had received.

Ector Co. Texas Operator has a well that he plugged back and shot perforations in a new zone. The operator utilized the PSD to preclean and acidize the well in order to prepare it for a frac job. The frac sand was tagged with tracers, and the frac was performed smoothly. The logs revealed that not only did all the perforations in this 140 ft. interval take sand, it was almost evenly distributed.

Salt Water Disposal Wells

Lea Co. NM Operator has a salt water disposal well that over the last four years they had done 4-5 acid jobs under a packer which would generally drop the injection pressure down to 600-700 psi. It was normal for the well to pressure up within a year to system max (1100 psi). The well was treated with the PSD by precleaning the perforations with water and injecting acid at 5 BPM with an 800 psi annular pressure. When the well was returned to disposal the operator reported the well was taking water on a vacuum at the maximum rate the disposal pump would pump. Eight months later the well was taking 700 bbls/day on a vacuum; all the fluid the operator had available.

Lea Co NM Operator has a disposal well that was an important well that had gotten to where it would no longer take fluid. The operator used the PSD to water preclean and acidize.The well went on a vacuum after treatment. Operator stated that this workover saved him $3000 in disposal costs per day!

Economic Considerations

The cost of utilizing the PSD will generally add 10-20 % more cost to the average acid stimulation in tool costs and added rig time. Due to the small job cost increase and the added benefit, the PSD is an economically feasible method to stimulate a well.

Conclusion

While no stimulation method is 100% effective in every scenario, the PSD has proven to have many different applications in which it is more effective than traditional stimulation practices; and is economically feasible in the amount of added cost for treatment.

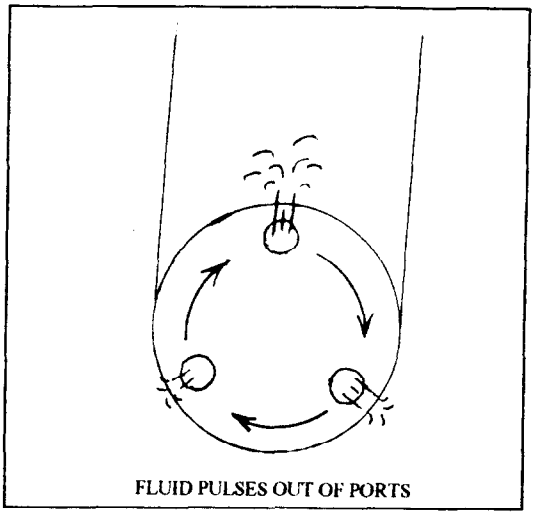

Figure 1

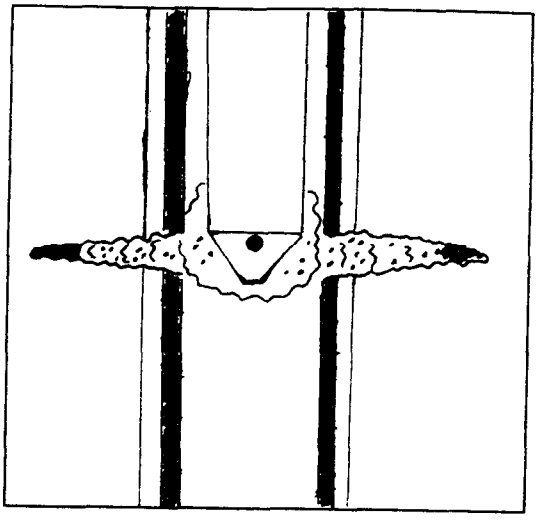

Figure 2

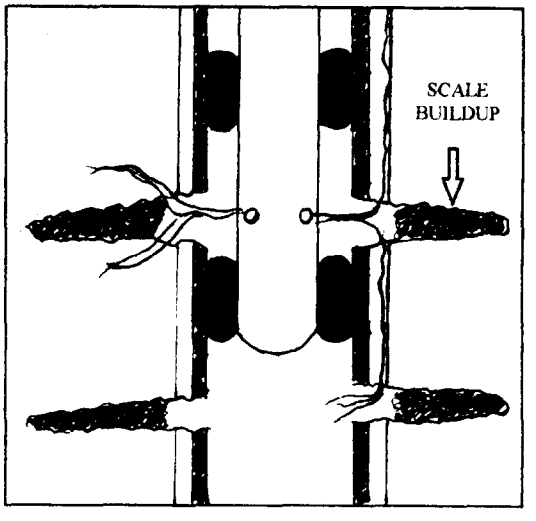

Figure 3

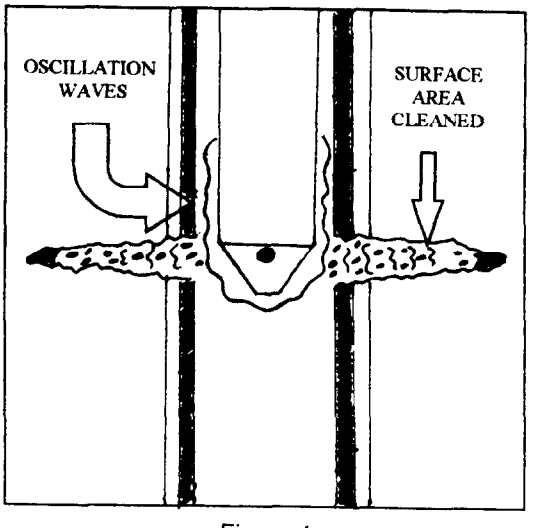

Figure 4