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Perforation Techniques in brown fields for Production optimization.

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Summary

Different techniques are adopted for perforation like conventional perforation with casing gun in positive head, through tubing perforation with negative head, special type of through tubing perforation using pivot- mounting folded big shot charges, tubing conveyed perforation technique, stimgun perforation technique, combining perforation & perforation breakdown using propellant sleeve, perforation with extremely over balance pressure., drillable perforating system to have in one-trip perforating, packer placement and cementing. All the techniques have been discussed and compared with their relative advantages and disadvantages with special emphasis on through tubing perforation (TTP).

This technique of through tubing perforation adopted in the oil fields of N-E,India, has added in production enhancement and reducing the rig time.

***Key Words**: Brown field, oil field explosives charges,, Perforation Through tubing perforation (TTP)*

Introduction

The method of conventional perforation is very simple. It avoids the cumbersome pressure control equipment and the diameter of the gun is restricted to the internal diameter of the casing. Repeated runs are possible to achieve high shot density. Selective firing is available with HSC gun and leaves no debris in the well. The HSC guns are reusable and high penetration is possible by selecting suitable charge sizes.

The major disadvantage here is the positive head perforation, resulting in blockage and impairment of fluid flow into the well bore and the well can not be tested immediately.

Theory and/or Method

When through tubing perforation (TTP) is carried out, the tubings are lowered with a bellbottom to the required depth and positioned. Subsequently a suitable perforating system by wire line is lowered and perforated against the zone of interest. Pressure control system is a requirement here to perform the job.. Three types of perforating assemblies are available vig, retrievable, semi-expendable and fully expendable. The size of the guns is limited to 1 3/8" to 2 7/8". They are usually run with a de-centralizer, either magnetic or mechanical. This ensures that the charges are in line with the casing, enabling maximum penetration. Disadvantages here are the limited charge size and the gun length.

Some distinct advantages of negative head TTPs are, choking of perforation of well fluid is removed. Owing to back surge, perforations are automatically cleaned. Productivity here is better than the conventional +ve head perforation. Immediate activation and flow test is an advantage. It is economical and best for remedial measures. Some advancement in TTP in recent years are, new techniques in gun/charge carrier design, various phasing options and improved charge penetration like Deep star, power jet, NT charges.

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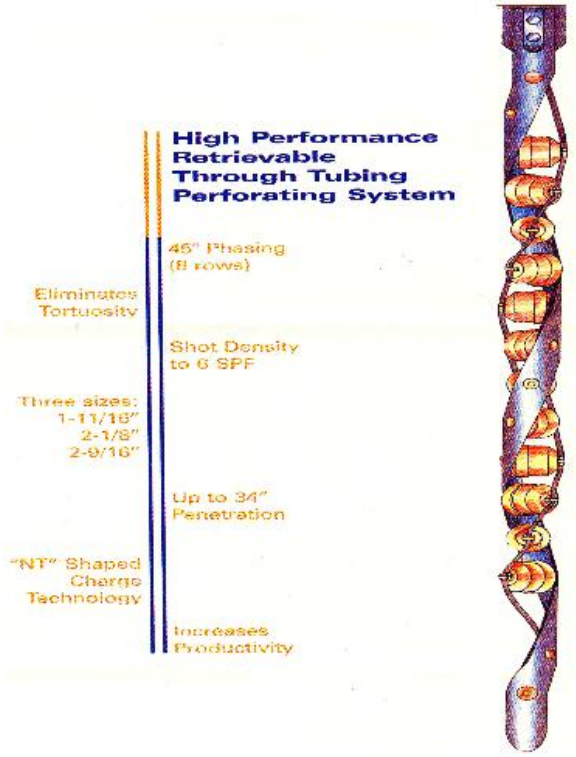


There is a system of through tubing, under balance perforation, using gun with big shot charges, having penetration power of a casing gun. Example, a) Pivot gun of Schulumberger and b) Swing jet of Owen and Halliberton.

Pivot gun system utilizes all the advantages of under balance perforation and at the same time eliminates the limitations of earlier through tubing perforation by using big shot charges of higher penetration. Its 26.63 inch penetration is almost twice the penetration of other through tubing gun. Pivot mounting charges are used in cylindrical carrier. Charges are linked to pull rods which run the length of the carrier to a top mounted deployment head. Charges are folded to pass through tubing. Folded charges can be opened by lifting the pull rods for horizontal alignment.

Tubing conveyed perforation(TCP)

Safety drop-bar firing system

The drop bar is the simplest TCP firing system. A cylindrical weight or sinker bar is dropped into the tubing and strikes a percussion type detonator in the gun firing head. The bar can be dropped by hand through an open wellhead control valve or contained in a wire line lubricator and released when wellhead valves are opened.

The drop bar contains a safe firing pin that automatically retracts at a set time after impact. Therefore, if guns do not fire, the retracted drop bar cannot fire the guns while tripping out of hole. In addition, the safe-arm sub contains a spring-loaded shuttle pin with a port that must be aligned before detonation can occur. The pressure activated pin automatically shifts to the arm position as the guns descend in the well and shifts to the safe position when live guns are retrieved.

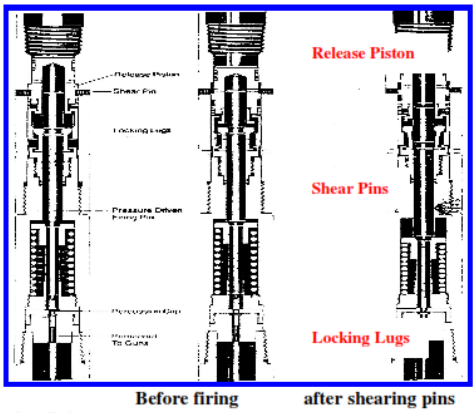
Pressure – activated firing head

Pressure activated firing systems are normally used in highly deviated wells and can be used in all TCP operations. Pressure to activate the firing head is applied down the tubing or down the tubing casing annulus when a packer is used.

Differential pressure firing head

The differential pressure firing head utilizes a flow tube through the packer to transfer annulus pressure above the packer to an isolated piston in the firing head, located beneath the packer.

The differential pressure firing head is activated when the pressure in the annulus above the packer exceeds the pressure in the rat hole by a preset amount. The pressure in the rat hole below the packer then drives the firing pin into the percussion cap, igniting the prima cord which fires the perforating guns.



The advantage of this firing method is that, after setting the packer, the tubing and packer can be tested in the direction of well pressure by internally pressurizing the tubing and transmitting this pressure to casing, beneath the packer.

After pressure testing, the desired under balance pressure is fixed before firing the guns.

Tubing pressure firing system

This system uses a percussion activated firing head similar in principle to the differential pressure and drop bar system, except that it is activated by internally pressuring the tubing. After setting the packer, it is tested by pressuring the tubing annulus. Next the tubing pressure is raised through three specific pressure cycles to arm the gun. Redundant safety cycles built into the system prevent surges, swab pressure and high circulating pressure. After the three cycles sequence, there is a five minutes delay before firing, in order to correct under balance pressure and adjust well head choke manifolds.

An advantage of the tubing pressure system is that, it can be fired in wells where the casing above the packer is leaking; due to. split or corroded pipe and old squeezed perforations.

Selection of under balance

The under balance selected should be sufficient to overcome the capillary forces for the removal of involved mud filtrate. The local capillary pressure can be determined using core analysis. It can also be calculated assuming capillary pressure as a function of the height above the free water level and the difference in fluid densities.

The under balance should be approximately twice the capillary pressure as it has to act at some distance in the reservoir. This approach addressed the cleanup of the formation by drilling / completion fluids, but it does not consider the clean up of a perforation through flushing of loose debris and removal of crushed zone around the perforations.

Safe limits of under balance

From the productivity standpoint, one should strive for the highest value of under balance. However, there are a number of reasons why one should limit the drawdown imposed on the formation.

- The drawdown should not cause mechanical failure of the formation.
- Excessive drawdown may lead to mechanical deformation of the casing and may cause permeability damage in the near well bore region.
- Initial spurt rates under high drawdown can be so high as to reach the critical velocity through the completion, ie. the drawdown is limited by the area open to flow. Imposing higher values of drawdown than is needed to reach critical flow is useless and only endangers the completion mechanically.

STIM GUN

Perforating and perforation break down with propellant in one go.

It is designed to combine perforating and perforation break down with propellant in one tool and operation. The purpose of this technology is aimed to improve.

A) Perforation efficiency
B) Hydraulic fracturing efficiency
C) Well production

Features:

1. The device consists of a perforating gun surrounded by a propellant sleeve. The propellant sleeve looks like a piece of pvc pipe, held in position by slightly larger end subs on the carrier.
2. Technical design of the propellant sleeve is complex to ensure a consistent ignition and burn rate.
3. Any conventional deep penetrating or big hole shaped charges can be used with stim gun assembly.
4. A special “kiss” charge has also been developed for use in soft formation. Kiss charge is designed to have larger diameter hole with penetration just to kiss the formation after passing through the cement sheath.

Perforation with extreme overbalanced pressure

In this perforating system, perforation is done using an environment of extreme overbalanced pressure instead of under balance or conventional overbalance. TCP Perforating system is used for this type of perforation. Before perforation, a suitable fluid is kept against the formation to be perforated and the well is pressurized to an extreme overbalanced condition – pressure gradients of at least 1.4 psi / ft (31 KPa / m.). At those pressures, a fluid “spear” is driven into the perforation at velocities exceeding 3,000 ft / sec (900 m / sec) and rates that can exceed 140 bbls / min. This process, not only removes

much of the damage in the crushed zone but also creates short fractures, often resulting in negative skin factors. Under such situation we may have better access to the formation for cleanup and stimulation procedures and formation fluids have better access to the well bore.

Advantages of perforation with extreme overbalanced pressure

1. Low formation pressure :

The violence of the perforating charge creates a crushed zone around the perforation tunnel. In many formations, under balanced perforating allows formation pressures to remove the damaged rock instantly. But if formation pressure is too low to move the damaged rock, permeability at the face of the perforation can be greatly reduced. In many wells the damage is so severe that, only the 25% of the perforations produce. Not only the production potential is reduced, but also the cleaning up and stimulation procedures are far less effective. In such cases, this method proved to be very useful.

2. Sand control :

This method can be suitable for wells having sand production problems. Before perforation, sand consolidation resin is kept as the fluid to be used as fluid spear. After perforation the resin surges into the formation. Then a catalyst is pumped to set the resin. The initial surge removes debris from the perforation tunnel and crushed zone. The thin resin coating retains close-to-original permeability. Since the exposure to completion fluid is minimized, the risk of additional formation damage is substantially reduced.

3. Very tight reservoir with low permeability :

This method may be suitable to have optimum production from a very tight and low permeability reservoir. The factures created after the perforation will increase permeability, reduce skin factor and increase production.

4. Stimulation job with perforation :

We can have perforation and stimulation jobs simultaneously by incorporating acid / suitable materials as the fluid spear.

Drillable perforating system consists of the following

- All drillable materials including an aluminum perforating gun.
- High performance perforating charges.
- Utilizes suitable field proven cement retainer: the EZSVB packer.
- Unique design specific firing head.
- Adjustable operating pressure.
- Tandem guns.
- Under balanced perforating to 5000 psi
- 15,000 psi gun case
- 10,000 psi retainer

Advantages of drillable perforating system

- One-trip perforating, packer placement and cementing on tubing.
- Provides for block squeeze cementing in under balance conditions.
- Clear well fluids could remain in place for work over operations.
- Centralized perforating gun.
- Correlation with wire line if necessary.
- Could be used for low volume drill stem testing.

Conclusions

The statistics say that more than 70% of oil production comes from brown fields, typically completed with technology that is long obsolete. However, production decline resulting from outdated completion techniques can be reversed through selective re-perforation with today's technologies and does not require costly intervention using a drilling rig. Rig-less operation can use perforating trucks, coiled tunings, and slikline or tubing conveyed perforating deployed from work over rigs. Key to re-perforating success is the doubling in shaped charge penetration and improved perforating techniques that achieve clean perforations.

Selective re-perforation of old assets with Power jet omega, and PURE perforating system for clean perforations incorporated reservoir properties, well bore construction, and gun string performance in the job design to deliver the optimum dynamic under balance needed in each interval to minimize damage and skin effect for maximized productivity and injectivity

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