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New Method To Squeeze Perforations and Reduce Sand Production

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Abstract

This paper describes a new method to squeeze perforations using non toxic chemical products. The product, belonging to the cyanoacrilate family (Ref 1), reacts with connate water dramatically reducing rock permeability in the injected intervals. Some technological solutions using this methodology are discussed. A variation of this methodology can be used to reduce or control sand production in low consolidated sandstones.

At the present time, useless perforations are plugged by squeezing cement into the perforating tunnel. The proposed alternative method is to eliminate fluid conduction through the perforations blocking the permeability in the surrounding formation. To obtain this, non toxic, low cost chemical products are injected to react with connate water, generating a mechanical resistant structure with negligible permeability. A simplified alternative allows for sand control. In this case the proposed methodology the products react partially with connate water, bridging together the sand grains. The chemical product is similar to that used to squeeze the perforating, but at lower concentrations. Several lab tests have been run to check the principles and limits of the chemical products used.

Consequently, it is now available a new system to plug useless perforation by injection of a chemical product, at low cost and operationally safe.

Using this new methodology it is possible to minimize cost and time during workover operation.

Introduction

At the present time, the most used method to communicate hydraulically the production casing with net pay is the perforating.

To do this, shaped charges with different sizes, configurations, phasing and orientations are used, according needs determinated by reservoir engineering. Also the proper methodology, like under balance or overbalance is selected according needs. The entrance hole is in the range of 0,3 to 0,5” (0,762 cm to 1,27 cm) diameter, and the average penetration is in the range of 12 to 20” (30,48 to 50,8 cm).

Sometimes, due to different reasons, it becomes necessary the hydraulic isolation of some already perforated zones.

The system used, at the present time, for hydraulic isolation of the perforating is filling all and each one of these with cement slurry (Ref. 2). The cement should be low permeability, low filtrate and controlled set according temperature and well conditions.

The volume of the tunnel generated by the shaped charges is low (in the order of few cubic centimeters), and must be filled by these cement Fig.1. The cement volume to be use should be at least the perforating volume, plus de filtrate volume, plus an operating volume to fill the casing shooted interval plus an excess to carry all these volume and squeeze under a pressure below the formation fracture and high enough to displace the liquid and or debris in the tunnel.

The squeezed slurry penetrates the perforating, displacing gradually the liquid in there, as the hesitation pressure forces the slurry to fill up completely the tunnels. This leads to the typical variation of pressure versus time in a normal cement squeeze operation, where the operation is considered normal when the final hesitation pressure, below formation fracture pressure, remains constant.

Different methods are used to place the cement slurry in the perforating zone: Balanced plugs and squeeze the plug; cement retainers bridge plugs; packers alone or joined with recoverable bridge plugs and well known combinations.

All this operations require a minimum slurry cement volume of 30 sacks and the use of different kind of down hole tools. As surface equipment, a minimum of a bulk truck and a cementer to mix and pump the slurry and the displacements is needed.

After the squeeze operations the excess cement should be drilled to continue the operations.

Objectives

The method proposed in this paper has the following objectives:

- ✓ The isolation of formation by blocking the perforating between the formation and the production casing.
- ✓ The reduction of the risk, avoiding the use of unnecessary tools.
- ✓ The reduction of cost and operating time used in squeeze operations.

Using the same chemical product at low concentrations it has been shown an effect of consolidation in unconsolidated water wet sandstones.

Performed Tests

In order to test the process efficiency, two laboratory test were performed. One of them was devoted to test the effect on unconsolidated sandstone, and the second one was made on actual reservoir rock of medium range permeability (about 100 mD).

Test #1- Unconsolidated Sand. This test was performed on a sand pack of sieve #100/170 sand (near. 20 D permeability).

This test was planned to obtain consolidation and blocking in one-step operation using a limited amount of the sealing product.

As shown in Fig. 3 at the entrance hole of the target, has been made a cylindrical hole with a conical end, with 8 cm length as a simulation of a perforating tunnel.

At the entrance of this target, a 2.45 cm diameter sphere was placed, filled with the chemical product and hermetically sealed.

During previous tests it was determined that the average breaking pressure of this rigid plastic sphere was close to 200 psi when hydraulically pushed over a ½ ” hole.

Prepared the samples as descript, API brine was injected to displace air, wet the sand and measure the permeability.

After that, light oil was injected to reproduce original field conditions and a plastic sphere filled with the sealing chemical product breaks, injecting the product into the simulated formation. The sealing effect was almost instantaneous and, after a brief period, non measurable rate into the “formation” was detected and 350 psi constant differential pressure was sustained for 30 minutes. Same effect was observed in both flow directions.

When the sample was visually observed, a zone of near one inch (2,5 cm) of impervious consolidated sand around simulated perforating tunnel zone was detected (Fig. 4)

Previous tests showed that using low concentrations of the same product has a consolidation effect over unconsolidated sand. In this case, not full blocking but a permeability reduction is observed, suggesting that adequate formulations allows for sand control (Ref 3).

Test #2- Reservoir Rock. This test was performed on a well consolidated sand sample of 95 mD permeability.

API brine was injected to obtain 100% water saturation, and, after that, light oil was injected to get irreducible water saturation (Swirr) and measuring the permeability at these conditions.

Once the sample was conditioned as just described, the chemical product was injected and a total and instantaneous reaction was observed. Once again, no measurable permeability was observed at 1,000 psi differential pressure over 30 minutes. This effect was observed in both flow directions.

Conclusions

The different tests, performed at laboratory level, lead to the following conclusions:

The chemical product used is adequate to seal perforatings in water wet sandstones.

The efficient treatment using isolated plastic spheres, suggest that the chemical product could be carry to the perforating zones using tubing, coil tubing, or wire line injectors.

Low product concentrations allows for consolidation or sand control during production.

The product is environmentally safe an innocuous. It is used also in medical applications

Additional laboratory and field tests should be performed to validate and establish pressure and temperature limits. Additional test could include the control of loss circulation zones and cement channeling.

The economical advantages of usage of this new sealing proposed technology probably justify the development of additional techniques.

An efficient usage of this method can reduce risks on well completions and repairs, as no cement is injected. Rig time could be substantially reduced as no rotation time is required.

Significant rig time could be save avoiding tubular trips.

References

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3. Crotti, M., Galacho N., Huergo, H. Patente Acta Nº P 020100139. "Nuevo uso de un adhesivo para fijación de arenas o areniscas humectadas con agua o una solución acuosa, no consolidadas o consolidadas parcialmente y/o modificar características petrofísicas de las mismas y el procedimiento para su aplicación"

Figures

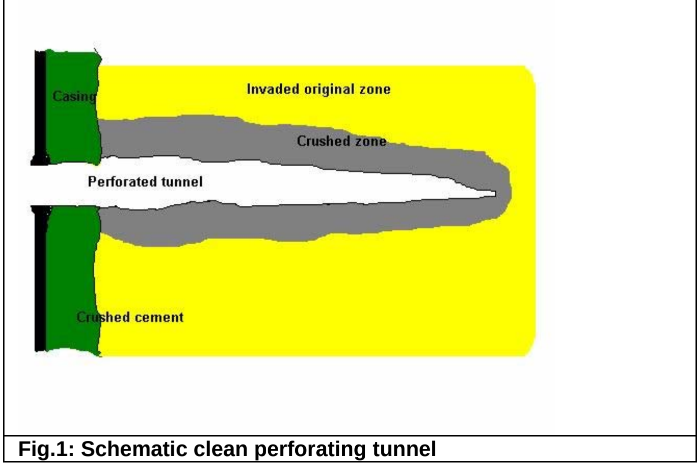

Fig.1: Schematic clean perforating tunnel

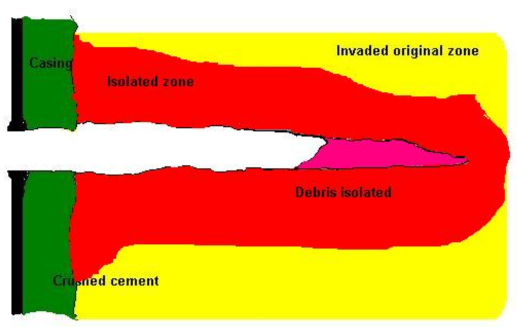

Fig.2: Perforating tunnel after chemical blocking

Fig.3: Unconsolidated sand after chemical blocking showing the plastic holder of initial "sand pack" and the broken sphere used as carrier for the chemical product.

Fig.4: Consolidated tunnel after chemical blocking. Poor consolidated sand has been removed. Reference scale in cm.