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Aspects of New Stimulation Technology of Oil Wells

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Abstract

Efficient exploitation of hydrocarbon deposits in various stages is conditional on a good communication of these hydrocarbons through porous media to reach in borehole.

Forming and maintaining collecting rocks in jams around the wellbore creates situations when only a very small amount of hydrocarbon saturated rock pores can get in wellbore and then to surface.

In this situation becomes apparent necessity of execution periodical of operations incentive to unblock the flow channels existing to create new ones that connects the probe to the area unaffected by contamination, so to improve permeability rock collectors around the wellbore or to increase mobility for oil wells. Knowledge producing detailed causes blockage of fluid flow from the wellbore in layer and its effects and reactions that occur phenomena and productive formations undergone treatments in stimulation has shown the need of continuous improvement of processes.

Key words: *oil well stimulation, electrical shock technology, Coanda Principle, fluid circulation recipes, acid stimulation solutions*

Introduction

The methods for oil wells stimulation by shock application are based on creating a system within the formation, where the pressure that acts on the fluid in the wellbore or on the fluid injected from the surface, thus exerting pressure on the walls of the well, a quick action of pressing and unloading. Depending on the size and duration of these request actions, one can frequency obtain:

- Clean walls or the unclogging of the layer or perforation;
- Cracking a zone in the layer around the drill hole.[1, 3]

This article will explore two methods of stimulating productive layers of wells with compromised perforations.The new technologies were brought on the Romanian market by oil companies and were implemented in our country on water injection wells and production wells requiring reinstatement.

These technologies are:

a. Stimulating flow of fluids technology, WASP - Wireline Applied Stimulation Pulses (stimulating pulses applied by electric cable) [10];
b. Stimulating technology using a pulsation generating device based on the Coanda Principle [9].

Experimental Part

The technology of stimulating the flow of fluids, WASP - Wireline Applied Stimulation Pulses (stimulating pulses applied by electric cable) increases the wells' production by means of economy. This method leads to an increased production of oil in new wells, but also in old wells and helps the recommencement of production in wells stopped for repairs and an increased flow of injected fluid in injection wells.

The Energy Conservation Law is at the basis of this technology. By releasing energy very quickly (within a very short period time) pulses are generated in the probe through the existing well fluid, which leads to creating shockwaves with an amplified power. Each shock wave propagates through the fluid in the well with a speed higher of 1500m/s and the pressure created by the shock waves on the fluid can be as high as 700 bar. This may be repeated depending on the characteristics of the productive layer [10, 11].

Interaction with the shockwave in the immediate vicinity of the wellbore creates a force that has the effect of:

- unlocking existing perforations through deployment and removal of organic and inorganic deposits;
- formatting new channels of communication in the productive layer around the wellbore by creating micro cracks, as shown in Figure 1.

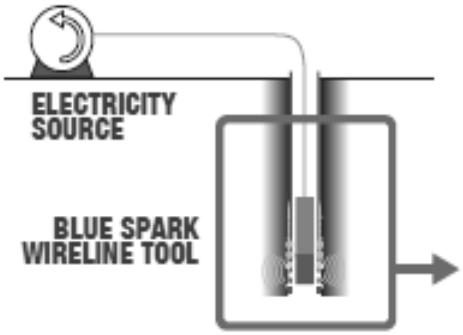

Fig. 1. Shock wave propagation in well [11]

The maximum hydraulic pulse intensity is reached in 7 micro-seconds as illustrated in the diagram in Figure 2, completed on a case study involving a distance of 15 cm from the source generating the shockwave.

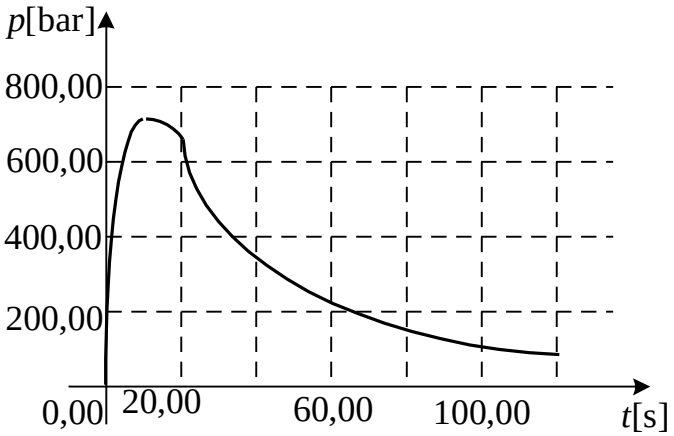

Fig. 2. The variation of pressure over time.

Preparing wells for stimulation consists in the removal of pumping equipment and in mounting the installation responsible with preventing breakouts that will be checked on pressure. In each well, foot control will be performed with the help of tubing.

Preparing for the treatment itself is done by extracting the tubing at surface and by positioning the geophysical unit (Wireline) and the logging equipment with which several tests are performed in the operation column.

This is followed by placing the WASP electrodes after performing functional tests on the surface.

The electrods has the characteristics shown in Table 1.

The electrode is positioned at the bottom of the perforations, and we begin triggering impulses in each well; the frequency of the impulses is 5, and the number of impulses will be determined by the specific conditions of the perforated productive layer.

Table 1.The characteristics of used electrodes [11]

Diameter [mm]	Electrode length [m]	Maximum work temperature [^{0}C]	Pressure [bar]
101.6 - 169.9	Max. 13	80 - 120	345-700

Figure 3 shows the situations of two wells stimulated by this technique: a probe with continuous perforations in the range of 2212 m - 2221 m, and other one with four intervals of perforations between 2160 m - 2186 m.

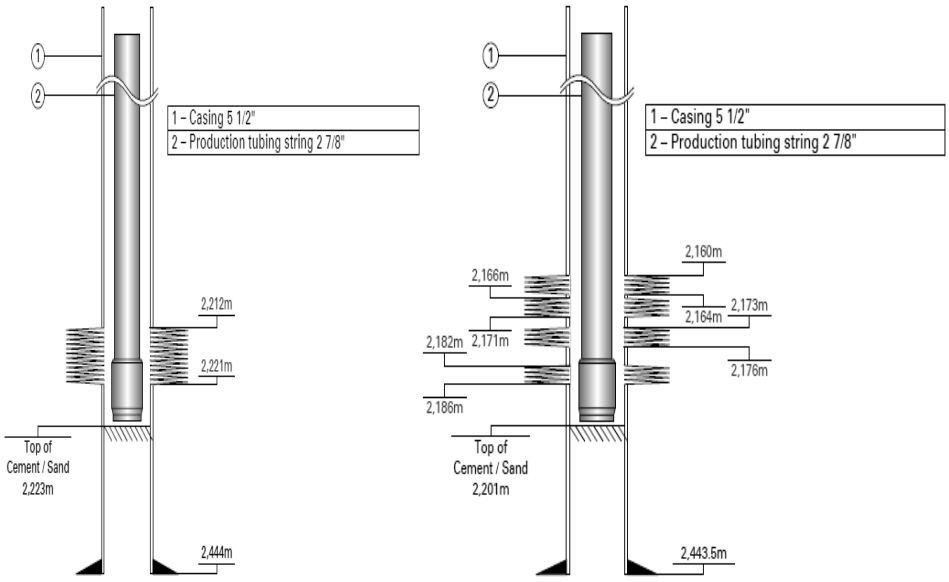

Fig. 3. Well completion for circulation and injection of surfactant [10]

In both probes, in order to optimize even more the effect at the time of stimulation by generating electric pulses with the electrode, the use of recipes for the preparation of fluid needed for the operations was proposed.

As a circulation fluid for both wells we choose a mixture of fresh water with a solution of clay stabilizer, ammonium chloride concentration of 5%.

The necessary amount in these cases is of 30m^3 of prepared solution.

After the movement circulation operation of the well a volume of 5m^3 is pumped in probe A and 8m^3 in probe B; the pumped solution is a mixture of a solvent and a corrosion inhibitor, with the characteristics presented in Table 2.

Table 2. Solvent and corrosion inhibitor characteristics. [10]

Component	Use	Specific volume	Total quantity	
			Well A	Well B
		l/m^3	*l*	*L*
DEGMBE	Solvent	500	2500	4000
Mopechim X258 (Xylene)	Corrosion inhibitor	500	2500	4000

For bringing the solvent next to the perforations, but also for filling in the column during the extraction of the tubing, a solution by displacement is prepared (table 3) consisting of ammonium chloride in a concentration of 3%.

The required amount of prepared solution for each of the analyzed probes is of 10 m^3.

Table 3. Displacement solution receipe. [11]

Component	Use	Total quantity	Measure unit
Fresh filttered water	Base fluid	9900	L
3% NH_4Cl	Clay stabiliser	500	Kg
Ecostim	Surfactant	100	L

For probe A we determined the height of the perforated layer to be stimulated at 6 m and there were applied 20 pulses on each 5 cm, for a total of 400 pulses / m, and for probe B with a drilling range of 16 m there were 24 pulses applied on each 10 cm intervals, with a total of 240 pulses / m. After completing the stimulation, the wells were brought into production with the help of a sucker rod pump, and production development was monitored for the next 30 days.

Before this operation the wells were operating intermittently, pumping 0.5 t of oil / 2 days, but after the operation, the average yield was 1.7 t oil / day during continuous pumping, so the stimulating operation by acidification was dropped; initially it was proposed for usage 30 days after the wells entered production.

For the acidizing treatment of production and injection wells, which have large perforated intervals, in order to reduce the consumption of the acidic solution required for the treatment, devices generating pulses at the perforations can be used.

One of the devices (Figure 4) frequently used in well stimulation in our country is built on the Coanda Principle. [9]

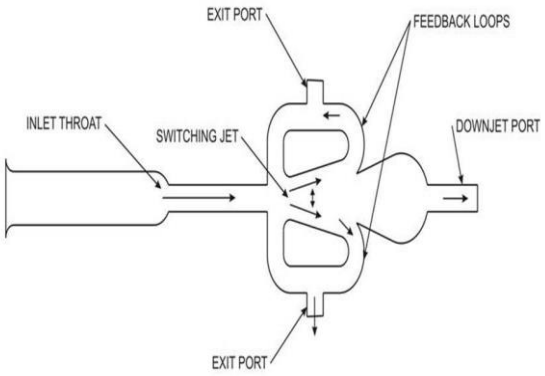

Fig. 4. Pulsation generator device [9]

This device will be attached to the underside of the flexible tubing which is inserted through the existing extraction tubing inside the well. By moving the device to the perforated intervals,

during the acidic solution pumping, hydraulic pulses are created at the exit nozzles formed in the device, which will allow the perforations to be released and the creation of micro cracks in the vicinity of the borehole (Figure 5). The data on the physical properties of the collection rocks and their mineralogical composition, from the productive layer, well construction and perforated intervals is absolutely needed when applying this technology.

Based on this information an acidizing treatment solution will be chosen, the type of acids and necessary additives will be determined as well as the pumping method and working parameters to be used. The placement of acidic solutions will be made through flexible tubing by using the pulse generator mounted right where the perforations are located (figure 6).

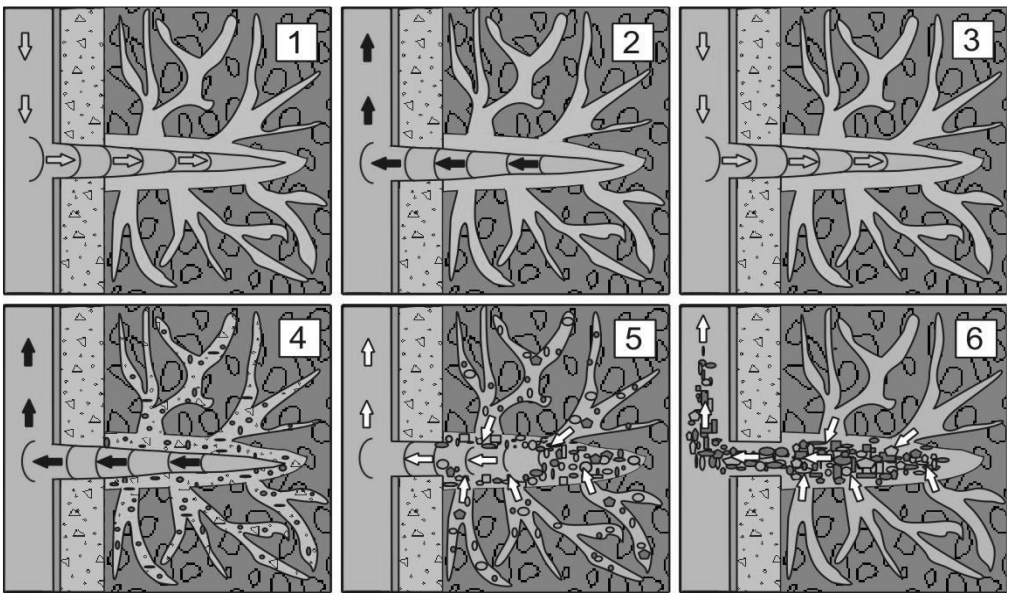

Fig. 5. The trajectory of injected fluid [9]

In this image we can see the shaped trajectory of the fluid pumped in the layer.

The low pressure area creates a suction effect which causes the flow to veer toward the other switching jet and achieving a low-pressure similar area. Every time there is a change of direction in the fluid flow this creates a pressure oscillation. Pressure waves propagate radially in the probe and may help remove near wellbore deposits. The goal of this treatment was to increase the injectivity index. For pumping acid solution in the layer through this device we follow the same working steps used in conventional acidizing operations.With this technology different types of nonabrasive fluids can be placed inside the layer. The injected fluids are an integral part of the stimulation treatment.The probe stimulated by this technology is a waste injection well/pump, for which we want to increase the injected volume (Table 3).

Table 4. Formation characteristics [10]

Formation	BHT	Permeabily	Average porosity	Formation pressure	Rock
Meotian Pontian	36 ^{0}C	148 mD	26 %	105 bar	Alternation of sand and sandstone with marl and clay

Stimulation is made with acid solutions and placement of acidic solutions will be made right by the perforations through the flexible tubing with the help of a stimulating tool, which at a certain flow will produce those hydraulic pulsations, thus contributing to the release process.

To increase the well injectivity in the perforated interval it is recommended to undergo an acidizing operation in three steps with a preflush solution + a mainflush solution and averflush solution.

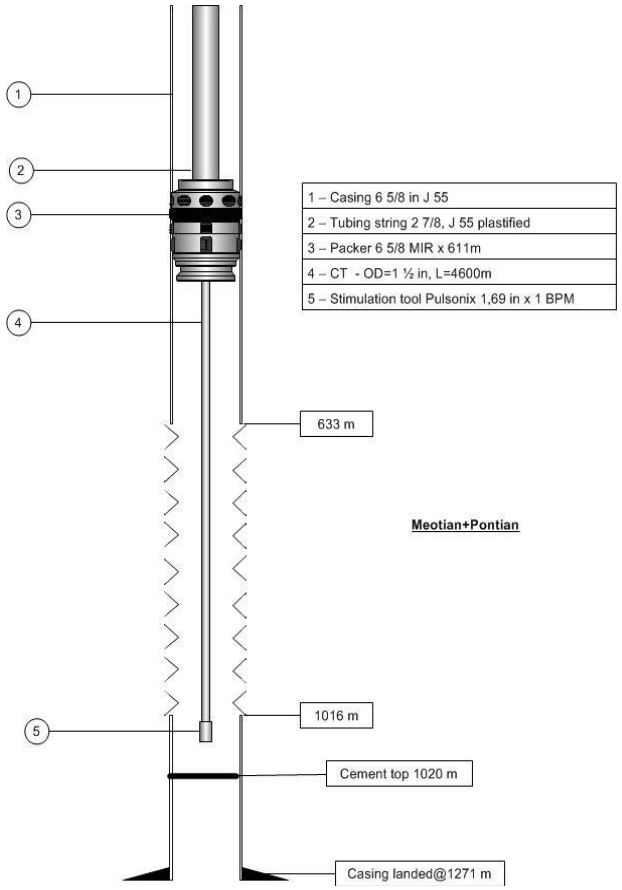

Fig. 6. Well equipped with pulse generator device [10]

Conclusion

Due to the complexity of the geological - technical conditions that cause a reduction or a blockage of the fluids flowing at the level of the productive layer, we cannot develop stimulation recipes on types of reservoirs or probes. We must analyze in detail the specific conditions of each probe and the laboratory tests results on the physico - chemical properties of the treatment fluids and additives used to develop computer simulation programs for each stage of the stimulation therapy in order to select the suitable treatment fluids and working parameters.

The probe will be investigated for a few days after the recommencement of production in order to asses the outcome of the stimulation treatment. Depending on the flow value obtained from the probe following the applied treatment we can do further research to find the causes for the failure of the therapy applied; or in the case of unsatisfactory results we will reassess the conditions in the probe and of the productive layer in order to apply combined treatments (applied sequentially) for the greater efficiency of fluid flow from the layer in the wellbore.

In this case the two wells subjected to this new electric pulse stimulation technology, the schedule is based on starting the well by pumping and surveying production for one month. Shockwaves can be repeated every 5 to 15 seconds depending on the type of electrode used.

Hydraulic shock waves have as main advantage that they do not damage the column or cement behind the column. This methodology is applied to stimulate oil deposits and does not require mechanical isolation of the area undergoing stimulation. The electrodes depth positioning is very accurate and can avoid areas of water. Stimulation technology applied to these electrodes is quick, requires low cost with low risk levels.

By using the generating pulsation device we noted the following advantages:

- It helps to increase and restore natural permeability through the pressure waves of the solution, thus helping to place the treatment solution and maximizing chemical reactions between the treatment fluids and porous media.
- It applies well in all phases of completion and after major repairs.
- It allows the operator to maximize profits while reducing the costs of operation.
- The pressure waves propagate radially through the probe and may remove near wellbore deposits.

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Aspecte privind noi tehnologii de stimulare a sondelor de petrol

Rezumat

Exploatarea eficientã a zãcãmintelor de hidrocarburi în diferite stadii este condiționatã de o bunã comunicație a acestor hidrocarburi prin mediul poros pentru a ajunge în gaura de sondã. Formarea și menținerea unor blocaje în rocile colectoare din jurul gãurilor de sonde creazã situații când numai o cantitate foarte micã de hidrocarburi ce saturează porii rocii pot ajunge în gaura de sondã și apoi la suprafațã. Față de această situație apare evidenta necessitate a executării periodice a unor operații de stimulare care sã deblocheze canalele de curgere existente, sã creeze altele noi, care realizează legãtura sondei cu zona neafectatã de contaminare, deci de a îmbunãtãți permeabilitatea rocilor colectoare din jurul gãurii de sondã, sau de a mãrii mobilitatea țițeiului spre sonde.

Cunoașerea detaliatã a cauzelor ce produc blocajul curgerii fluidelor din strat în gaura de sondã și a efectelor acestora, precum și a reacțiilor și a fenomonelor ce au loc în formațiunile productive supuse tratamentelor de stimulare, a dovedit necesitatea perfecționãrii permanente a tehnologiilor de tratare.