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CONVERSATION WITH THE WELL

INSTEAD OF INTRODUCTION

In article 'Strippers' Pose Dilemma for Oil Industry" (The Wall Street Journal) from September 7, 2015, Nicole Friedman writes: "In the United States more than 400,000 stripper wells, most of which produce less than five barrels a day. They losing money every day. If oil prices will be held at the level off $ 30 per barrel or below, more than half of stripper-well production could be shut down. Thousands of individual operators could turn out to be a key element in ending the oil-price rout, rather than a large producing country like Saudi Arabia or a big public company. A sharp drop in stripper-well output, currently estimated at a million barrels a day, or 11 % of total U.S. production, would be nearly impossible to observe as it happens, but it could still shrink the glut that continues to weigh on prices, surprising the market".

http://www.wsj.com/articles/stripper-wells-are-wild-card-in-oil-rout-1441660049

CONDITION OF THE TRADITIONAL AMERICAN MARKET OF THE OIL AND GAS INDUSTRY

The number of drilled oil and gas wells in the world is huge. Most of the wells are in the United States. It was established that in vertical wells the hydrocarbon extraction is not more than 25-40 %, and for horizontal less than 10 %. Extraction of oil, mainly confined to the good collectors. More than 70-80 % of the cemented reservoirs contain basic unrecoverable hydrocarbons.

There are millions of wells. A large part of them liquidated. Among the millions of working oil wells are about 400 thousand low-productive (from zero to 3-5 barrels per day), and even closed (abandoned) wells. At the same time, during all period of exploitation of the wells in most cases was used no more than 25-35 % of the available stocks. Geological estimates show that the residual oil reserves are still around 200 billion barrels of oil. The age of most low-production wells 60 - 80 or even 100 years.

Companies, which have any relation to oil and gas industry looking for ways out of the situation, and views on this issue are completely different. Some owners of the wells, who still has some resources for maintenance and service half-dead or low-productivity (0-5 barrels per day) wells choose to do nothing in hope the better time in a possible future. Someone tries to reduce expenses to a minimum by reducing the amount of works and staff. Someone intensively discuss of various management strategy, monitoring, more ways to extend the life of still working deposit-fields, implementation and use of some new technologies (especially those, who do not have any relation to any technology), oil booms, new computer's programs for drilling, offshore structural inspections, petroleum engineering educations, etc.

WAYS TO STABILIZE

Reading numerous articles and specialized forums, is possible to trace some trends, suggested for stabilize situation:

1. do nothing
2. close wells
3. sell wells
4. drill more new wells
5. reduce costs of operation
6. train more staff
7. change management policies
8. reduce number of staff
9. retrain in other professions
10. leave to another business
11. integrate more computer software

12. more discuss about fantastic new technologies
13. dream about cheap methods of stimulation
14. recover old wells and increase the productive inflow

What do you think, which of the above items can really help in solving the problem of low-productive wells ?

Those few, who are trying to adopt to the existence at current prices, they trying to increase the current inflow of useful product, or get additional inflows. Therefore, for those few, who have decided to raise their oil or gas inflow, and accordingly, financial income up to previous (before lower prices) level, a little more interesting a few other things. What are the real and optimal (price + efficiency) ways to increase the inflow of useful product ?

Huge number of proposals from service and operating companies vying with offers about well's recompletions and increasing inflows by thousands of different methods and technologies, for "any taste and color" (www.mergernetwork.com). They promise make recovery and increase the inflows in dozens and hundreds times for any money, beginning even from 10-20 thousand dollars. Wonder, what can be done for this money, and why it was not done before ?

Let's be clear a few moments concerning wells, fall of inflows and recoveries.

Why inflow is fell ? Only when the cause of the fall inflow in the well is determined, is necessary take a decision about real and effective methods of treatment on the basis of financial possibilities and the desired effect.

Treatment a medicine for the common cold does not help to a patient with pneumonia. The reason for the fall of inflows must be determine first, and only after that is possible to determine the really effective treatment.

TECHNICAL REASONS THE FALL (OR ABSENCE) OF PRODUCTION RATE

1. incorrect grid drilling wells on the deposit-field (including inadequate drainage distance between wells)
2. shielding drainage areas between the reservoirs
3. absence of product (oil or gas)
4. natural depletion of productive reservoir
5. fall of internal pressure in the reservoir
6. Improper development wells (including incorrect or inefficient methods of initial opening the productive formation with a small drainage area; use of hydraulic fracturing in the thin-interbedded formations, shale, etc.)
7. absence of hydrodynamic connection (or poor connection) productive formation with the well (including inappropriate methods of initial opening the productive formation, formation of melted borders, for example, after gun or cumulative perforations, or after subsequent plasma-pulse stimulation)
8. formation of joint and harmful links between productive and non-productive (and water) layers (for example, after fracturing)
9. watering of the producing formation (including casing flow, for example, as a result of cement cracks after shock methods of opening the casing)
10. improper development well (including the wrong chemical treatment)
11. improper exploitation of the well (including excessively high operating modes)
12. damage of the productive formation (including wrong chemical treatment and some stimulation methods, melted formation, creating reflow border, destructive formation and ultimately ruining the well, etc.)
13. ineffectiveness and short duration of stimulating methods of influence (including small area of the initial opening)
14. colmatation, clogging, contamination of the productive formation in the near wellbore zone (including crumbling (sloughing) sand and specific chemical composition of the formation water)
15. high viscosity, density/gravity (with subsequent waxing), low temperature
16. increased viscosity due low temperature of productive layer
17. content of the productive formation of bridging impurities (including natural and dragged during operation)
18. contamination of underground pumping equipment, etc.

PHYSICAL FACTORS DETERMINING THE QUANTITY OF FLOW

1. deposit
2. reservoir rock quality
3. porosity
4. permeability
5. pore size
6. water present
7. reservoir temperature
8. viscosity
9. density/gravity
10. thickness of the productive formation
11. depth of occurrence
12. location (relative to other wells, distance to the injection well, by depth of productive and aquifers layers)
13. internal reservoir pressure
14. method of extraction (vertical/horizontal)
15. productive formation's perforations/open hole (opened productive formation's area)
16. casing's perforations (opened casing's area)
17. connectivity (hydrodynamic connection the well with producing formation)
18. cement condition
19. ID casing/open hole and condition
20. ID tubing and condition
21. drawdown pressure difference
22. choke size/setting
23. underground pumping equipment's condition
24. surface equipment's condition

Which of the above factors is possible to change/improve, if the influx has already fallen?

Of course, location, deposit (remaining reserve), rock/formation composition, pore size, porosity/permeability, depth of occurrence, thickness of the productive formation, design (vertical/horizontal) and casing in the existing wellbore no longer change. Only if drill a new well in another place.

Some service-companies argues, that new drilling of vertical well can cost as low as 20-25 thousand dollars. But do not forget about casing's installation, cementation, logging, geological analysis, casing opening, opening of productive layers, subsequent development of the well, etc. This process is several times more expensive than drilling, and no guarantee that you will get inflow. So the drilling of a new well, we will not be considered.

What proposes service and operating companies under so-called recovery/recompletion for increase the flow? Alas, the selection is small: additional drilling, additional gun/cumulative/abrasive jet (point) perforation, additional chemical or some stimulation treatment, additional hydraulic fracturing, and pump-jack parts replacement.

FIRST IS DETERMINING THE CAUSE OF DROP FLOW

It is impossible for all low-production wells apply the same standard methods of recovery/recompletion.

Accurate geological analysis allows to determine the cause of the fall inflow in the well, but this would require additional information. Location map, test results, production and exploitation history by oil, gas, water and pressure, well logging, including neighboring wells, perhaps core analysis, and sometimes require other additional data.

According to the analysis of oil wells, registered in state and national databases, for the period of operation of the well production rate drops to 12 barrels per day, and in many cases to zero.

MOST FREQUENTLY AND MAIN CAUSES DROP FLOW

Along with the above reasons of drop flow, there is one more very important moment. For the most cases, affect the entire future work of the well, this is *initial opening of the casing, cement and productive layer*.

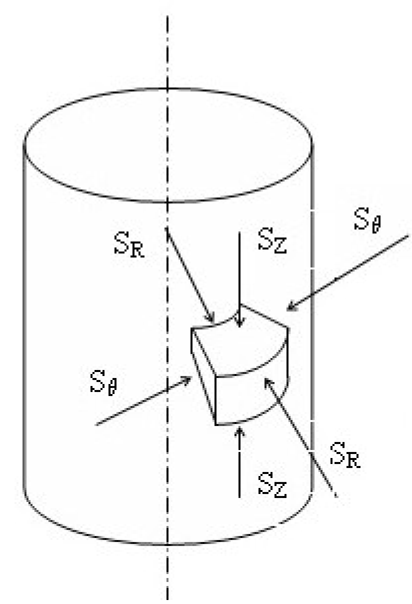
Research has shown that almost the main reason for fall production rate are the initial methods of opening the productive formation, among which a leading position occupies the gun or cumulative perforation in the old wells.

1. too small depth of penetration
2. too small opening zone
3. too small drainage surface area
   bad hydrodynamic connection the well with producing formation
4. malicious impact force on the casing, cement sheath and productive formation

a. mechanical damage of casing
b. mechanical damage or destruction of cement sheath (with the formation of cracks and subsequent increase under the influence of circular tangential compressive stress conditions and rock pressure, which contributes to the water overflows from the watering layers, and subsequent flooding of the productive formation)
c. formation of melted borders, clogging the productive formation

PHYSICAL REASONS THE FALL (OR ABSENCE) OF PRODUCTION RATE.

During the drilling of any well (perforation of any horizontal or vertical holes) under the action of hydrostatic, mining and high overburden pressures in the annulus are formed the circular tangential stress conditions (stress-strain states). Not to be confused with the hydrostatic or rock pressure.



It is known that one of the main causes of the declining production rate of oil and gas wells is the deterioration of the permeability of rocks in the near-wellbore zone directly from the borehole wall. This occurs both during drilling and during their operation (figure on the right). Study the role of this factor is still neglected.

Under the action of these stress conditions occurs a significant reduction in permeability in the near wellbore zone. Oil or gas flow cannot penetrate into the well, and in some cases close to zero.

Traditional methods of opening the productive formation did not consider this complicated situation in the near-well zone and therefore was not effective. Porous and fractured formations are subjected to compression, that deform the rock mass and reduce its permeability. The depth has a significant influence on the stress-strain state of the rock mass around the wellbore. The more depth - more stress-strain states, the lower permeability, and as a result the decrease of productive inflow efficiency.

500 ft.	1000-2000 psi
1000 ft.	2000-3000 psi
1500 ft.	3000-4000 psi
2000 ft.	4000-5000 psi
2500 ft.	5000-6000 psi
3000 ft.	6000-7000 psi
3500 ft.	7000-8000 psi
4000 ft.	8000-9000 psi
4500 ft.	9000-10000 psi

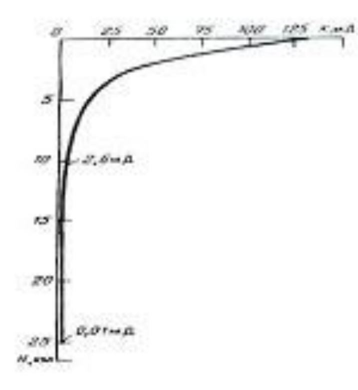


Fig.1 Permebility vs. depth (calculated)

Newly drilled well already has a negative potential, which does not disappear in the subsequent opening of the casing (column) and productive formations:

1. reduction in permeability
2. reduction of porosity
3. as a consequence: reduced productivity inflow into the well (in some individual cases to zero)

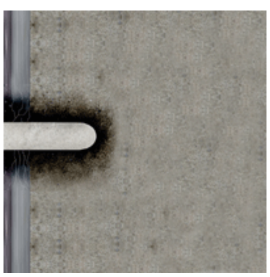
MAIN REQUIREMENTS OF GEOMECHANICS TO INITIAL OPENING OF THE PRODUCTIVE FORMATION.

1. casing must be opened fully (maximum on the entire length of the production interval along the column), but with considering the strength of the column
2. productive formations area should be opened as much as possible, and with possible a greater depth (exclude hit pieces of cement into the opened space of productive formation)
3. cement sheath should keep the integrity (cracks and destruction of the cement promote the flows of water from watered intervals and eventually lead to the flooding of the productive formation)
4. exclude formation of melted and other borders between opening area and productive formation (this prevents hydrodynamic connection of the well with the productive formation)
5. exclude connection (mixing) of productive and unproductive (watered and harmful) intervals (opening should take place only within the required production interval)

Based on the foregoing about malicious stress-strain states conditions in the near wellbore zone, can be argued one more the following requirement:

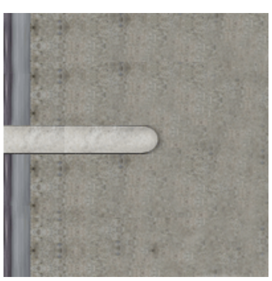
6. is necessary unloading stress conditions in the near wellbore zone (in opening productive formation zone)

COMPARATIVE CHARACTERISTICS OF METHODS OF INITIAL OPENING THE PRODUCTIVE FORMATION WITH CONFORMITY THE MAIN REQUIREMENTS OF GEOMECHANICS.



gun or cumulative perforation					
depth	area	cement	border	mixing	unloading
(1)	(2)	(3)	(4)	(5)	(6)
0.15 m	0.05 m^2	destroyed (cracks)	formed (melted)	not occurs	not occurs
0.5 ft.	0.5 ft.^{2}				

Gun or cumulative perforation occurs the impact, deformation of casing, destruction and formation of cracks in cement that become longer and deeper especially after subsequent fracturing. Also gun or cumulative perforation creates a stable melted border. Unloading the stress conditions in the near wellbore zone is not happening.



abrasive jet (point) perforation					
depth	area	cement	border	mixing	unloading
(1)	(2)	(3)	(4)	(5)	(6)
0.3 m	0.1 м^2	not destroyed	not formed	not occurs	not occurs
1 ft.	1 ft.^{2}				

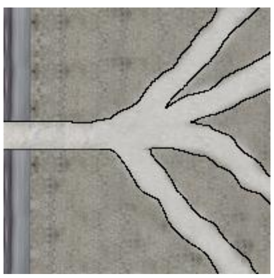
Abrasive jet (point) perforation not deforms the casing, does not destroys the cement (keeps the integrity of the cement sheath), and does not forms the borders in the opening productive formation zone, but the penetration depth not exceeding 1 ft. (0.3 m). Unloading the stress conditions in the near wellbore zone is not happening.

hydo-mechanical (non-abrasive) slotting perforation (HMSP)					
depth	area	cement	border	mixing	unloading
(1)	(2)	(3)	(4)	(5)	(6)
up to 0.7 m	up to 5 м^2	not destroyed	not formed	not occurs	unloading occurs
up to 2.5 ft.	up to 18 ft.^{2}				

Hydro-mechanical (non-abrasive) slotting perforation (HMSP) does not deforms the casing, does not destroys the cement (keeps the integrity of the cement sheath), and does not forms the borders in the opening productive formation zone. Penetration up to 2.5 ft. (0.7 m) and drainage opening area up to 18 ft.^{2} per linear foot, or 5 м^2 per one linear meter (with simultaneous formation of four slots). Occurs unloading of the stress conditions in the near wellbore zone.

hydo-slotting (abrasive) perforation (HSP)					
depth	area	cement	border	mixing	unloading
(1)	(2)	(3)	(4)	(5)	(6)
up to 1.5 m	up to 12 m^2	not destroyed	not formed	not occurs	unloading occurs
up to 5 ft.	up to 40 ft.^{2}				

Hydro-slotting (abrasive) perforation (HSP) does not deforms the casing, does not destroys the cement (keeps the integrity of the cement sheath), and does not forms the borders in the opening productive formation zone. Penetration up to 5 ft. (1.5 m) and drainage opening area up to 40 ft.^{2} per linear foot, or 12 м^2 per one linear meter (with simultaneous formation of four slots). Occurs unloading of the stress conditions in the near wellbore zone. HMSP and HSP are environmentally friendly and only the methods of the initial opening the casing, cement and productive formations with unloading stress conditions in the near wellbore zone.



hydraulic fracturing					
depth	area	cement	border	mixing	unloading
(1)	(2)	(3)	(4)	(5)	(6)
~	~	questionable	not formed	mixing layers	not occurs
~	~				

Hydraulic fracturing is the most powerful method of opening a productive formation. Application is possible only after prior opening of the casing (initial opening). It forms deep cracks and micro cracks, the direction of which defies prediction, integrates productive and unproductive formations, "pulls" the nearest water. Good results after HMSP and HSP, which sets the follow geometry for hydraulic fracturing.

Comparative characteristics of the main initial opening methods clearly shows, that the most effective and meets all the required parameters of Geomechanics are HMSP (hydro-mechanical slotting perforation) and HSP (hydro-slotting perforation). The second, even more efficient because it uses abrasive sand. Wells which initially developed with using such effective opening methods (HMSP and HSP) continue to "work" 10 -15 and more years.

IT SHOULD CLEARLY DISTINGUISH MAIN (PRIMARY AND MANDATORY) METHODS OF INITIAL OPENING AND SECONDARY (SUBSEQUENT AND POSSIBLE) STIMULATION METHODS.

The problem of increasing the productive inflows given great importance. Particularly acute issues of increasing inflows in low-debit wells (from 0 to 5 barrels per day) began to be discussed with the fall in oil prices. Raising the production rate in 5-10 times can completely solve the financial problems.

Wells developed by more traditional but less effective methods ("old-fashioned") require reconstruction (recovery), and the first step in solving the problem of the increase (recovery) productive inflows can be re-opening of productive formations using more effective main methods of opening the casing, cement and productive formation.

METHODS OF SUBSEQUENT (ADDITIONAL, POSSIBLE) STIMULATION (INTENSIFICATION) OF OIL AND GAS WELLS.

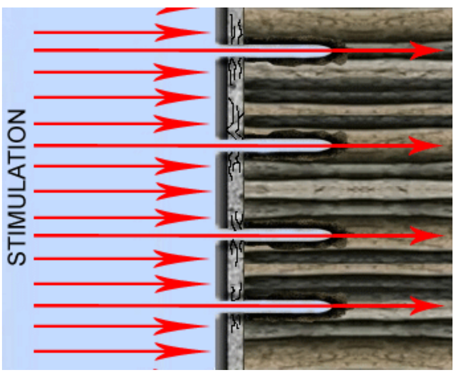
Methods of additional (possible) stimulation is much more than the basic (initial) opening methods. Their value and real effectiveness of the various possible respectively much lower, and duration of a possible real effect can be up to several months, but they unfortunately do not solve the underlying problem. The most common used method of well stimulation is a chemical treatment. The most powerful and effective stimulation method also may include hydraulic fracturing, as not initial opening method.

KNOWN TODAY METHODS OF STIMULATION:

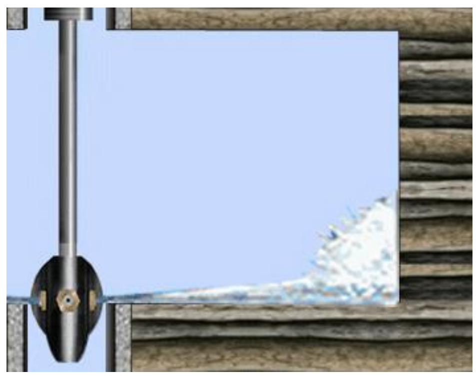
1. acoustic
2. acid
3. air
4. cavitation
5. chemical
6. electrical
7. frequency
8. gas
9. hydraulic
10. laser
11. magnetic
12. plasma
13. pneumatic
14. pulse
15. resonance
16. shock
17. steam
18. stress (overstress)
19. temperature
20. thermal
21. ultrasonic
22. vacuum
23. vibration
24. wave

EFFICACY AND DURATION OF ANY KNOWN STIMULATION METHODS IS DEPENDING ON THE SIZE OF OPENED SURFACE AREA IN THE STEEL CASING AND CEMENT. NONE OF THE CURRENTLY KNOWN STIMULATION METHODS CANNOT OVERCOME THIS BARRIER TO FULLY AFFECT THE PRODUCTIVE FORMATION BEHIND THE CASING.

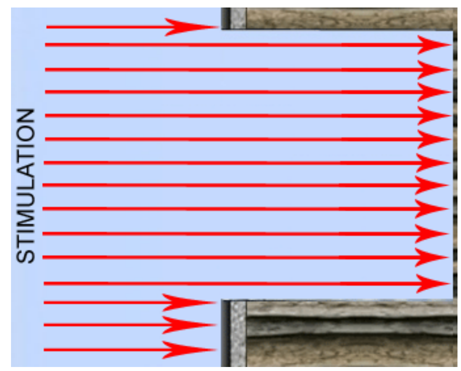
any stimulation after
gun or cumulative perforation



main (initial) opening
with hydro-slotting perforation



any stimulation after
hydro-slotting perforation



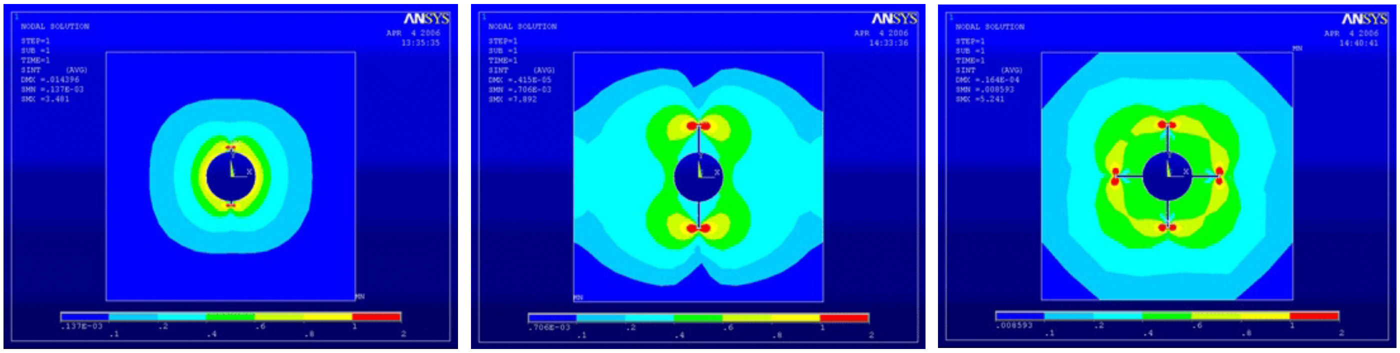
HYDRO-SLOTTING PERFORATION AS THE MAIN (INITIAL) OPENING METHOD.

Slotting perforation technology is the cutting of continuous slots along the wellbore.

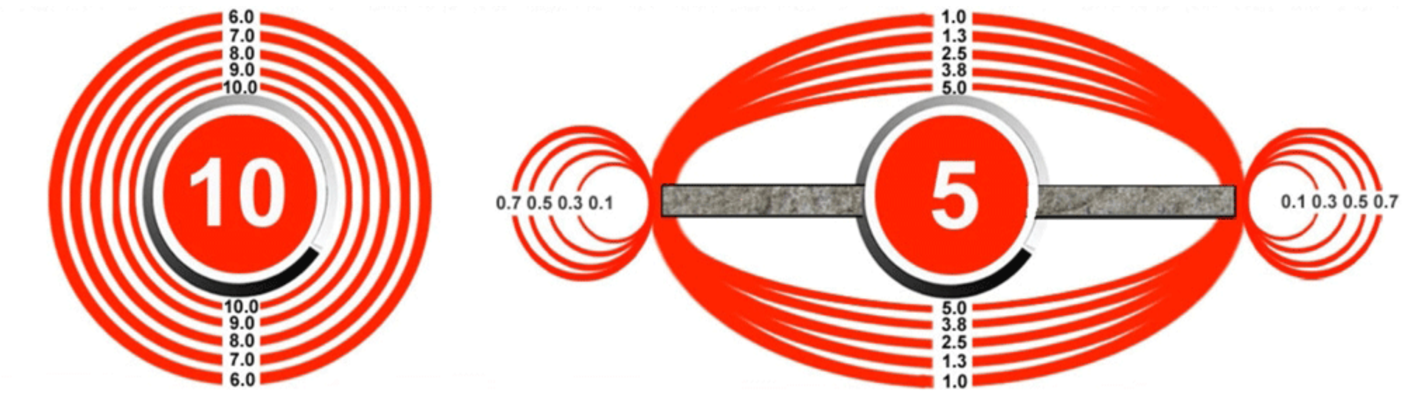
The main idea of the technology is unloading of the annular compressive stress conditions (stress-strain states) around the wellbore zone. Unloading effect is occurs due creating longitudinal slots along the borehole, at the cutting depth equal 5 diameters of the well (~ 2.3 ft. or 0.7 m). This effect can only give a slot; the hole never gives unloading effect.

The idea came from the coal industry (coal mines), where occurred special excavations (collaborations, grooves, slots) of various cross-sections depending on the magnitude and direction of rock pressure, which significantly unloaded the stress-stain states of rock.

The second and third figures below shows the intensity distribution of shear stresses in the near-wellbore zone with two and four diametrically opposed vertical slots. The figure shows that the slots almost twice reduce the effect on the contour of the borehole shear stresses, and the zone of reduced permeability is significantly reduced in size and are pushed into the interior of the reservoir.



HSP creating mining facilities across the producing formation, unloading the components of rock pressure in the near wellbore zone of the productive reservoir and provides greater surface drainage flow of oil. To unload a cavity is formed along the axis of the well by cutting slots in the productive reservoir, oriented perpendicular to the principal stresses in the rock mass. As a result, with sufficient thickness to unload cavity, shear stresses are removed completely and will not be restored. In addition, it is an opportunity to significantly reduce the horizontal tangential stresses at the depth of the reservoir. The discharge zone covers virtually the entire formation.



As seen from the graphs, when cutting vertical slots along a portion of the wellbore is unloaded the hoop stress and redistribution of the stress-strain states to the ends of these slots.

MAIN ADVANTAGES OF HSP:

1. continuous slots along the wellbore allow unloading of the annular compressive stress-strain states around the wellbore zone
2. unloading of annular compressive stress-strain states around the wellbore zone increases the permeability of the producing formation
3. permeability of producing formation in the near-wellbore zone increases on average up to 50-100 % (statistical data)
4. increases of permeability in the near-wellbore zone improves reservoir properties and increases the flow on average up to 30-50 %

ALL BENEFITS FROM HYDRO-SLOTTING PERFORATION USE

1. ecologically safe, environmentally friendly (produced water and an abrasive filler)
2. penetration depth is up to 1.5 m (5 feet)
3. opening area per one linear meter up to 6 m² (2 slots), and 12 m² (4 slots)
4. opening area per one linear foot up to 20 ft² (2 slots), and 40 ft² (4 slots)
5. cutting speed is one linear foot per 60 min (cased wells) and one linear foot per 30 min (open hole)
6. simultaneous cutting 2, 3, and 4 slots along the wellbore
7. no detonation impact, no casing damage, no cement cracks, and no clog-up the formation borders
8. unloading of the annular compressive stress conditions in the near wellbore zone up to 50-100 %

9. accordingly, the increase of permeability up to 30-50 %
10. accordingly, the increase in the useful inflow up to 5-10 times
11. can be used in oil, gas, and injection wells
12. can be used in newly drilled and low productivity, low debit wells
13. can be used in vertical and horizontal wells, with tubing and coiled tubing
14. can be used in any formation (sandstone, carbonates, shale’s, thinly interbedded, quicksand, etc.)
15. can be used near the water reservoirs (impossible to make a hydraulic fracturing)
16. extract more than 20 % of additional oil from the layers with higher productivity
17. duration of the effect 10-15 years
18. make an excellent geometry for subsequent fracturing (if necessary)

COMPARISON HYDRO-SLOTTING PERFORATION WITH HYDRAULIC FRACTURING:

Hydraulic fracturing (fracking) - hydraulically pressurized liquid made of water, sand, and chemicals (optional).
Hydraulic Fracturing is the most powerful method, creating very long cracks and micro cracks spread in the direction of the greatest fracture.
Fracturing can be applied only after one of the known methods of opening the casing.

Positive aspects

- large area of opening
- large productive inflow (especially in the initial stage)

Negative aspects

- process has practically no control
- process affects the other layers and zones
- cracks and micro cracks of large length extend the boundaries of producing formation and transferred to other layers
- coefficient of efficiency sometimes reduced up to 20 % (within productive formation), the remaining 80 % are harmful
- violation of the integrity of a producing formation
- combining unwanted productive and non-productive reservoirs
- generating unwanted flows
- Pulling up the water with subsequent flooding of the productive layer
- Reducing the life of the well

Coefficient of efficiency of hydraulic fracturing in shale’s or thinly interbedded layers, for example, is very low and financially not beneficial.

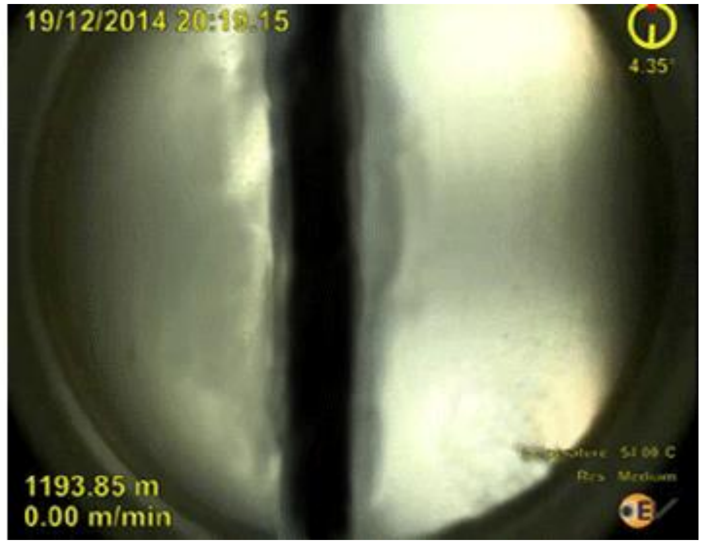
Hydro-slotting perforation - continuous moving jet slotting perforation along the borehole, it uses only water and sand (abrasive).
Hydro-slotting perforation is the most effective method of opening the casing, cement and productive formation. Uses a special slotting perforation tool that produces linear motion with constant velocity of abrasive cutting jets along the wellbore, and without moving the tubing from the surface.

Positive aspects

- ecologically safe, environmentally friendly (water and sand)
- very long duration of effect (up to 10-15 years)
- opportunity of using near the water reservoirs (impossible to make a hydraulic fracturing)
- process is controlled (length and depth of slots)
- process takes place within the productive formation, and not affects other layers and zones
- large opening area, penetration depth is up to 5 feet;
- no detonation impact, no casing damage, no cement cracks, no clog-up the formation in borders
- unloading the tangential circle stress conditions in the near wellbore zone up to 50-100 %
- Increases the collecting properties in the near wellbore zone
  Increase of the drainage volume characteristics in more than 6 times
- Increase of permeability and accordingly increase the useful inflow up to 30-50 %
- opportunity to use in any wells and in any formations

Negative aspects

- process is quite complicated in the performance



HYDRO-SLOTTING PERFORATION IT IS UNKNOWN METHOD ?

HSP has been recommended for industrial use since 1980. Every year in Europe with this method is being developed about 1200 wells. Hydro-slotting perforation was used in Azerbaijan, Brazil, China, Eastern and Western Siberia, Jordan, Kazakhstan, Komi Republic, North Caucasus, Russia, Udmurtia, Ukraine, Urals, Uzbekistan and Yemen. The first mention regarding the hydro-slotting perforation in the United States was in 1987 at the "Oil and gas conference" in Texas. The first use of hydro-slotting perforation in the United States dates back to 1996. Since 2012 hydro-slotting perforations is used in the United States and Canada on the service basis.

IN WHICH WELLS CAN HYDRO-SLOTTING PERFORATION (HSP) CAN BE USED

- oil, gas and injection wells
- vertical and horizontal wells
- newly drilled and old wells
- sandstone, carbonate, shale, etc. formations
- shallow and deep wells
- high-temperature and low-temperature wells
- low-viscosity and high-viscosity, etc.

IS PREFERABLE

- newly/old drilled wells with the following criteria:
- having no problems with the water during operation
- total period of operation not exceeding 10-15 years
- designed exclusively via gun perforation or cumulative perforation
- designed exclusively via hydraulic fracturing, but without water during the whole period of operation
- the operational reservoirs one or two
- having a very good productive inflow in early or mid-operation
- currently idle or even abandonment
- currently inflow 0-0.5-1.0-1.5-2.0 bod

REQUIRED INFORMATION (USUALLY GIVEN WHAT IS AVAILABLE)

- area map with the location of wells, geological map with absolute height
- well's design, methods of opening the productive formations, packers and so on
- history of drilling, development (with test's results), exploitation
- logs (electrical-induction, gamma-ray-neutron, acoustic, and mud-chat-log)

- core analysis, lithology, etc.

THIRD-PARTY SERVICES DURING HSP RECOMPLETION

- rig with crew
- tubing
- wellhead and surface piping
- tank with formation water
- shaker (blender, mixer)
- frack service (pump service)
- high pressure line
- manifold block
- abrasive filler (abrasive quartz sand)

FINANCING

The fall in oil prices in 2015 severely affected the Oil and Gas Industry, but investments in oil business have not ceased to be profitable.

With oil prices fell prices on a land and low-productivity wells. Also fell prices for the services. Currently is possible to buy low productive well for $ 50,000-$ 60,000, and for owners of low productive wells full recompletion (including all the necessary services) for increase the productive inflow from 0-5 bbl./day to 25-35 bbl./day (for example) will cost $ 60,000-$ 100,000 (meaning recompletion with hydro-slotting perforation technology). Invested funds are returned in less than a year, but then the well begins to make a profit during 10-15 years.

The table below clearly shows all calculations for investments and profit. Table has a range for oil prices $ 10-$ 50 per bbl., and possible getting productive inflows from 10 bbl./day to 50 bbl./day.

Consider the average example. Assume that the price of oil $ 30 per bbl. Assume that you have invested money in the amount $ 100,000 in recompletion of low productive oil well with hydro-slotting perforation technology, and after that you got productive inflow 30 bbl./day.
At the top of the table looking for a column with productive inflow 30 bbl./day. It is 900 barrels of oil per month, and accordingly 10950 barrels of oil per year. Looking in the left column of the table price for oil $ 30 per barrel. The next column: investments for recompletion $ 100,000. The next column: payback in months (under the column with productive inflow 30 bbl./day): 3.7 month. This means, that you will return back your invested money in four and a half months in near 111 days. In the yellow sell of the same column you'll find annual profit $ 328,500 per year. Effect after recompletion with hydro-slotting perforation technology lasts 10-15 years.

This means, that investing one-time $ 100,000 you return your money back in 111 days, after that you will receive an annual profit $ 328,500 every year during 10-15 years, that accordingly be $ 3,285,000-4,920,000. This is only from one well. Perhaps then you will want to sell this well and buy another low-production well for the next recompletion.

FINANCIAL ANALYSIS OF PAYBACK AND BENEFIT PROFITS
AT DIFFERENT COSTS OF RECOMPLETION WITH HSP (MAXXWELL-TOOL)

RECOMPLETION OPERATIONS FOR INCREASE OF PRODUCTIVE FLOW IN OIL WELLS BY HYDRO-SLOTTING PERFORATION										
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$10	Full cost of recompletion	profit per year	$54,750	$73,000	$91,250	$109,500	$127,750	$146,000	$164,250	$182,500
	$60,000	payback (in month)	13.3	10.0	8.0	6.7	5.7	5.0	4.4	4.0
	$70,000	payback (in month)	15.6	11.7	9.3	7.8	6.7	5.8	5.2	4.7

	$80,000	payback (in month)	17.8	13.3	10.7	8.9	7.6	6.7	5.9	5.3
	$90,000	payback (in month)	20.0	15.0	12.0	10.0	8.6	7.5	6.7	6.0
	$100,000	payback (in month)	22.2	16.7	13.3	11.1	9.5	8.3	7.4	6.7
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$15	Full cost of recompletion	profit per year	$82,125	$109,500	$136,875	$164,250	$191,625	$219,000	$246,375	$273,750
	$60,000	payback (in month)	8.9	6.7	5.3	4.4	3.8	3.3	3.0	2.7
	$70,000	payback (in month)	10.4	7.8	6.2	5.2	4.4	3.9	3.5	3.1
	$80,000	payback (in month)	11.9	8.9	7.1	5.9	5.1	4.4	4.0	3.6
	$90,000	payback (in month)	13.3	10.0	8.0	6.7	5.7	5.0	4.4	4.0
	$100,000	payback (in month)	14.8	11.1	8.9	7.4	6.3	5.6	4.9	4.4
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$20	Full cost of recompletion	profit per year	$109,500	$146,000	$182,500	$219,000	$255,500	$292,000	$328,500	$365,000
	$60,000	payback (in month)	6.7	5.0	4.0	3.3	2.9	2.5	2.2	2.0
	$70,000	payback (in month)	7.8	5.8	4.7	3.9	3.3	2.9	2.6	2.3
	$80,000	payback (in month)	8.9	6.7	5.3	4.4	3.8	3.3	3.0	2.7
	$90,000	payback (in month)	10.0	7.5	6.0	5.0	4.3	3.8	3.3	3.0
	$100,000	payback (in month)	11.1	8.3	6.7	5.6	4.8	4.2	3.7	3.3
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$25	Full cost of recompletion	profit per year	$136,875	$182,500	$228,125	$273,750	$319,375	$365,000	$410,625	$456,250
	$60,000	payback (in month)	5.3	4.0	3.2	2.7	2.3	2.0	1.8	1.6
	$70,000	payback (in month)	6.2	4.7	3.7	3.1	2.7	2.3	2.1	1.9
	$80,000	payback (in month)	7.1	5.3	4.3	3.6	3.0	2.7	2.4	2.1
	$90,000	payback (in month)	8.0	6.0	4.8	4.0	3.4	3.0	2.7	2.4
	$100,000	payback (in month)	8.9	6.7	5.3	4.4	3.8	3.3	3.0	2.7
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$30	Full cost of recompletion	profit per year	$164,250	$219,000	$273,750	$328,500	$383,250	$438,000	$492,750	$547,500
	$60,000	payback (in month)	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3
	$70,000	payback	5.2	3.9	3.1	2.6	2.2	1.9	1.7	1.6

		(in month)								
	$80,000	payback (in month)	5.9	4.4	3.6	3.0	2.5	2.2	2.0	1.8
	$90,000	payback (in month)	6.7	5.0	4.0	3.3	2.9	2.5	2.2	2.0
	$100,000	payback (in month)	7.4	5.6	4.4	3.7	3.2	2.8	2.5	2.2
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$35	Full cost of recompletion	profit per year	$191,625	$255,500	$319,375	$383,250	$447,125	$511,000	$574,875	$638,750
	$60,000	payback (in month)	3.8	2.9	2.3	1.9	1.6	1.4	1.3	1.1
	$70,000	payback (in month)	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3
	$80,000	payback (in month)	5.1	3.8	3.0	2.5	2.2	1.9	1.7	1.5
	$90,000	payback (in month)	5.7	4.3	3.4	2.9	2.4	2.1	1.9	1.7
	$100,000	payback (in month)	6.3	4.8	3.8	3.2	2.7	2.4	2.1	1.9
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$40	Full cost of recompletion	profit per year	$219,000	$292,000	$365,000	$438,000	$511,000	$584,000	$657,000	$730,000
	$60,000	payback (in month)	3.3	2.5	2.0	1.7	1.4	1.3	1.1	1.0
	$70,000	payback (in month)	3.9	2.9	2.3	1.9	1.7	1.5	1.3	1.2
	$80,000	payback (in month)	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3
	$90,000	payback (in month)	5.0	3.8	3.0	2.5	2.1	1.9	1.7	1.5
	$100,000	payback (in month)	5.6	4.2	3.3	2.8	2.4	2.1	1.9	1.7
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$45	Full cost of recompletion	profit per year	$246,375	$328,500	$410,625	$492,750	$574,875	$657,000	$739,125	$821,250
	$60,000	payback (in month)	3.0	2.2	1.8	1.5	1.3	1.1	1.0	0.9
	$70,000	payback (in month)	3.5	2.6	2.1	1.7	1.5	1.3	1.2	1.0
	$80,000	payback (in month)	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2
	$90,000	payback (in month)	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3
	$100,000	payback (in month)	4.9	3.7	3.0	2.5	2.1	1.9	1.6	1.5
Price for barrel		bbl./day	15	20	25	30	35	40	45	50
		bbl./month	450	600	750	900	1,050	1,200	1,350	1,500
		bbl./year	5,475	7,300	9,125	10,950	12,775	14,600	16,425	18,250
$50	Full cost of recompletion	profit per year	$273,750	$365,000	$456,250	$547,500	$638,750	$730,000	$821,250	$912,500
	$60,000	payback	2.7	2.0	1.6	1.3	1.1	1.0	0.9	0.8

		(in month)							
	$70,000	payback (in month)	3.1	2.3	1.9	1.6	1.3	1.2	1.0	0.9
	$80,000	payback (in month)	3.6	2.7	2.1	1.8	1.5	1.3	1.2	1.1
	$90,000	payback (in month)	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2
	$100,000	payback (in month)	4.4	3.3	2.7	2.2	1.9	1.7	1.5	1.3