Radial Jet Drilling (RJD)

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There are many different methods to increase the efficiency of oil & gas wells production that along with progress and expansion of science have under gone changed and developed. Radial Jet Drilling is a technique which utilizes hydraulic jet energy of fluids to drill lateral holes inside the reservoir.

At present time in Iran the rate of production has decreased due to over extraction. Using new methods such as Radial Jet Drilling (RJD) would be more effective to increase rate of production instead of drilling new wells.

This method (RJD) has been used in case of oil reservoir with high porosity and permeability for many years.

1. Fluid Jet Drilling

In 1950 Norman Franz who was an engineer that used primitive method of water jet in cutting lumber. This method didn't develop until Mohamed Hashish used a new method by adding some abrasive material to water jet. These days water jet is the only method in many aspects of cutting. There are different types of water jet such as simple water jet (without any additive), water jet with abrasive material, impact water jet, water cavitation jet and hybrid jet.

Spraying a stream of fluid with high velocity and pressure, is useful in different industries. Using water jet is common in metal industry, drilling, grinding and polishing stone. This method is used in cutting stones in case of decorative stone industry and construction. However drilling with water jet method has been known for a long time but recent advantages in manufacturing nozzles causes increasing production.

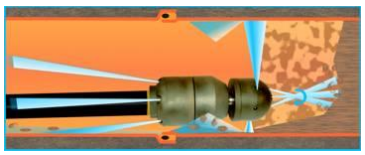
In this way, fluid, often being water or abrasive particles mixed with water under high pressure is pumped through the coil tubing into the well. The fluid is ejected out from nozzle drill head at high pressure, wears out the stone resilience, and thus, drilling is done.

In some cases, the water pressure is not used alone in the drilling, but the drilling technology is used along with adoption of other methods. For example, in directional drilling, a method of causing detour in the well is fluid jet.

Drilling with fluid jet, includes wide range of methods and plenty of research have been carry out in this area. For example, we can use the jet of carbon dioxide, abrasive material or variable pressure of water jet. Very high pressures such as 20,000 to 60,000 pounds per square inch (psi) is used in cutting pieces of stone with water jet. But in normal drilling, water pressure is about 3,000 to 10,000 pounds per square inch (psi) respectively.

2. Radial Jet Drilling Method (RJD)

RJD method is one of the very environmental friendly and economically feasible technologies that makes high-volume drilling achievable. The drilling in horizontal and vertical direction is done in different levels. Ramifications are done in mother well in different directions and levels, in exploring for oil or gas.

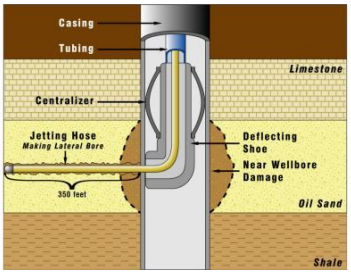


3. RJD Technology

RJD is a drilling method which utilizes coil tubing conveyed drilling to create micro diameter holes by expending the energy of high velocity jet fluids. A small section of casing of the mother well is cut and then lateral holes are drilled in desired direction.

The hardware used in this method are: bottom hole assembly consisting of casing cutter, small diameter bit, orienter, steering tool, controller, coil tubing unit (3 1/2" , 2 1/8") is use to convey the drilling process from the surface, two mud pumps and 100 flexible hose. Experiments show that the

deeper holes, the more efficient the wells are. The lands containing of consolidate stones in this way have shown better results rather than non-consolidate stones. It is necessary to carry out soil mechanics studies and tests before RJD operation. Maximum operating depth is approximately 4,000 - 3,000 ft and a maximum operating temperature is 248 ° F. In higher temperatures, hose will be damaged. The fluid properties is depend on the fluid used in the method and ingredients as well as the rocks and geology. The most common fluid is water, but when the fluid reservoir is in the form of wax, it would be better to use diesel fuel.



3.1. Procedure of the operation

In this way, whether on land or sea, requires drilling machine style (500-1000 hp). Drilling process is as follows:

1. First drilling rig is transferred to the well station.
2. Equipment and well completion equipment must be removed from the well.
3. Coil tubing 2 1/8 "or 3 1/2" with deflector shoe that is mounted at the end, driven into a well and is in a convenient location. At the top of the deflector shoe, Jairo determine the direction of the hole.
4. Size of mobile tubing which is based on the well can be 5/8 "or 1". With flexible hose and drill for making hole in liner in the desired direction and the hole is created same radial size of driller (1 3/4 ").
5. Pull out mobile tubing with drill from the well and hundreds meters flexible hose (special) with a nozzle that is fastened to the end of the coil tubing is driven into a well.
6. According to figure, hose enter into the hole and flow is pumped through tubing and flexible hose with 3,000-10,000 psi pressure. Drilling possibility for hundred meters and with the pressure of the fluid will be available in two hours and in returning the second injection it is possible to widen the hole to 4 inches.
7. Mobile tubing with flexible hose bring out from well and shoe direction is changed according to require by rotating tubing. To create a new hole the same way is done again.

In return of hole, it is possible to inject acid with different concentration to increase production according to reservoir engineering order. Usually four holes (the more is possible) is done in four directions. This technology hasn't good result in falling reservoir.

If the hose was stuck in the hole and is not possible to take out it, hose cut to stay within wells by drawing pipe tubing, and make other holes without stopping.

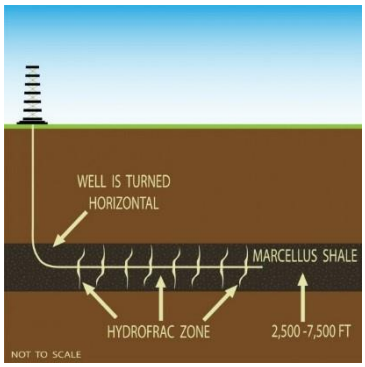
The required time for well operation is 5 days by considering 2 hours for each hole and bring out coil tubing (2 1/8" or 3 1/2").

Operating cost is estimated about 300,000 to 350,000 $. Experience has shown that in some of the wells, the efficiency increases 3 times.

3.2. Advantages of RJD

- Create and increase reservoir seepage channels
- Connect natural gaps to each other and therefore possibility of faster drainage
- Small and large scale fractures formation around the hole
- Deep acidizing possibility directional fractures
- Remove barriers around wells and the area around it
- Communication between the past perforation and new district
- Increased efficiency of operation with combination of acidizing and hydraulic fraction
- Extension the discharge area of each well
- Reduce the flow resistance by increasing evacuation radius
- Increase the radius of the practical effects such as acidizing, nitrogen injection, CO2 injection and intended solvents
- Better access to the high gain points of well
- Ability to multidirectional jet drilling at different depths

- Improve permeability formations without harming structure
- Improve geomechanical operating efficiency and also directional sensitive operations
- The applicability of usage of various chemicals and fluids as the working fluid jet
- Use as an alternative to friction layer
- A method for controlling friction layer and other chemical injection or steam
- Easy usage of this method at perforation



Also in this method it is possible to create holes in down direction and horizontal angle by changing the angle of the deflector shoe, but not to create hole with up direction angle.

One of most important point that the oil industry is facing today, is an infection caused by drilling oil wells. With proper management and implementation of appropriate requirements, the amount of pollution could be reduced.

One of these methods is to use the radial drilling with fluid jet that can sometimes increase production up to three times and is a step towards improving efficiency in the use of drilled wells.

It is worthy to mention that Franegar Industrial Design & Engineering Company (FIDEC) has collaboration with companies in this technology and with staff of experienced engineers in this field, is capable to carry out such projects.

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