Groundwater Section

Fact Sheet for Water Well Development by Hydrofracturing

Introduction

Hydrofracturing is a water well development process that involves injecting high pressure water via the well into the bedrock formation immediately surrounding it. This procedure is intended to widen existing fractures in the bedrock and/or extend them further into the formation thereby enlarging the network of water bearing fractures supplying water to the well. Water well stimulation is a cost effective means of increasing the yield of existing wells with insufficient production rates, or existing older wells with decreased production rates due to incrustation or mineralizations of existing bedrock fractures.

History

Hydrofracturing was originally developed for the oil and gas industry to increase oil and gas well production. It is a relatively new technique adopted by the water well industry. Other methods of increasing well yield are using dynamite and dry ice(CO_2). Both are relatively uncontrollable with regards to pressures exerted. Frequently the use of dynamite, called "shot firing" in Newfoundland, caused wells to collapse. In the case of dry ice expansion, increased upward pressure on the well casing caused the drive shoe seal to lift consequently breaking the seal and allowing surface water to enter the well. In some instances, the well casing has shot out of the ground. The hydrofracturing technique eliminates these problems by controlling the down hole pressures.

Technique

All piping and pumps need to be removed from the well before commencing. The procedure involves the lowering of one or two inflatable hard rubber balloons or packers as they are called, on a pipe down into the wellbore. These packers are inflated to seal off a section of the well. The packers are set a minimum of 7m below the end of the casing and 20m below ground surface to prevent a breakout of water under pressure and surface water entering the well. High pressure water is pumped through the packer. The pressure within the sealed off section of the well will rise as the formation resists flow into it. At some higher pressure, the pressure will suddenly drop off indicating that the formation is accepting water and resistance to flow has decreased. Water is pumped into the formation from 5 to 45 minutes at a rate of 25 to 60 gpm. Up to 1600 gallons of water can be pumped into the formation. Indications of a successful hydrofracturing procedure are a sudden drop in the pressure combined with increased flow into the formation, and a strong backflow of cloudy water when pressure is released. If the pressure increases to the maximum working pressure (3000psi) of the equipment with no sudden drop in pressure, then the hydrofracturing procedure may have been unsuccessful.

When a single packer is used, the packer is set near the top of the well. Applying pressure in this manner to the wellbore means that the weakest fracture or the fractures of least resistance would be

affected. Usually the packer is then moved down the hole to hydrofracture another section of the well. This may be fine for domestic well purposes since the cost for single packer hydrofracturing is less than when a double packer system is used. When using a double packer system, the packers are situated on a pipe called a drill string, typically 14 to 20m apart. A selected zone in the well can be pressured by inflating both packers and then when done, the packers are deflated and moved elsewhere in the wellbore to pressure another section of the well. This system is more efficient since discrete sections of the wellbore are hydrofractured. A number of zones can be hydrofractured in this manner. The packers are usually first set near the bottom of the well and moved up the bore to isolate another interval of the well for hydrofracturing. Information on specific sections of the well to be hydrofractured can be obtained from the well drillers log. The well log will indicate at what depths water was found to be entering the well. The use of a downhole camera is also helpful in determining where suitable fractures exist in the wellbore and if they are flowing water.

Well Owner Considerations

This technique applies to bedrock wells only; that is to wells that obtain their water by fracture flow through cracks in the rock intersected by the wellbore. The yield of a bedrock well will depend on the number of fractures encountered, their width, orientation, and how well they are connected to other fractures in the rock formation. When hydrofracturing a private well, identify the locations of any neighbour's wells. If a neighbour's well is within the same fracture trend or 20 to 30m away, there is some risk of impacting an adjacent well. As the distance increases the risk diminishes. The costs involved in hydrofracturing an existing well should be compared to the costs of drilling a new well and its associated infrastructure. For a non domestic well where higher yields are needed, hydrofracturing becomes more favourable than drilling a new well. For municipal and local service district wells that have had their yields reduced over time, hydrofracturing is a proven option to rehabilitate the system by increasing well yield.

Equipment

The equipment required for hydrofracturing should be industry standard equipment capable of supplying high enough pressures to fracture existing rock sequences. Most applications will require between 500 and 2000 psi pressure, while occasionally greater pressures are required in tight formations. Injection pump delivery rates from 40 to 55 igpm have generally been successful.

Geological Considerations

A study done for the Department of Environment and Environment Canada in 1994 showed that hydrofracturing successfully increased the yield of all six wells tested in different geological settings. Different rock sequences produced different degrees of success. From the limited results for six wells, it was noted that the greatest increase in well yield occurred in sandstone and siltstone sequences, while shales and volcanic sequences showed a somewhat lower increase in well yield. There was no well stimulation done on a well drilled in a granite. Increases in well yield ranged from 35% to 1000% with the average being 200%.

Contractors

For hydrofracturing a well, it is necessary to consult with several water well drilling contractors who specialize in this technique. These professionals can evaluate water supply needs and give some indication of the success of hydrofracturing the well given the local geological setting. It is also a good practice to ensure each contractor has suitable equipment to do the job. A well yield test done immediately after hydrofracturing must take into account water that was injected into the formation. The well should therefore not be tested until equilibrium conditions are again reached.

Safety

Since high pressure water (up to 2000 psi) is used in hydraulic well stimulation, it is essential that precautions should be taken to prevent the likelihood of a mishap. All piping, hoses, and valves must be rated to exceed the maximum pressures expected during hydrofracturing. Pressure gauges and pressure relief valves must be in good working order. The use of restraints on hose couplings is recommended. Only those people involved in the hydrofracturing procedure should be in the immediate area. The inflation pressure of the packers is usually 1.5 to 2 times the maximum pressure expected during hydrofracturing to prevent the dislodgement of the packers.

Proppants

Proppants are used to keep open or prop existing cracks in the rock. They are used extensively in the oil and gas industry. Proppants can be small beads that are jammed into the rock cracks during well stimulation. The usefulness of proppants to increase water well yield has not been studied to date and little can be said on its usefulness to sustain an increased well yield after well stimulation. Success depends on such factors as stresses within the rock regime, fracture geometry, selection of the right proppant, their placement, and well development after hydrofracturing.

Borehole Cameras

Borehole cameras are used to accurately pinpont the location of fractures to be hydrofractured. While this technique will increase the likelihood of a successful hydrofracturing operation, it must be weighted against the extra cost involved. Generally, hydrofracturing two sections of a well selected from the drillers well record may be sufficient. Usually a borehole camera is used in non domestic wells - wells drilled for communities, farms, and businesses to identify the location of the water bearing fractures. Colour cameras are best for detecting corrosion, bacteria growths (biofouling), and deteriorated well conditions.

Costs

As with all contracts, it pays to get several quotes in writing from the licenced well drilling contractors who should provide the details of the proposed procedure and the associated costs.

Disinfection

All water used for hydrofracturing must be chlorinated to avoid introducing bacteria into the well bore and fractures. If a water sample is to be taken after well stimulation, then it should be done after

pumping the well for a period of time to avoid sampling the water introduced into the formation during hydrofracturing.

Hydrofracturing Information

A file on hydrofractured wells is presently being created for the province. This file will include a list of wells that have been hydrofractured, their location, lithology and estimated success rate. This information will provide those planning on hydrofracturing their well some estimate of the chances of success for a given location and lithology.

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