Hydroimpulsive Development of Fluid-Containing Recovery

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Abstract. This work is dedicated to enhance the efficiency of development of the water bearing formations uncovered using a mud fluid. A formation clay cake removal method has been justified as the most efficient vibration method to be used for this purpose. Technical and technological means, based on generation of vibration pulses using a hydraulic hammer, have been developed and successfully tested while constructing geotechnological wells.

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1. Introduction

It's well known that one of the labor intensive operations while constructing water supply and geotechnological wells, drilled using rotary method and flushed with mud solution, is decolmatation of water bearing formations.

There are more than 20 methods of performing this technological operation [1,2,3]. Amongst them the hydro vibration development of water-bearing formations occupies a special place. The latter represents a transfer of the fluid, which fills out the well, fluctuations from the working body, which represents a drilling string with disks. The appearing pressure differences of 0.2-0.5 mPa cause delamination of the mud cake in the area, where the water bearing formation occurs, and the subsequent airlift extraction, however, cleans the well bore, and enhances formation's permeability.

Despite the effectiveness of this method, the latter has a significant disadvantage. It is that the location of vibrator on surface restricts effective decolmatation of the water bearing formations, when their occurrence depth is up to 150m, due to absorption of a large fraction of the fluctuation energy by a material of the drilling string.

Experimental part:

Some attempts of using downhole vibrators for hydro vibration development of water bearing formations [4] are known, however, they did not find a wide application due to complexity of the equipment.

The chair of technology and drilling engineering of the Kazakh National University has developed a sufficiently simple device for decolmatation of the deep-seated formations.

The device (fig.1) consists of a hydraulic hummer and a hydro vibration working body connected to it. The latter represents a pipe 11, on which bushings 9 are dressed with a gap, separated by discs 8. Radial holes are made in the pipe and bushings to dump the waste water out from the hydraulic hummer.

Gaskets are installed on the bottom end of pipe 11 and a clamping nut 12 is screwed in to exclude the uncontrollable leakage of fluid between discs and bushings.

The upper end of pipe passes through the flange and mates with a stop nut 2, which, in its turn, is connected with the anvil interacting with the adapter 1 through slots. A spring 4 is placed between the stop nut 2 and flange 14.

The suspension of working body on the hydraulic hummer is carried out using four studs 3. Upper ends of the latter are screwed into the adapter 1, but their bottom ends pass through holes of the flange 14, secured by nuts 6 and fixed against loosening of the bracket by locknuts 13. Pretension of the spring 4 can also be adjusted using the nuts 6 and studs 3.

Operation of the device is carried out as follows. When the working fluid (water) is fed along drill pipes, the hydraulic hammer's piston starts striking the anvil. The latter, at each strike of the piston, thanks to the slotted joint with the adapter 1, moves downward, thus compressing the thrust bearing 2, spring 4, and shifts the pipe 11 with discs in the same direction. The latter, in its turn, transmits the shock impulse of the surrounding fluid. The impulses, being repeatedly reflected from the fluid, cause a force effect onto the colmatated filter, and when cleaning it – onto the colmatated borehole walls. The power impulse, appearing with each strike on the fluid by the locknut 12, moves the plug of filter settler.

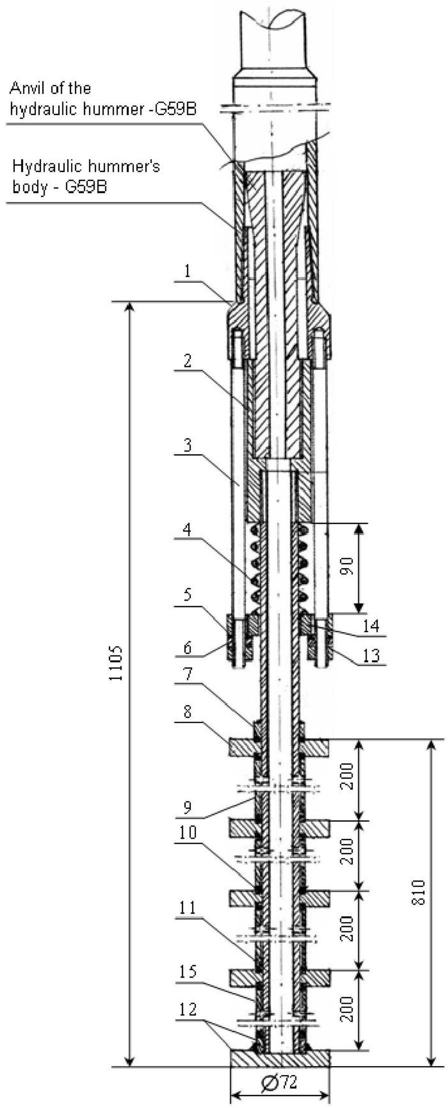

Fig.1. Design for hydro vibration clay cake removal from the water bearing formations.

Being reflected in the form of extension wave, the impulse returns to the nut 12. Arising cavitational phenomena, in this case, also helps clean the filter and decolmatate the borehole walls.

When the hydraulic hummer's striker piston, under effect of the return spring, travels upward, the waste water enters the pipe 11 along central channels of the anvil and stop nut, and is dumped out through the radial openings in it, and in the bushings 6, thus causing an additional cleaning effect onto the filter. The said device is protected by patent of the RK [5]. The mechanism of appearing and transmission of the fluid's striking impulses, while developing the formations, have been described in the works [6,7,8,9,10,11,12,13].

An experimental working body of the device has been created considering peculiarities of its industrial test conditions, which were conducted at the facilities of VolkovGeology JSC. This organization is engaged in construction of geo-technological wells for underground leaching of ores. Distinctive feature of the design of such wells is a small diameter of filters to be used, presence of their gravel package and sufficiently large length of the filtration part. The filters are made of plastic pipes, internal diameter of which is 74 mm, outer diameter is 90 mm. Thickness of the gravel package is 30-40 mm to the side.

Design of the extraction wells as follows: drilling diameter – 240 mm (drilling interval 0-110mm), 190mm (drilling interval 110-490 mm), 320 mm (expansion of the well at the interval 460-472 m). 110m long production casing, consisting of polyethylene pipes PVC-140/10, OD 140mm, mates with the 376 m long filtration string. The latter consists of polyethylene pipes PVC-90/8.

Polyethylene rings are put on the filtration string (with perforation of the latter) at the interval 460-472 m. As the result, a slotted disc filter KDF118 has been formed.

Production layers were opened through flushing with thin clay mud, which has following parameters: density – 1.12cm3, viscosity – 22sec., water loss – 10-12cm3/30min.

After the well has been expanded at the interval 460-472 m, and the filter has been installed, its gravel packages were created by delivering the gravel into the annular gap between borehole walls and casing pipes. The estimated volume of the gravel should fill out the interval from bottom hole (490m) up to the point 445m, i.e. the upper end of package locates above the filter for 15m. A cement sheath is formed at the interval 425-445 mm through injecting a corresponding volume of the cement slurry. The remaining annular gap between pipes and borehole walls is filled out using the gel-cement slurry.

The technology for developing formation, which existed earlier, was to conduct the following technological operation:

– Flushing the settler and filter using clean water during 12-16 hours;

– Airlift pumping during 12-16 hours until max. production rate (no lower than 25m3/h) has been received;

– Pumping during 8 hours at max. production rate.

By the moment of conducting device tests for hydro vibration clay removal, it was necessary to recover the original production rate of the well (25m3/h), which started decreasing gradually due to partial clogging of the filtration channels in the gravel package, and the filter by fine fraction was carried out from the productive sand formation. The method of conducting well's productivity recovery, was a hydro vibration treatment of the filter in combination with simultaneous airlift pump out.

In order to perform the hydro vibration treatment of the well's filtration part, a mobile drilling ring PBU-ZIF1200MR was mounted over its wellhead, the latter included a Drilling Rig ZIF-120MR, and a mud pump NB32. The rig was required to run the experimental device with the hydraulic hummer into the hole, and drive it.

The XRVS-346 brand compressor, manufactured in Belgium, was used for the airlift pump out. Tests were conducted in the following sequence. The hydro vibration working body on surface was connected with the G59B hydraulic hummer, which, in its turn, was connected with pressure hose of the NB32 mud pump. When launching the pump, the working body was checked at no load. Particularly, fluctuations of the working body's discs and output of the waste fluid, through holes in the pipe of working body, were noted.

The hydraulic hummer with working body was run into the hole using 50mm drill pipes and stopped at the filtration string so that the working body would completely enter the filter's upper part. Then an air hose with a perforated mixer on the end, was run into the production casing. The mixer depth is – 100m.

The NB32 mud pump was launched, which drove the hydraulic hummer, and the spring-loaded working body connected with its anvil. The latter with discs came into the oscillatory displacement. The XRVS-346 compressor was switched on and at the same time was to feed the air along the air hose to the mixer.

Then, the whole drilling string with hydraulic hummer and working filter was fed downward in the direction of the filter settler. The velocity of feeding was 20-30 cm/min. The said movement was stopped when the lower end of the working body had reached the filter's end. Then the movement of working body was carried out in the opposite direction (upward) and stopped when the lower disc of working body had reached the filter's end. Then the mentioned reciprocating movement was repeated for many times.

As the result of pressure differences in the fluid, occurring when the disc of working body fluctuates with frequency of 1200-1400 fluctuations per minute, and action of jets of the waste water jets through the slotted filter on to the filtrated zone, the clay particles and fine fractions were carried out from the gravel package and borehole walls inside the filter. Further, the colmatant was removed from the well through airlift extraction, which was detected according to the turbid liquid coming out of the hole.

The productivity of wells was recovered during 5 hours (until clean, no turbid water has been pumped out).

The production rate test after completion of the well, conducted using a volumetric method, showed that the latter had increased up to $27m^3/h$ against 25m3/h in the beginning of operations. In so doing, the term for completion of well has reduced from 24 hours to 5 hours.

CONCLUSION

1. The developed hydro vibration working body, with a driving unit from down hole machines (hydro or pneumatic hummers), is simple in design, reliable, as was demonstrated by the industrial test results.

2. The hydro vibration working body ensures that clays of deep water bearing formations (up to 500-600 m) are removed effectively while construction and reduce its construction period for 4-5 times.

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