Gravel padding filters for combating sandblasting in wells

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Abstract. This paper presents an analysis the technology for creating an artificial gravel pack behind the casing in the near-wellbore part of the formation in producing oil and gas wells. Gravel-embedding filter is not only a special device installed in the well to clean the fluid extracted from the formation of sand and other foreign impurities, but also the use of gravel in conjunction with the filter in order to retain the formation sand at the site of its occurrence. Wells are equipped with gravel filters when completing them in formations represented by medium to fine grained and silty sands. The desiccant layouts of gravel stuffing filters on lightly cemented sandstones are presented in the work show high efficiency, as they prevent the removal of sand during the well operation. Creating an artificial gravel pack is an effective way to prevent sand from entering the well.

1 Introduction

Gravel-embedding filter is not only a special device installed in the well to clean the fluid extracted from the formation of sand and other foreign impurities, but also the use of gravel in conjunction with the filter in order to retain the formation sand at the site of its occurrence. At present, this technology is most widely used in deposits exploiting layers of cemented rock. Significant progress in the technology and application of this method of well repair and completion has recently significantly reduced the frequency of failure results and increased the productivity of wells with in-column washed gravel filters. This progress consists in the improvement of perforation channel cleaning processes, the better use of special liquids for well repair and completion, and the application of optimal grit grain diameters.

Wells are equipped with gravel filters when completing them in formations represented by medium to fine grained and silty sands. These filters have high sand retention capacity and long service life. They consist of a conventional frame-wire or mesh filter, the working part of which is surrounded by a layer of gravel or coarse sand. There are several ways to create gravel filters at the bottom of a well: equipping wells with gravel filters during the completion of drilling; equipping cased production wells with suspended filters with gravel packing; creation of gravel filters in the cut out productive section of the production casing - the “super collector” during the process of major repairs.

The most effective and promising mechanical method for preventing sand deposits is the creation of gravel filters during the process of well completion by drilling. The essence of
the technology is as follows. The well is drilled and anchored to the top of the productive horizon, after which the productive formation is opened with a bit of a smaller diameter. After this, the wellbore is expanded in the productive interval, the filter is lowered taking into account the overlap of the productive interval, and gravel (coarse-grained sorted quartz sand) is pumped into the expanded interval between the formation and the filter.

The correct selection of gravel diameter is important. Analysis of domestic and foreign works showed that the optimal ratio is:

$$d = (5÷6) \cdot D_{50}$$

where $d$ is the diameter of the gravel;

$D_{50}$ - grain diameter of 50% fraction of curve of mechanical composition of plastic sand.

Gravel washing can be done in two ways: top soaking and bottom soaking.

When the gravel filter is created by means of a top wash, the bottom layout is connected to the flexible pipe by means of a disconnector. The stopper can also be installed after the separation of the mould. Further, the required amount of sand (gravel) is washed through a flexible pipe. The plug-plug is then removed and a sealing unit is installed at the top of the mechanical filter.

When using bottom washing technology, sand is first washed onto the face and then the filter is installed in place. To ensure the passage of the latter through the washed layer of sand, a flushing shoe is placed in its lower part.

Recently, wire filters with so-called gravel stuffing (gravel packaging) have become widespread to avoid expensive and unproductive gravel washing procedure. Such filters significantly reduce well preparation costs and increase the speed of installation of the shank with filters. According to numerous test results, the use of pre-packaged filters has shown their unconditional practical value, provided that the packing parameters are correctly selected depending on the well operating conditions. As a result, initial concerns about the possibility of rapid containment and the difficulties associated with the expansion of the well were not realized. And in the course of practical application, gravel padding filters, when properly designed, have started to be used intensively in many oil fields. Their scope is still very large. Especially where the sand produced with oil has previously caused serious problems and interruptions in the well equipment.

The creation of a gravel stuffing behind the casing in the near seam is an effective way of preventing sand from entering the well. Gravel pads are used in both pure sandy and clay-sand reservoirs. But numerous tests of the creation of pads with incomplete waxing of gravel and when the well is not put into operation showed that there is a transfer of sand into the well, and the interrepair period does not exceed 8-15 days.

Subsequently, there is a subsidence of gravel due to overthickening of the padding, resulting in the formation of gravel-free cavities, through which the sand again enters the well. The most widely used material for gravel padding is natural coarse-grained sand. However, the use of such a filler is largely limited due to the dissolution of silica with hot high-alkaline fluids (especially when injected into the formation of water vapor), as well as the crushing of sand when the gasket is washed. The use of other materials as filler for packing is not widely used. The widespread introduction of the gravel filling method is hampered by the lack of equipment for the process (mainly imported). In addition, the method is not very effective for the conditions of deposits developed with thermal recovery techniques.

One of the simplest and best quality water filtration designs for the well is a gravel filter. The main problem when drilling a well using a gravel filter is that the diameter of the well must be larger than the pipe. Then it is necessary to investigate the rock adjacent to the well and pick up gravel 5 times larger. After installation of casing the gravel is sprinkled. The thickness of the sprinkler should be at least 90 mm. Basically, all this is done by the drillers.
themselves. Gravel filter, in addition to its practicality, is also safe for health, as it has a natural origin.

The gravel filter for wells is downhole and sprinkled. The downhole filter does not require assembly inside the well, but is lowered already in the finished form. The sprinkle filter must be built inside the well, by sprinkling the walls of the frame with gravel. There are several ways to sprinkle wells:

1) Gravitational - gravel settles in annular space at the expense of its free fall, under the force of gravity. This is the easiest and most affordable way to build a well. This method cannot be used for drilling wells more than 100 meters deep. It is recommended to use fractionated gravel with the same chemical composition. All these recommendations reduce the risk of sanding and failure of the well.

2) Forced deposition - gravel with the help of various techniques is buried together with the flow of water under pressure.

The size of the gravel particles also matters. Their diameter should be larger than the size of the sand particles that were raised from the pit of the future well.

If the water contains a large amount of salt, the well may be sprinkled with two or three layers of gravel. This prevents overgrowth around the frame, extending the life of the well. The average layer of gravel when sprinkled is about 200 mm.

2 Materials and methods

Before conducting industrial tests, the authors conducted a study of the scientific literature on the use of gravel padding to combat sandblasting. Studies of types of gravel stuffing filters were conducted in the wells of the Ananiev field of the Orenburg region.

3 Results

Let’s look at the types of bottom gravel padding filters. Natural Gravel Stuffing - a complex of equipment for combating sandblasting in oil and gas wells is designed to equip wells with poorly cemented sandstone in the formation. Composition of equipment as shown in figure 1, provides natural gravel padding from plastic sand in the oil or gas extraction process, provided that the outer diameter of the filter and the gaps between the winding windings of the profiled wire are correctly determined.

The welded design of the filter winding and the use of the filter separation devices as part of the system ensure that the filter is removed without any failure in case of repair. The device for the selection thereof makes it possible to walk the part of the equipment situated above it, reducing the removal force by reducing the packing density of the packing by removing part thereof from the inside of such devices.

The parameters of the complex of equipment can be selected on the basis of such data as the granulometric composition of formations, porosity, kinematic viscosity of the fluid in formation conditions, the coefficient of formation heterogeneity, the permeability of the formation (horizontal)Formation thickness (filter cover height), well flow rate, casing wall diameter and thickness, well depth, formation pressure, chemical and physical characteristics of the produced product (gas saturation, water depth, etc.), formation temperature.
Next, consider the device for creating artificial gravel padding. The installation of gravel filling equipment is designed to create artificial gravel padding during the construction of gravel bottom filters in oil and gas production wells. Diagrams of the first and second steps are shown in Figure 2.

The technical description of this arrangement is presented in table 1.

Table 1. Specifications of installation of gravel filling equipment

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Characteristics value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer diameter of filter section, mm</td>
<td>89</td>
</tr>
<tr>
<td>Inner diameter of filter section, mm</td>
<td>72</td>
</tr>
<tr>
<td>diameter of the casing column, mm</td>
<td>168</td>
</tr>
<tr>
<td>Filter section length, mm</td>
<td>1690</td>
</tr>
<tr>
<td>Well-hole thickness of the slit shell of the section at least, %</td>
<td>8</td>
</tr>
<tr>
<td>Ratio of slit shell length to filter section length at least</td>
<td>0.75</td>
</tr>
<tr>
<td>Nominal filter slot size, mm</td>
<td>0.15</td>
</tr>
<tr>
<td>Permissible tensile force on assembly, kN</td>
<td>160</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>The minimum rate of failure per hour</td>
<td>8000</td>
</tr>
<tr>
<td>Minimum failure rate set for operating</td>
<td>Not more than 50%</td>
</tr>
<tr>
<td>conditions in a water-filled oil well</td>
<td></td>
</tr>
<tr>
<td>Temperature, °C</td>
<td>≤ 80</td>
</tr>
<tr>
<td>Plastic sand</td>
<td>poorly cemented</td>
</tr>
<tr>
<td>The diameter of the middle sand (d_{cp} sand), mm</td>
<td>0,15</td>
</tr>
</tbody>
</table>

### 4 Discussion

The downhole filter does not require creation inside the well, but is lowered already in the finished form. The sprinkled filter must be constructed inside the well, by sprinkling the walls of the frame with gravel. The bottom filter has a simple design and low cost, which is its undoubted advantage.

### 5 Conclusion

The creation of a gravel stuffing behind the casing in the near seam is an effective way of preventing sand from entering the well.

The desiccant layouts of gravel stuffing filters on lightly cemented sandstones are presented in the work show high efficiency, as they prevent the removal of sand during the well operation.

### References

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