# Designing gravel pack for uranium ISL wells

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**Abstract**. The paper describes the improvement of gravel packing technique applied for the production wells. The authors have suggested new design of gravel pack for gravel packing of productive formations. The issue is currently topical because gravel packing at drillhole ISL is less time- and money-consuming. The subject of the research is gravel pack design and content. The purpose defined by the authors is to design the gravel pack and to suggest the composition of gravel cement agent. As a result of the research, the authors have described different designs of the gravel pack, its optimal shape, as well as a choice and justification of cement agents, a hold cover of the gravel pack, and suggested the methods of experimental research.

## 1. Introduction

Drillhole ISL permits poor uranium ores to be used more efficiently. In this case, it is no need for actual mining, additional ore breaking and reduction, radioactive ore pile stocking and waste storage. Drillhole ISL efficiency depends directly on a pack in a production interval of the bottomhole. The key component of the production well construction for uranium ore drillhole ISL is a pack, irrespectively of well type (injection well or production well), because it influences well integrity and, consequently, the efficiency of drillhole ISL.

The requirements to packs for production wells are as follows:

- high aggressive reagent resistance;
- high mechanical resistance;
- long-term performance within well production;
- open ratio enough for required amount of fluid to pass at low inlet velocity and hydraulic resistance;
- sanding up a pack (acceptable for pumping tests only).

Gravel packs meeting the requirements mentioned-above have considerable advantages over other packs, such as consistency of operation, higher parameters of intake capacity and flow rate. They are particular efficient when there is fine-grained sand in the productive formation. Using gravel packs at drillhole ISL increases flow rate by 30-40 % compared with that when using slotted liners or gauze filters. As a result, there is a twofold increase in flowing time, as well as in round trip equipment capacity [1].

There are two main designs of gravel packs – open hole gravel packs and cased hole gravel packs. The first design - open hole gravel pack, which can be of different types, is inefficient and expensive, tends to colmatage easily, and is difficult to be placed in a well. Besides, after open hole gravel packing, additional packing by a gravitational method is necessary, which increases the costs.

For the second design – case hole gravel pack – the density of gravel pack is recommended to be 1.9 ton/m$^3$. The methods to place cased hole gravel pack are as follows:

- gravitational method: gravel is intentionally placed into the annular space under the action of gravity (well depth is no more than 100 m);
- hindered settling of gravel by pumping the fluid into the botomhole (well depth is no more than 250 - 300 m).

However, it is difficult to ensure efficient gravel packing by cased hole gravel packs. In addition, it is necessary to increase the diameter of a well and to expand a gravel packer to secure required gravel pack thickness, causing time and financial expenses. To reduce costs and time at gravel packing at drillhole ISL, new technique of gravel packing of producive formations is a critical issue.

The purpose of the paper is to design a gravel pack for uranium ISL wells. The authors have designed a new gravel packing technique. They have suggested using the gravel pack in a form of a solid composition of gravel and cement agents. The gravel pack is placed with a production string into a well, where cement agents are destroyed under the action of acids and permit the gravel pack to evenly fill annular space.

The advantages of this gravel pack design are as follows:

- efficiency of the gravel pack placement in the productive formation since it is installed simultaneously with a pump column and gravel pack equipment;
- low price and simplicity of the construction;
- reducing labor costs of well construction.

The subject of the research is designing the gravel pack and formulation of cement agents. The purposes are as follows:

- to design the gravel pack with considerable durability and low hydraulic resistance over the round trips;
- to prepare the composition of cement agents.

## 2. Methods and materials

The methods of sample preparation were as follows. To obtain the gravel pack, the gravel-cement agents' composition is prepared and put into metal and plastic frames. The metal rod was installed in a frame, imitating gravel pack equipment through a hole. Then gravel composition was tamped and the samples were put into the drying cabinet ShS-80-01, SNOL under specified temperature over the specified time interval.

Physical and mechanical properties of the gravel pack are defined by the following parameters: time and temperature in the drying cabinet, formulation and concentration of a cement agent, which are varied within the experiment. The sample was placed into a glass cylinder, imitating a well and filled with solvents of various concentrations. The experimental data were registered by a digital camcorder. The test parameters affecting the time of the gravel pack solution were as follows: cement agents' concentration $n_{ca}$, %; dryout time $t_d$, h; temperature, $T$; cement agents' concentration of a hold cover $n_{hc}$, %; and thickness of a hold cover, $h_{hc}$, mm.

## 3. Results and discussion

The gravel pack is a substance consisting of gravel, cement agent and (or) a hold cover, installed on gravel pack equipment, which dissolves within the specified time filling the annular space.

The requirements to the gravel pack are as follows:

- it should dissolve within 5 – 10 hours after its placement in a well;
- it should not be destroyed when running a casing;
- it should ensure minimum hydraulic resistance;
- it should be easily assembled with a production string;
- it should secure homogeneous gravel packing.

Taking into account hydraulic resistance, the following designs of gravel pack have been suggested (fig. 1.): solid cylinder, longitudinally ribbed cylinder, capsule, cylinder with longitudinal holes for fluid to flow, cylinder of changing diameter.

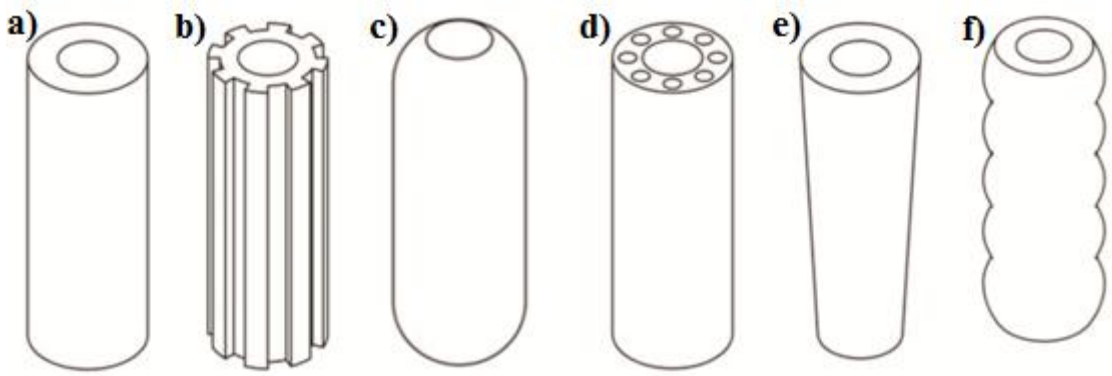


**Figure 1 –** The designs of gravel pack a) solid cylinder, b) longitudinally ribbed cylinder, c) capsule, d) cylinder with longitudinal holes for fluid to flow, f) and e) cylinders of changing diameter.

Ideal engineering solution should satisfy the following parameters: minimum outer diameter and length of the gravel pack to provide required amount of gravel to a gravel packer.

When cement agents have been identified and analyzed, the possible compositions of the gravel pack have been investigated within the experiment [2], such as:

- the gravel pack with a soluble hold cover;
- the gravel pack, consisted of gravel and the cement agent;
- the gravel pack with cement agents and a soluble hold cover.

## 4. Conclusion

To sum up, the following results have been obtained within the experiment:

- three designs of the gravel pack have been suggested: with cement agents, with a hold cover, as well as both in combination;
- it has been proved that to reduce the hydraulic resistance and ensure the effective volume of the gravel pack, it is necessary to ensure that the ratio of gravel pack diameter to a well diameter is about 0.8 – 0.9;
- the possible cement agents and a hold cover have been analyzed;
- the methods of experimental research have been suggested;
- the methods of increasing time for the gravel pack to dissolve have been proposed.

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## References

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