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## ОБЗОР НАБУХАЮЩИХ ПАКЕРОВ

### OVERVIEW OF SWELLABLE PACKERS

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**Аннотация.** Как известно, разрушение цементной связи в скважине может привести к снижению продуктивности, снижению давления в скважине и преждевременному проникновению воды. Для восстановления цементной связи требуется дорогостоящий капитальный ремонт скважин. Набухающие пакеры используются для предотвращения разрушения связи. Когда в цементном слое кольцевого пространства образуются трещины, эластомер набухающего пакера взаимодействует с пластовыми флюидами и набухает, тем самым предотвращая дальнейшее движение флюида. В этой статье обсуждаются набухающие пакеры и их преимущества.

**Ключевые слова:** набухающий пакер, эластомер, цемент, пластовые жидкости, защитные кольца.

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**Annotation.** As known, the destruction of the cement bond in the well can lead to loss of productivity, lower pressure in the well and premature penetration of water. To restore the cement bond requires expensive overhaul of wells. Swellable packers are used to prevent the destruction of the bond. When cracks form in the cement layer of the annulus, the elastomer of the swellable packer interacts with the formation fluids and swells, thereby preventing further fluid movement. This article discusses swellable packers and their benefits.

**Keywords:** swellable packer, elastomer, cement, formation fluids, protective rings.

The advantage of swellable packers is that there are no moving parts in their design, which makes it possible to avoid special operations. The sealing element of swellable packers has the ability to self-repair sealing properties. Also, the advantage of such packers is that their use provides reliable and irreversible isolation of formations [1].

Swellable packers should be used in wells with damaged casing [2–4].

Unlike packers of other designs, which are preferably installed in areas of stable impermeable rocks, swellable packers can also be used in open hole wells with unstable soft and loose rocks, since the sealing element of this packer is able to protect the borehole walls from disturbing the integrity of the formation. Suitable for use in wells with an uneven cross-section, since when sealing element of swellable packer can take the form of a wellbore.

Several parameters of swellable packer:

- the swelling rate of the elastomer depends on the composition of the elastomer, the physico-chemical composition of the fluid in which it swells, the degree of access of the fluid to the surface of the elastomer, as well as temperature conditions;
- elastomer which swells in water, the swelling process proceeds according to the principle of osmosis – the process of movement of water molecules through a semipermeable membrane. Water penetrates into the elastomer and is retained there due to the difference in the mineralization gradient between the fluid and the elastomer;
- elastomer which swells in oil, absorption, diffusion processes are observed;
- depending on temperature conditions, mineralization of produced water, hydrocarbon composition, degree of fluid access to the elastomer, the swelling process can last from several hours to several days and weeks. A full increase in volume can vary from 100 % to 200 % or more.



However, basically, elastomeric packers that swell under the action of well fluids are consists of a casing with an elastomer swelling from contact with a particular fluid. The casing is provided with threaded connections that meet customer requirements. At both ends of the elastomer there are anti-extrusion rings that resist extrusion. Standard elastomer length: 0,9; 1,5; 3; 4,5 and 6 m. It should be noted that swellable packers with elongated elastomers are able to withstand higher pressure drops.

Protective anti-extrusion rings protect the sealing element (elastomer) and guide the packer during its running into the well [5–7].

After lowering and installing the packer in the required place, the protective rings prevent the elastomer from being squeezed out. In most cases, the extrusion protection of packers is designed in such a way as to ensure swelling of the elastomer in the radial direction. A new type of protective rings (stop ring) is known whose advantage is the ability to shorten the length of the packer, while maintaining the necessary pressure drop. In this case, the length of the swellable sealing element (elastomer) is the main factor for the contact area. For withstanding of swellable packer to the great differential pressure required long elastomer

Systems that regulate the swelling process when swellable packers are lowered into the well there is a risk of premature swelling of the sealing element in contact with the wellbore fluid. Most often this happens in case of unexpected stops during the running of the well with swellable packers. Swelling of the elastomer should occur at the installation site in the interval necessary for isolation. In order to exclude premature packer swelling, various systems are used that can slow down the swelling process. Manufacturers of swellable packers strive to create an elastomeric composition for a particular well.

For this purpose, systems are developed that provide regulation of the swelling process of the sealing element (elastomer) so that the setting time can be set based on the needs of the customer. Control systems for the swelling process include polymers with the inherent properties of slowing down swelling, as well as various delayed diffusion barriers and coatings. Disadvantages of swellable packers despite the many advantages of swellable packers compared to packers of other designs, their use is limited by a number of factors.

One of the relative disadvantages of swellable packers is the time needed to swell the sealing element. Mechanical and hydraulic packers are installed and begin to act immediately after the descent into the well. Therefore, where urgent isolation is required (in case of step cementing, pneumatic drilling, prevention of aeration of cement, etc.), it is advisable to use hydraulic and hydromechanical packers.

The use of swellable packers is also unacceptable in extreme conditions, for example, in gas wells with high pressures and high temperatures, or in Arctic wells.

When using swellable packers in practice, it is necessary to take into account that when the elastomers swell, the intermolecular bonds are weakened, as a result of which their mechanical properties are reduced. As a result, under the influence of forces caused by the pressure drop, the tendency to extrude, force out, or deforms, which leads to the loss of the sealing ability of the elastomer.

Also, at high temperature differences (for example, when pumping a fracturing fluid for making hydraulic fracturing), the swelling elastomer can be reduced so much that its sealing ability will be completely lost. Given these circumstances, it is recommended to use swellable packers with caution in case of significant pressure and temperature differences. In multi-stage processing, where the use of a large number of packers, the use of swollen packers are required wholeheartedly. The work of swollen packers does not require the creation of loads (pressures) with sides and complex operations with pipes. The swollen packer can be used in wells with damaged casing column, as the packer element (elastomer) has self-restoring properties.

Packers of these structures (hydraulic, mechanical, etc.) are recommended to be installed in unrefined wells in places of stable, impenetrable rock. Swelling packers can be installed in wells with soft, loose and unstable species, so the swollen sealing element is able to protect the walls of the wells from violation of the integrity of the formation.

One of the real factors in the work of packers is time. Hydraulic and mechanical packers are installed quickly and are activated immediately after the start of the layout. In this case, the load on the casing column carries a strong and short-lived character that can cause damage to it. Swelling or packers begin to act gradually, in the course of several days, which provides long-term insulation of layers and protects the casing column from damage. Recently, packers with hybrid compaction systems have appeared.

Several companies provide swellable packer such as: TAM, Halliburton, Weatherford and etc. TAM company provides vary types of swellable packer like FREECAP I, FREECAP II, FREECAP III, FREECAP IV, Smart FREECAP, FREECAP Geothermal and TAM's FastSwell® technology. Unlike others packers of TAM company TAM's FastSwell® technology provides a fast swell and controlled swell time in slow swell conditions. FastSwell system has developed to enhance into heavy oil and to improve performance in the high salinity and low temperature environment. Main benefit of TAM's oil or water swellable elastomer can be used in all environments. Features of TAM's FastSwell® technology are:

- Swellable Packer touches to well wall approximately 2,5 days with a 5–3 / 4 in. (146 mm) OD to seal in a 6–1 / 8 in. open hole with well conditions of 140 °F (60 °C) and 9,0 ppg 10 %;
- Variable seal length;
- Anti-extrusion end rings;
- Provides excellent sealing in corroded casing and in irregular shapes.



Another company which provides swellable packers are Weatherford. This swellable packer called GENESIS Anulus Swellable Packer. This packer suitable for open hole and cased-hole well environments. Features, advantages and benefits are:

- Absence of moving parts;
- Can be used with most thread connections and tubular configurations;
- Isolate irregular changing annular geometries and hole shapes.

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