

Water Well Packers

Packers are mechanical devices used to seal/isolate different sections of a well. As a range of technologies they originated in the much larger oil and gas industry, although inflatable packers have since been developed specifically for the water well industry and in turn versions of these have been adapted for the oil and gas industry.

There are three main types:

- a) Mechanical packers – cased hole applications only – three basic types:
 - (1) Interference type – designed to be pushed down into location in a well and provide a seal by virtue of an interference fit between the packer and the ID of casing.
 - (2) Mechanically actuated – typically consist of a donut/cylinder of rubber that is compressed axially to force it to expand radially and thus create a seal between two pipes in a well.
 - (3) Hydraulically actuated – very similar to the former type but set by means of hydraulic pressure.

This type are very common in the oil and gas industry and have several applications. There are versions also used for hydraulic fracture zonal isolation in highly competent open hole formation.

- b) Swellable packers – cased or open hole

These consist of a pipe with a rubber cover securely bonded to the pipe. The rubber is specially formulated so that it will, over time, swell by absorbing well fluid. Once it has swollen sufficiently, it will provide a seal between the borehole wall and the centre pipe. These are only used as casing packers, mainly in the oil and gas industry for zonal isolation.
- c) Inflatable packers – cased or open hole

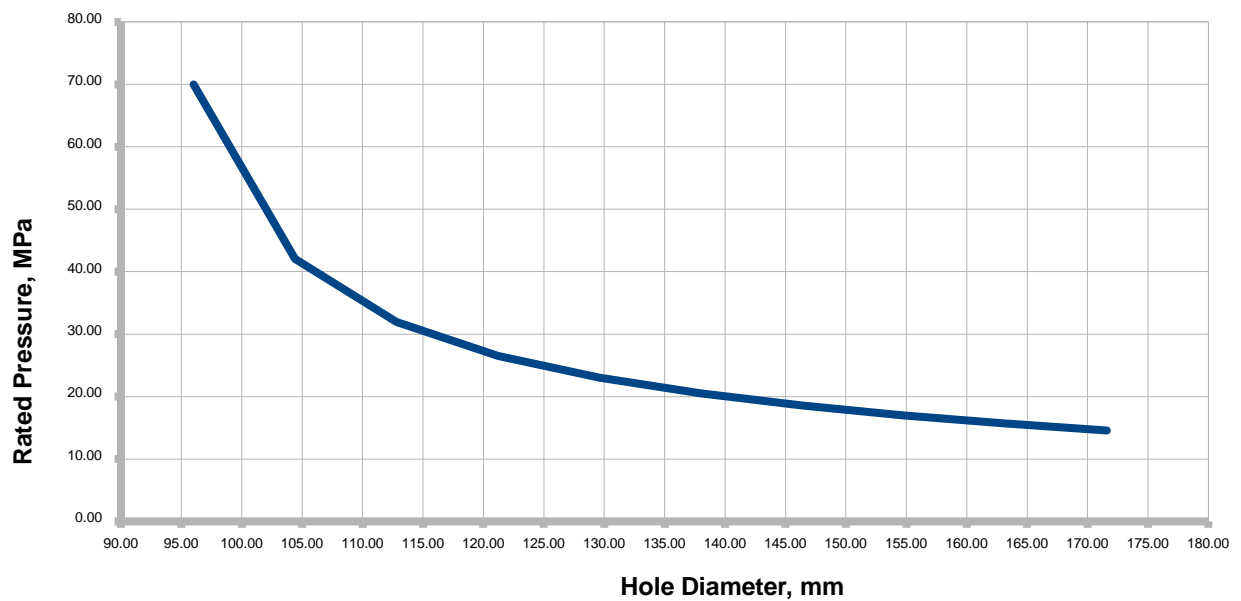
There are two main types:

- (1) Fixed end – consists of a long cylinder of rubber mounted on a steel centre pipe and fixed and sealed at both ends. Introducing an inflation fluid between the ID of the rubber tube and the OD of the centre pipe causes the packer to inflate radially to seal the borehole.
- (2) Sliding end – similar to the first type but with one end in sliding, sealing contact with the centre pipe and full length reinforcement which generally affords much higher pressure rating and expansion capability.

Regardless of the specific type, inflatable packers offer the greatest versatility in terms of application, degree of expansion and length of seal and the bulk of this article is dedicated to this topic.



89 HP Packer Element Rated Pressure vs Hole Size



Inflatable Packer Characteristics

Expansion Ratio:

- Up to 3x "At-rest Diameter"
- As Expanded diameter increases pressure rating at that diameter decreases

Sealing Length:

- From about 10 cms (4 inches)
- To over 6 metres (20 feet)

Inflation Pressure:

- From 10's of psi (few bar)
- To 12,000 psi (840 bar)

What gives an inflatable packer these characteristics?

- The pressure rating for an inflatable packer is similar to the pressure rating for a pipe. In both cases it depends on the diameter and wall thickness.
- As a packer expands, its diameter increases but its wall thickness actually decreases.
- Thus the pressure rating decreases accordingly.



Wall thickness for a packer has more to do with the strength of the reinforcement than with the actual rubber thickness. Several types of reinforcement are commonly available:

- Contra-wound steel cables
- Woven steel cables
- Steel slats
- Other synthetic cords (low pressure)

Each of the different reinforcement types suit different applications. For example, many oilfield, single set, inflatable packers use parallel, over-lapping steel slats for reinforcement.

Woven steel cable reinforcement is another type popular for oilfield packers. In this case, the slats are replaced with weave of heavy duty, relatively large diameter cables. These have the advantage over slats of being able to better recover their initial diameter when deflated since the reinforcing cables do not yield during inflation.

True composite construction is a feature of inflatable packers built using contra-wound steel cables embedded in a rubber matrix. These include the so-called “hose packers” which are manufactured by attaching steel ends to cut lengths of machine made hose. Such packers are typically small diameter, natural rubber only and relatively low pressure rated. They find application in many construction grouting applications and low pressure testing and monitoring work.

The other member of the contra-wound steel cord category which, while offering all the advantages of true composite construction have none of the limitations imposed on machine made “hose packers”. Being hand-made these can be built to suit a very large pressure range, in diameters and lengths for most applications even including those demanding specialized elastomers and/or metal parts to suit challenging chemical and thermal environments which must also be considered when selecting packers.



For groundwater and ambient temperature applications these inflatable packers are made with natural rubber. For higher temperatures, aggressive chemical or hydrocarbon environment synthetic elastomers such as nitrile are used.

Inflation Methods and Fluids

Inflatable packers are activated by some means of introducing an inflation fluid between the central pipe and the inflatable element. Two main inflation methods are available, namely, through the string or via an external tube.

The first of these uses the pipe string to which the packer is attached to inflate the packer. Inflation pressure is retained by means of downhole valves of one sort or another.

The external tube inflation system uses a small diameter tube or hose run alongside the deployment pipe as a direct conduit to the inflatable packer. Such systems are naturally resettable and also allow continuous monitoring of packer inflation pressures during operations.

For a reusable packer, the issue of packer deflation must also be addressed. This may become a problem for external tube inflated packers, for example, where the static head in the well is considerably lower than ground level and the packer is water inflated. In this case, the head of water in the inflation tube above static level may be sufficient to keep the packer inflated. Several methods are available to address this issue, for example, dump valves, gas lift deflation, etc.

Setting tools should have an emergency deflation system that is independent of borehole hydrostatics to guard against this possibility as well. Such emergency systems may also have other benefits such as permitting deflation when well conditions prevent activation of standard deflation methods.

In general, packers may be inflated with either a liquid or a gas. Drilling mud, oil, water, nitrogen gas and air are commonly used. In some circumstances a liquid which sets hard, such as cement or epoxy, is used.

The choice of gas or liquid may be influenced by the packer's response to applied pressure. If inflated with a liquid, the packer inflation pressure will respond positively to any applied differential pressure and continue to provide a seal owing to the essential incompressibility of the inflation volume.

This characteristic of liquid inflated packers is often made use of in grouting and fracturing applications to avoid initial high inflation pressures. As an example consider a fracturing job.

Two packers are inflated to isolate a test zone between them. The fracture pressure is expected to be around say, 20 MPa. In order to observe the fracturing process during fluid injection into the test zone, the last thing you want is for the packers to initiate fracture before you even start the test. To guard against this eventuality the packers would be inflated to only 10 MPa, say. As the test zone injection pressure increases, the packer pressure will increase in parallel while maintaining a seal thus avoiding premature fracture.

If gas is used for packer inflation, due allowance must be made for the duration of the application as rubber is gas permeable and will absorb gas throughout the inflation



period. While this may not be a problem while the packer remains downhole in a pressurised environment, when the packer is returned to the surface the gas will desorb from the rubber and may collect in pockets of local weakness causing eventual delamination and gas bubbles to form in the element making re-use inadvisable.

In addition to this criterion the choice of inflation fluid should be carefully considered with respect to several other factors as follows:

- chemical compatibility with the packer materials;
- setting depth;
- hole conditions;
- the period for which the packers will remain inflated;
- availability.

Inflatable packers have a broad range of applications in the water well industry but their successful deployment relies on a thorough understanding of their characteristics and limitations. Hopefully the comments made here assist in developing an understanding of these.

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Clem Rowe is the MD and founder, in 1999, of Inflatable Packers International Pty Ltd (“IPI”), based in Perth Western Australia. From 1987 to 1999 he was the Engineering Director of AGE Developments Pty Ltd, where Australian inflatable packer technology was originally developed in the 1980’s. He now spends most of the year in IPI’s European office but is often at the Perth design and manufacturing centre in Osborne Park.

