Sealing Oilfield Valves and Down-Hole Oil Tools

By Jeff Spira

Sealing oilfield tools and valves is perhaps one of the most difficult jobs for any seal. High temperatures and pressures, corrosive chemicals, and abrasive particles make this a nearly impossible task for most off-the-shelf seals. With careful engineering and modern materials, though, seals can be built for this task that do the job they're asked of.

Let's first examine the oilfield environment. No longer are wells just drilled a few thousand feet to tap shallow oil fields. Those fields have been pretty much exploited over the past century and are starting to dry up. Many are being mostly shut down because they don't produce as well as those 10,000+ feet down. When you get that far down, often the temperatures are in the 400 F (200 C) range with pressures as high as 40,000 PSI (275 Mpa.) Traditional rubber or even PTFE seals have no chance of withstanding those environments.

Oil valves and tools must also withstand one of the most corrosive substances in existence, Hydrogen Disulfide gas. This eats through steel and stainless steel springs to render them useless in short order. If metal springs are used in these seals, they must be made of one of the nickel super-alloys, Inconel, Hastelloy or Elgilloy. These are the only that can remain unaffected by exposure to H_2S without affecting their service life.

Seal jackets for the oil field environment must be made of polymer alloys to maintain their integrity under the high temperatures and pressures. Unfilled PTFE (Teflon) would squirt out of the gland like toothpaste from a tube if exposed to these pressures. Combinations of inert fillers like chopped glass or carbon fibers, minerals and graphite are needed along with combinations of polymers, like PFTE (Teflon) and PPS (Ryton.) Other polymers have proven themselves useful as well.

The seal must be pliable enough to fill the micro-finish of the seal gland wall while being sturdy enough not to extrude through the clearances being sealed. This is a tall order and often cannot be accomplished with a one-piece seal, so backup rings are often used to close off, or at lease minimize the extrusion gap. These are generally made of polymers with a higher modulus (stiffer) than the seal rings, since they are not required to seal, only to close off the gap. Clever designs using multiple rings cammed against each other create the ideal sealing condition – a near zero extrusion gap.

Designing seals for the severe environment of oilfield valves and down-hole oil tools is a combination of proper mechanical design and of proper seal materials. Correct design can make for reliable, save equipment, while the converse, improper design can lead to disaster.

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