Advances in Plunger Seal Technology

(Chemical Injection Pumps)

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This article discusses pump plunger seal life as it relates to chemical injection in the midstream and upstream sectors of the oil and gas industry. Chemical injection is widely used to prevent or reduce: corrosion, asphaltenes, wax, scale, microbial growth, friction, foaming, hydrates, and freezing. Pump seal performance directly impacts operating costs such as manpower requirements, chemical consumption, and environmental clean ups. Let's take a look at the challenges pump manufacturers have.

Plunger Seal life is influenced mainly by: chemical type, mechanical wear, pump design, debris, and environmental factors.

Chemical injection pumps used in upstream and midstream applications are generally located on remote sites and are installed outdoors. These conditions include the bitter cold and blowing snow of northern climates and the extreme heat and violent sand storms seen in desert environments. Fluctuations in temperature can affect the expansion and adjustment of sealing elements, and blowing debris or ice build-up can obstruct moving and sliding parts, resulting in increased wear and premature failure.

Sand, dirt, and other foreign materials are often present in the chemical being pumped. This debris may be introduced at the chemical plant, or contaminated during transport and storage. In some cases, vacuum trucks used to clean tanks are later used to refill tanks with new chemical prior to proper cleaning. Foreign material can also be introduced on-site during filling operations, especially in windy desert climates. Foreign debris can be mitigated by placing a filter upstream of the pump, which is generally limited to a low cost stainless steel "Y" strainer. This

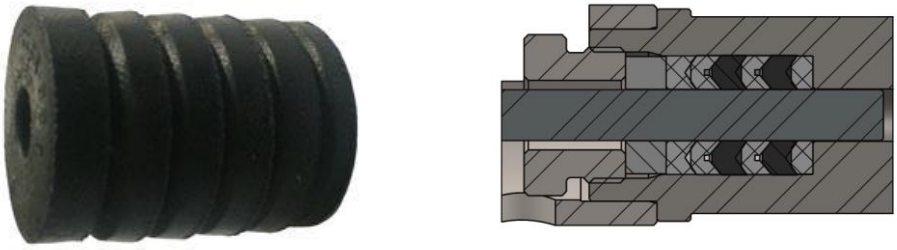
A chemical pump exposed to the brutal Canadian North where temperatures regularly dip to -40°F (-40°C)

In a stark contrast this pump operates in the sandy Arabian desert where peak temperatures exceed 122°F (50°C)

protects the pump internals from very coarse particles. Larger, more effective filters with finer mesh sizes, have historically been considered cost prohibitive.

The corrosive nature of many chemicals is in itself a large contributor to premature pump failure. Traditionally, chemical injection pumps have interchangeable sealing elements made from a range of elastomers and polymer types (such as EPDM, FKM, FFKM, NBR). The intent is for the sealing material types to be selected based on the known properties of the chemical being pumped. However, operators and chemical providers are constantly optimizing their chemical programs and creating new proprietary chemicals or custom blends. Selecting the ideal seal material becomes difficult when chemical types are proprietary and chemical providers are protective of their IP. The seal material selection process can, in some cases, be reduced to trial and error in the field which is time consuming, wasteful, and can result in unwanted chemical leakage or damaged parts.

The majority of pump manufacturers today utilize a plunger packing technology first introduced on chemical pumps in the 1930's. The packing consists of a stack of "V" shaped sealing elements that seal against the pump plunger. The sealing load against the plunger is adjusted by tightening a nut that compresses the sealing stack. As the plunger moves back and forth it constantly wears against the packing and small traces of material are slowly removed. This results in a gradual loss of seal compression and requires the packing be regularly re-adjusted. Although advances in material science has improved packing performance over time, this basic design has remained unchanged for nearly a

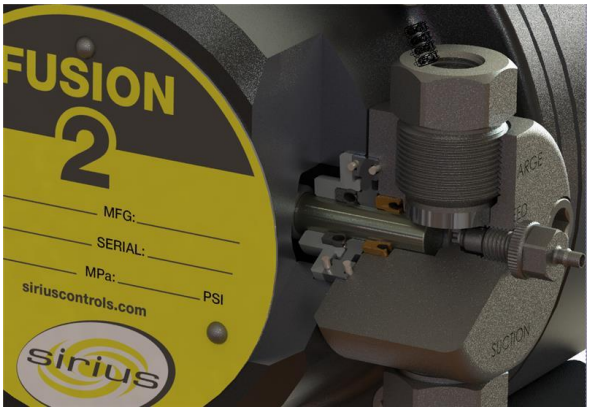


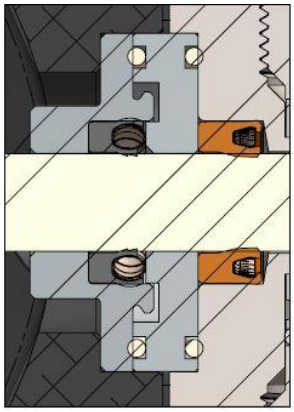
Traditional Plunger Packing

century. In today's world where chemical costs are high, environmental standards are rising, chemicals are always changing, wells are increasingly remote, and everyone is striving to increase efficiency of manpower; this century old sealing technology has many drawbacks.

Advances in plunger Seal Technology:

Sirius utilizes a unique dual seal system which overcomes many of the shortcomings of packing designs. The primary seal is flow wetted on both sides and is protected from external debris. The secondary seal is *only* ever subject to suction line pressure and is far less prone to leak large volumes of chemical to the environment than just a single staged seal acting against high pressures. The internal springs within the seals provide a constant force on the sealing surfaces which automatically compensate for variables such as seal wear or operating temperature. These springs eliminate any need for manual adjustment of packing. The seals are made of a special Teflon™ based compound which is impervious to the vast majority of chemicals used in the petroleum industry. Sirius first used this technology in 2008 and has continued to improve on its design each year.





To evaluate the performance of this seal technology, Sirius was able to analyze eight years of detailed historical data. The scope of the data set was quite large, over 10,000 pumps, requiring several assumptions to be made as listed below.

Data used:

- Number of pumps and pump heads sold. (Every “Comet” style pump head sold by the company is included)
- Number of service kits sold. (Every service kit ever sold by the company is included)

Assumptions made:

- All pumps are still in service. (oldest pumps are eight years old)
- All service kits have been consumed. In reality many customers purchase spare parts to put into maintenance inventory which would still be available for use.
- There are no third party seal kits in service. This is a valid assumption because of the unique and patented design on the parts and seals. To date, Sirius has yet to encounter an aftermarket seal service kit. The vast majority of Sirius pumps and parts are sold directly to the end users.
- All seals currently in service are 50% spent.

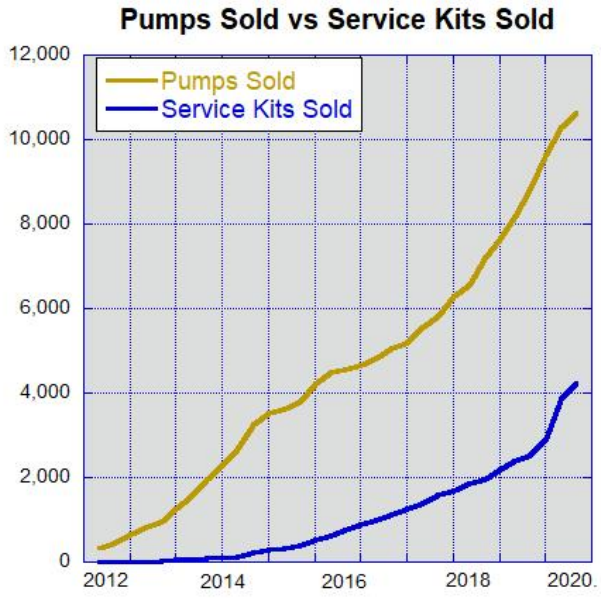
Other pertinent information:

- No effort was made to identify duty time. Whether a pump was operating winter only, or an 8 point multi-point running continuously for 12 months of the year, they are treated the same for this study.
- No effort was made to differentiate between pumps in extreme service or light duty. For example, all pressures, climates and chemicals were grouped together.

Although this data set combines many different service conditions which effect life cycle of the pump, this study was published to look at seal life in general over a wide range of applications. Based on the above, “Pumping Years” are considered to be the number of years in service for a pump. A pump sold four years ago would constitute 4 pumping years.

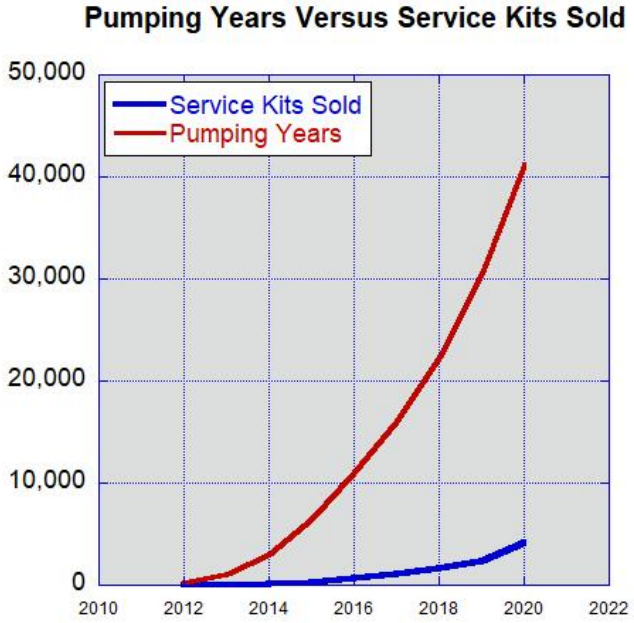
The graph to the right shows the plot of cumulative number of pumps sold alongside cumulative number of seal kits sold for Comet™ style pumps. Over an eight-year period Sirius shipped over 10,000 pumps and only 4,200 service kits. Based on the data, it can be ascertained that over this time period, less than 40% of the pumps have ever had a service performed.

By comparing the same number of service kits sold to the number of "pumping years", the lower graph was generated. Here we see there have been over 40,000 pumping years created from the 10,000 pumps.



The data shows that Sirius' customers have purchased a service kit for every 9.8 pumping years. **The life cycle of the original and replacement seals was calculated using an algorithm and found to be 4.5 years.** Sirius does not recommend running the pump for this duration prior to servicing.

Unlike many larger pumps used in process control throughout the world, chemical injection pumps are not typically subjected to preventative maintenance. Sirius believes that this may be a result of the constant attention and manual adjustment required from the traditional packing style pumps most operators use. These pumps are checked and adjusted so frequently that parts are simply replaced whenever they are found to be worn out. Most customers run the Sirius Comet™ in a similar fashion, where they are run to failure and maintained only when parts are found to be worn out. Because of the importance of pump accuracy and the importance of environmental stewardship, Sirius recommends that preventative maintenance be performed on an annual basis to ensure peak performance.



Sirius' historical sales data clearly shows that the life cycle of modern dual seals far outlasts the six months to a year, typical of traditional packing style plunger seals. In addition to longer service life, the lack of any need to manually adjust the seal packing reduces operating costs and gives operators the confidence to run the Comet™ pumps for long durations, in remote sites, and in challenging environments throughout the world.