When to consider using an API 610 VS4 Vertical Pump instead of an API 610 VS1

technical bulletin

There are various types of vertical pumps available from VS1 to VS7, each of which suits a range of applications. Within the oil and gas industry the two most common API 610 vertical pumps employed are VS1 and VS4. In many cases when a VS1 pump is specified the more cost effective VS4 pump could meet the duty required.

There are many engineers who continue to specify the well-known but complex VS1 pumps, more through historic reasoning than whether or not a much simpler VS4 pump may be adequate for the duty. VS1 pumps will always be suited to those duties that require high flow or head but for many applications a VS4 pump (with or without a booster pump) will perform the required duty perfectly well (see Figure 1).

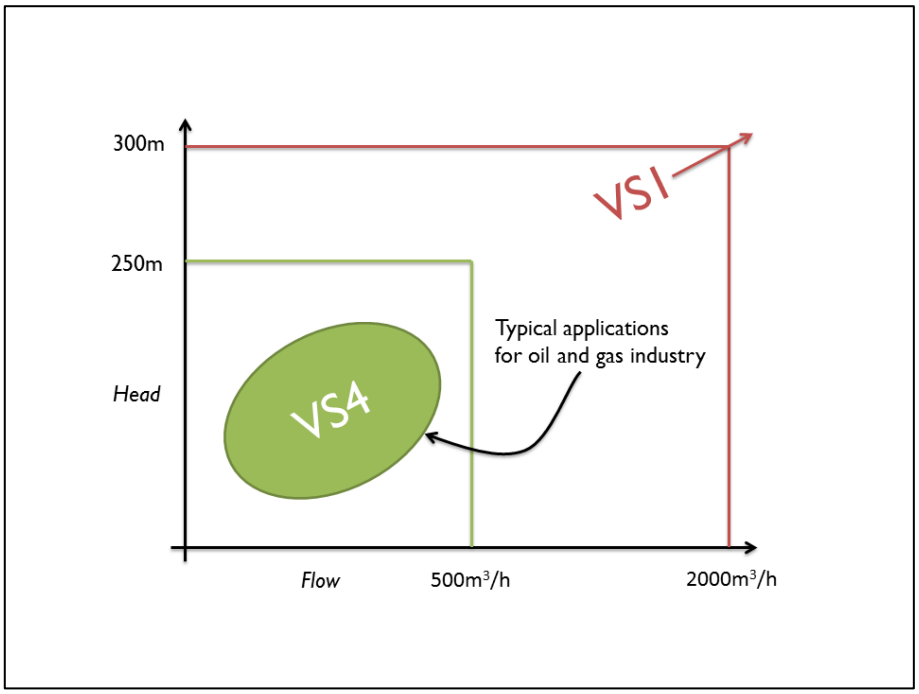

Figure 1 – VS1 vs. VS4 Head and Flow

Design and operation of VS1 pumps

VS1 pumps can be single or multistage and in theory can work to a limitless depth. VS1 pumps achieve this through the ability to have multiple stages stacked one on top of the other (see Figure 2). The fluid is pumped from the sump through the support column and out into a discharge bend. The sharp bend on the discharge however produces a loss in performance. The VS1 pump generally requires an expensive double mechanical seal and Plan 53 seal support system to prevent leakage.

The bearings of the shaft in each stage of a VS1 pump are mounted inside the support column by spiders. This works well for relatively clean fluids but where the fluid being pumped contains sand or grit, which is typical in oil and gas applications, wear of the spiders occurs. In addition, where sand or grit is present, VS1 pumps require an expensive seal support system to enable a clean flush to be fed to the bearings. The grease lubrication of the bearings in VS1 pumps is also expensive to manufacture and whilst all vertical pumps require removal from time to time, disassembly and reassembly of VS1 pumps is quite time consuming.

Design benefits of VS4 pumps that overcome many of the issues with VS1 pumps

In a VS4 pump the central column contains the drive shaft to the pump which is supported by a number of bearings depending on the length, but the process fluid exits via a separate discharge pipe running parallel to the column from the sump to the top plate which means it can pump the gritty fluid independently of the shaft bearings using various filtering techniques (see Figure 2).

There is no need for a complex mechanical seal at the top plate, usually just a simple vapour seal is required which costs significantly less than a double mechanical seal system. The discharge pipework can also be better designed to reduce losses.

The shaft bearings, sometimes also referred to as line bearings, in the VS4 pump can be easily lubricated and flushed, either by recirculating some of the process fluid (which can be filtered through strainers if sand or grit content is high) or using a separate clean fluid flush system should this be available on site.

VS4 pumps can also be built in stages allowing for the quick and easy removal for maintenance in areas of limited headroom. Where a higher flow is required, a VS4 can act as a booster pump with the main pump operating in series and feeding a horizontal centrifugal pump above ground which will then achieve similar head and flows to a VS1, but with the added advantage of maintenance to the horizontal centrifugal pump being much quicker and easier as it does not require lifting out of a sump before maintenance can commence.

Comparison of API 610 VS1 and VS 4 pumps

	API 610 VS1 Pump	API 610 VS4 Pump
Working depth	In theory work to **limitless depths.**	Proven to work at **depths required in most oil and gas duties.**
Flow and head	Work well for **high flow and head** applications.	**Less head and flow** but can act as **booster pump** in series with a horizontal pump above ground to **achieve high head and flow**.
Efficiency	**Efficiency losses** at the sharp discharge bend.	**Higher efficiency** due to reduced losses of separate discharge pipe with no sharp bends.
Seals	**Complex double mechanical seal and Plan 53 seal support system** to prevent leakage.	Usually just a **simple vapour seal** at the top plate to prevent leakage.
Bearing lubrication	**Grease lubrication** of the bearings that are **mounted on spiders** in the process fluid.	Bearings are **mounted directly** on the shaft and **flushed** by recirculating some of the **process fluid**.
High particulate content	High particulate content in the process fluid **causes wear** to the bearing spiders and needs an **expensive seal support system** to deliver a clean flush to the bearings.	The process fluid used to flush the bearings can be **easily filtered through strainers** or a separate **clean fluid flush** can be **easily installed**.
Ease of maintenance	Removal, disassembly and reassembly are **time consuming** and **need plenty of headroom.**	**Quick and easy** removal and reassembly by breaking into sections **needing little headroom.**
Cost	Overall **higher cost than VS4** to perform the same duties and to maintain.	Overall **lower cost than VS1** to perform the same duties and to maintain.

Summary of when to consider using a VS4 pump instead of a VS1 pump

There are definitely occasions where a VS1 pump must be specified, such as when there is not enough NPSH available to feed the pump, but a VS4 pump can offer a cost effective and easier to maintain option than selecting a VS1 pump, even when an additional horizontal pump is brought into the equation.

If there is a requirement for a vertical sump pump and a VS1 has been specified then consider whether a VS4 pump will meet the duty. If so the VS4 pump is less expensive, simpler and less costly to maintain than the equivalent VS1 pump, particularly if the fluid which is being pumped contains abrasive solids.

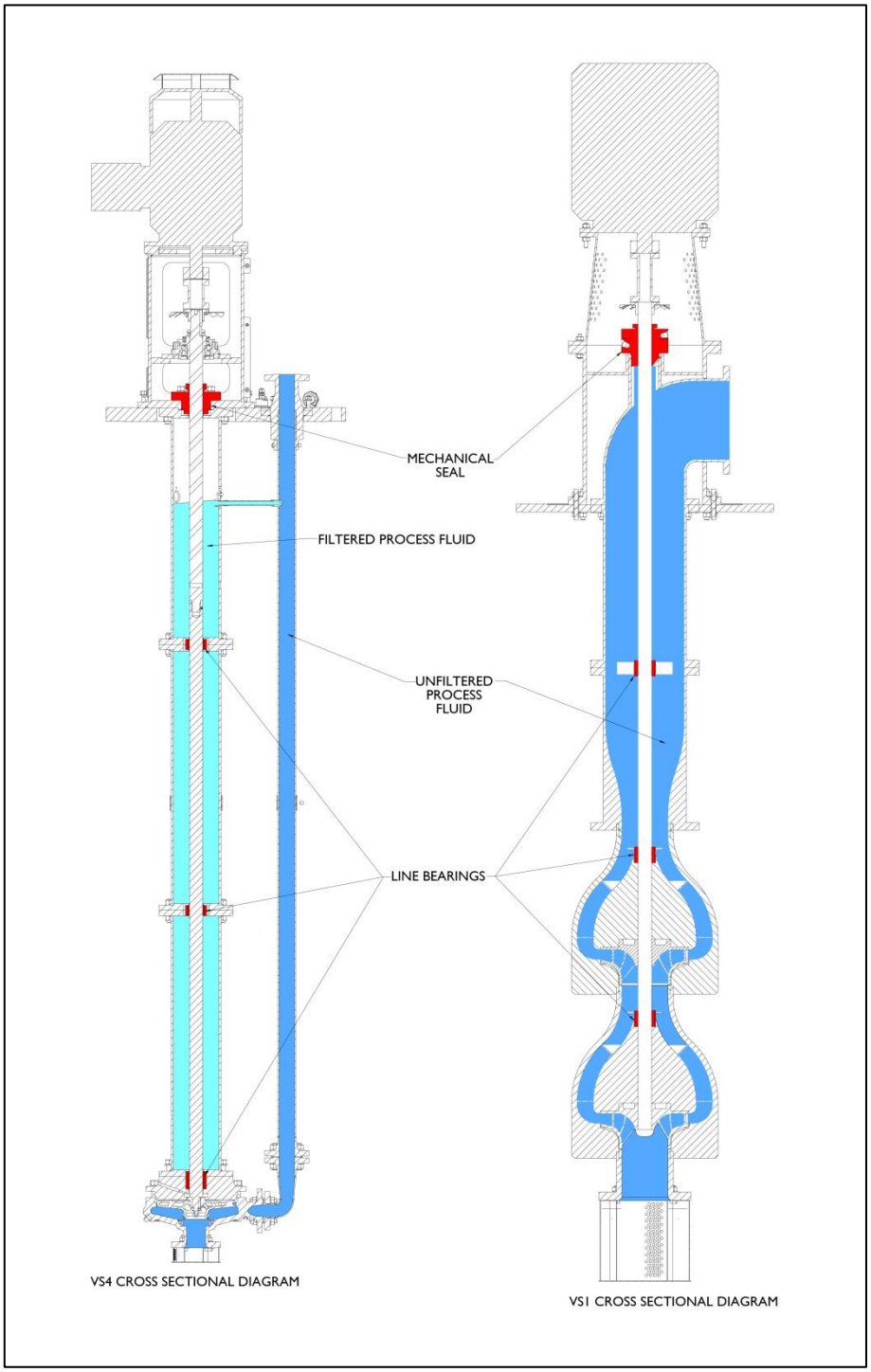

Figure 2 – Comparison of API 610 VS4 and VS1 Vertical Pumps