Since the mid-1960s, when the LNG business began to gain traction, submersible centrifugal pumps have dominated the cryogenic application market. However, this was not always the case. Prior to the 1960s, conventional vertical motor-driven (API 610 VS6 type) pumps were the only viable option for these applications. The challenge was how to seal the cryogenic pump with 1960s mechanical-seal technology.

Bingham Pumps invented the J-unit over 60 years ago and sold the first units in 1952. The J-unit consisted of an isolation chamber to separate the cryogenic fluid from the mechanical seal area. The standard double
Freezing cold

The word cryogenic comes from the Greek; “cryo” meaning “icy cold” and “genic” meaning “producing.” In essence, the term means “the production of freezing cold.” In Sulzer’s pumping applications, cryogenics involve temperatures below –85 °C (–120 °F, or 189 K).

Pumps designed for low temperatures serve a variety of applications such as the processing and transport of ethane, methanol, and liquefied natural gas (LNG). LNG is becoming an increasingly important energy source around the world. A key benefit of LNG is that after the natural gas has been liquefied at a very low temperature, it has a much smaller volume and can be shipped in tankers to regions outside the reach of conventional pipeline networks. After shipment to the destination port, the liquid is pumped through a heat exchanger, where it returns to a gaseous state for conventional piped distribution. In this last phase, a send-out pump passes the LNG through the heat exchanger at high pressure. Sulzer plays a leading role in developing cryogenic pumps, e.g., the JVCR high-pressure canned LNG loading pumps.

www.sulzer.com/JVCR

mechanical seal was lubricated with oil from a pressure unit, which had a piston inside that was connected to the suction region of the pump. The oil pressure for the mechanical seal was then maintained at a pressure slightly above suction pressure. A pumping ring was used to circulate the oil to the seal. This was decades before the advent of mechanical-seal standards like API 682, plan 53C, etc.

In 1988, Sulzer bought Bingham Pumps and, with it, came the J-unit technology. The Bingham heritage continues on the banks of the Willamette River in Oregon (USA), now as the reconfigured and modern Sulzer Portland plant.

Cold spin tests are performed using liquid nitrogen at the Sulzer plant in Brookshire, TX, USA.
Continuous design improvements
In 1998, the J-unit came up for redesign. In the second-generation model, the pressure unit was modernized so that the barrier fluid pressure could be maintained at 1–2 bar (15–29 psi) above the insulation chamber pressure. This change updated the previous simple weight-loaded design and eliminated the use of the diaphragm.

In recent years, due to improved mechanical-seal technology, between-bearing, single-stage, and multistage pumps have routinely been applied to –80 °C (–112 °F) methanol. In turn, the J-unit was once again revisited and improved.

These recent further developments yielded the current third-generation design, which was finalized in 2012. The pressure vessel was redesigned from its previous cast body construction to a built-up assembly of tie rods and hydraulic-cylinder-type components. The gas side of the piston was relocated to the bottom of the cylinder to allow engineers to check easily for any barrier oil that may have entered the gas leg from a weeping piston seal. Notably, the piston rod and springs are external to the unit, which allows for the installation of springs with differing spring rates for a broader range of differential pressure conditions.

The available volume of the seal buffer oil was increased from 3.5 liters (~1 gallon) to up to 8 liters (~2 gallons). This change increased maintenance intervals by doubling the time required between oil top-offs. Additionally, the total volume of oil in the vessel is available as a buffer fluid, whereas in previous designs, over 70% of the oil was dead volume. In current models, there is no unusable oil—meaning that there is a smaller change in seal oil level with thermal expansion.

Prototype testing of the third-generation J-unit.

Design benefits
The latest design improvements of the J-unit were driven by a need to provide simple and affordable sealing system solutions for low-temperature applications. Interchangeability, cost savings, and innovation were the targets for these solutions:
- Interchangeability due to similar component part design across product ranges
- Cost savings due to an increase in working oil volume in the seal oil unit to decrease maintenance intervals
- Innovation due to the invention of the piston rod and springs used for creating differential pressure outside of the cylinder

The advances in the design of the J-unit allow Sulzer’s conventional API 610 type OH3 and VS6 pumps with additional features, to once again be a viable option for cryogenic temperature applications. These pumps now provide improved reliability with simple maintenance, accessibility, and efficiency.

No leakage of LNG
The availability of equipment and safe operation are key product drivers. Modern J-unit systems are robust and require little attention. The evolution of design undergone by the J-unit in recent years has allowed Sulzer to remain competitive in this market providing valuable and reliable service to our customers. As an added benefit, the J-unit provides a near-zero emission sealing device—an immense benefit for the customers and the environment.

Contact: Raquel Benito
sulzertechnicalreview@sulzer.com