

Pumps for Liquefied Natural Gas

Ice-cold and Efficient

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Liquefied natural gas (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, large volumes can be shipped in tankers—essentially large floating thermos flasks—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 Pumps plays a leading role in the pumping of LNG and other cryogenic (low temperature) products.

► To produce LNG, natural gas is first cleaned to remove heavy hydrocarbons and impurities and then condensed by cooling until it liquefies at -163°C . By liquefying the gas, its volume is reduced to one six-hundredth. Because LNG is made from natural gas, it is a mixture of different hydrocarbon gases. Purified LNG typically contains over 90% methane as well as small amounts of ethane, propane, butane, and some heavier alkanes.

Gas Transport Without Pipelines

The infrastructure necessary to transport LNG includes cooling and loading facilities at the locations where the gas is produced and receiving terminals for discharge and regasification (Fig. 1). Regasification terminals are usually connected to storage tanks and a pipeline network. The regasification of LNG depends on the continuous, reliable operation of the main send-out pumps. In the past,

most send-out pumps were submersible pumps. The increasing size of LNG-receiving facilities has highlighted a number of disadvantages of the submersible solution. These drawbacks include relatively low efficiency, slender bearing reliability, and the need to remove the pumps from the storage vessel for maintenance. To overcome these disadvantages, Sulzer Pumps uses surface-mounted, external-motor pumps for LNG applications.

Superior Design

The external-motor design has significant efficiency advantages over other LNG pump options. The high-specific-speed impeller, which has been specially selected to deliver optimum head per stage, results in the highest pump efficiency available for this type of machine (Fig. 2). The use of conventional electric motors brings further efficiency advantages. These motors are typically air-cooled, explosion-proof (Exd) machines, which offer greater efficiencies than those of submerged motor designs. The result is a higher combined pump and motor efficiency than that available with any other LNG pump technology. This combination leads to significant life-cycle cost savings. Energy savings are such, that external motor pumps can pay for themselves in a relatively short time. Based on the successful API610 VS7 VCR verti-

cal multistage canned design, Sulzer Pumps specifically adapted the JVCR series for pumping at cryogenic temperatures. Pumps of this design have been installed in hundreds of locations operating with ethylene, ammonia, LPG, propylene, and LNG applications.

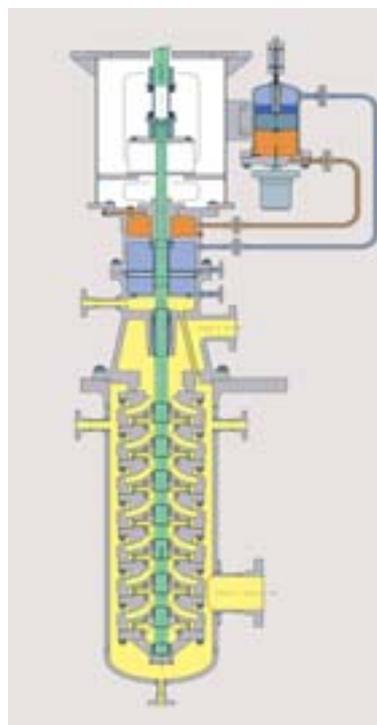
Unparalleled Reliability

The external motor design offers unparalleled reliability, because the thrust bearings in the pump and motor are conventionally oil-lubricated and the mechanical seals operate in near-perfect conditions. These critical components are not being subjected to the extreme low temperatures of the pumped LNG.

Sulzer Pumps has reference installations where the JVCR send-out pumps have been operating in excess of 400,000 hours (over 6 years) without any major component failure, including the bearings and mechanical seals.

For bearings and sealing, the Sulzer Pumps JVCR series uses reliable and proven solutions for cryogenic applications. The JVCR employs an externally mounted self-contained tilting pad thrust bearing. The bearing handles changing loads. Therefore, any fluctuations in suction conditions, process changes, or increased site ambient temperatures will have no detrimental effect on pump operation.

The Sulzer J-unit is a special cryogenic sealing system, which has



2 In surface-mounted pumps with external motor, essential parts are easily accessible for maintenance.

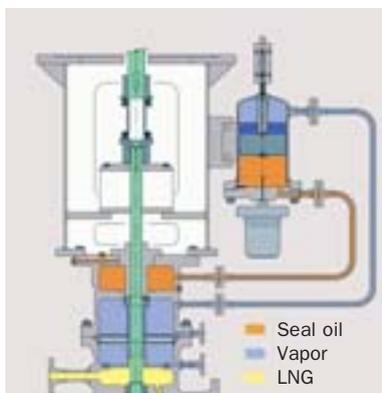
been in operation for almost 40 years in hundreds of pumps throughout the world (Fig. 3). An insulation chamber located above the pump discharge head is relieved to suction pressure. As this area is not lagged, the temperature is higher, which allows a small amount of LNG to gas off, which then pressurizes the upper chamber of the J-unit. The J-unit has a neoprene rolling diaphragm and a dead-weight piston that acts upon a light mineral oil contained within the lower chamber of the J-unit. This sealing fluid pressurizes the mechanical seal chamber—guaranteeing, regardless of suction pressure fluctuations, that the seals run in near-perfect conditions by sealing light mineral oil at a temperature at which icing cannot occur.



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1 Producing liquefied natural gas (LNG) makes it possible to use gas resources beyond the reach of conventional infrastructure. Here, a liquefying plant and a tanker. Sulzer pumps play an important role in LNG regasification.

3 The proven J-sealing-unit ensures good operating conditions for the seals with no leakage of LNG.



Proven Performance

Due to increasing environmental regulations, it is becoming impractical to carry out performance testing on cryogenic products. In order to prove pump performance, Sulzer Pumps undertakes a comprehensive range of other tests to prove the pumps' integrity. The hydraulic performance is determined with a fully staged pump at reduced speed, due to the difference in density between water



4 Liquid nitrogen cold spin test.

and LNG. The results for full-speed performance are then calculated using proven and widely accepted step-up procedures.

The mechanical performance tests are carried out on a destaged pump at full speed, again, destaging is due to product density differences. The results are then extrapolated to the performance of a fully staged pump.

The pumps' performance at low temperature is investigated through cold rotor spin tests with a fully staged pump using liquid nitrogen to chill the pump. These conditions help prove correct contraction rates and build quality at actual product temperature (Fig. 4). The alloy of the material has been specifically selected to give the excellent physical properties, including high mechanical strength and low temperature ductility. Other important properties in the material selection are thermal contraction and thermal conductivity, which assure reliable performance as well as consistency of the internal clearances and fits during all modes of operation.

Sizes Keep Increasing

For many years, LNG was used to supply peak demand surges rather than be part of the base gas supply. The move towards LNG as a fundamental part of the energy mix for many countries led to an increase in the size of receiving plants. Keeping pace with this growth, the size of send-out pumps has increased and the market has seen a move towards external motor solutions (Fig. 5).

The largest current LNG send-out pumps in the world, operating at the Botas LNG terminal in Turkey, were made by Sulzer Pumps.

These machines absorb 1200kW at their rated duty condition and have an installed motor power of 1400 kW. They have been operating trouble-free since their installation in 1994. More recently, as part of the current rush for LNG, the company received an order for 5 send-out pumps to be installed at the Zeebrugge terminal in Belgium. Zeebrugge is a major European LNG terminal. Once commissioned, these pumps will be the largest LNG send-out pumps in the world with 1450kW of hydraulic power and an installed motor power of 1600kW. Looking forward, the market is expected to continue to grow, and the current world record for power may not stand for long. ◀

5 Components and partly assembled pump. With a 2-piece shaft, the maximum manufacturing length is about 4.5m.



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