



Due to the increased demand for liquefied gas, oil companies require larger and more powerful pumps.

Photo: Edur

## Liquefied gas pumps: new requirements due to larger flow volumes

■ Rainer Pregla

Liquefied gas pumps which are used for unloading, filling tanks, transfer and discharging, have to be able to handle large pressure differences and also pump liquefied gas mixtures safely. In addition, users expect the pumps to be quiet, capable of dealing with outgassing, and have a high level of efficiency. A new liquefied gas pump has been specially tailored to meet these requirements and is already in use by an oil company in Latvia.



Harsh but friendly: In comparison with Northern Germany, the weather in the small Latvian town of Olaine, 20 kilometers to the south-west of the capital city of Riga, is cold and frosty. Even in summer, the temperature rarely rises above 22 °C. The town has a population of about 13,000 people, and the Russian oil company Lukoil has installed a terminal here to supply Latvia with liquefied gas. Through its distribution partner Flüssiggas Anlagen Salzgitter (FAS), a German manufacturer has supplied special pump units to Latvia for the transfer of liquefied gas from static tanks into special road tankers. The various international regulations presented a challenge for the planning of the project. However, these obstacles were mastered.

#### Extraction of LPG

The liquefied gas which is extracted in Olaine in Latvia is used as fuel. This has many advantages: Due to the lower emission of pollutants in the combustion of LPG (Liquefied Petroleum Gas), converted vehicles are considerably more environmentally friendly than vehicles which only use petrol or diesel fuel.

Liquefied gas is produced as a by-product in the production of petrol or diesel fuel and the extraction of natural gas. In the past, it was simply "flared off". This is still done in some refineries. If it was not such a valuable fuel, it could almost be considered to be a "waste product". Since 2007, in the context of the German Renewable Energy Act, the federal government has leveraged gas as a vehicle fuel by means of considerably lower taxation. In the case of petrol, the state charges a tax of 65.54 cents per liter for petrol and 47.07 cents per liter for diesel fuel. The tax on LPG is only 9.7 cents per liter.

Thanks to this tax relief, the fuel costs for drivers who use LPG are an average of 45 percent lower. For drivers who travel more than 20,000 kilometres per year, the conversion pays for itself after two years. Originally, the subsidy for LPG was limited to the period up to 2018. However, the coalition government in Berlin has announced that they intend to prolong this measure. Consumer associations believe that there is a good chance that subsidised LPG will still be available until 2025.

#### Objective: A more powerful pump

Due to the increased demand for liquefied gas, oil companies also require larger and more powerful pumps in this segment. Manufacturers are faced with the question: How can existing series production pumps be converted so that they can handle larger flow rates?

### Handling liquefied gas demands a high level of safety and sealing of the systems.

Only a few of the components can be proportionally scaled up from their original dimensions. After that, development work begins. The flow geometry of the impeller and the stator has to be completely recalculated. The flow geometry must be designed for the various operating modes of the pump, while at the same time providing customers with maximum efficiency.

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Fig. 1: Liquefied gas pumps achieve a flow rate of up to 340 m<sup>3</sup>/h with a pressure of up to 40 bars and a temperature range from -40 °C up to 110 °C. The viscosity can be up to 115 mm<sup>2</sup>/s.



Fig. 2: Prototype of a liquefied gas pump

Source: Edur

### New development of impeller and guide vanes

Depending on the plant, a specified amount of material must be pumped within a certain time with a defined head. Engineers use numerical fluid dynamics models to develop the optimal form of the impeller and the stator. This is a simulation method which is also known by the acronym of CFD (Computational Fluid Dynamics).

The most important factors are the angles at which the pumped medium enters into and

exits from the impeller or stator. These have a decisive effect on the geometry of the impeller blades. After this, the stator is developed using the same method. Once this has been done, the prototype is constructed. In the course of this process, the developers continuously examine whether the pump series fits in with the manufacturer's modular concept and if necessary make modifications to achieve this objective. Some components are easy to design. Others require modifications so that they can be used for other series.

Once the prototype has been completed, tests are carried out under conditions which are as realistic as possible. For this, the engineers work with partners who have suitable test facilities and measuring equipment, for example Kiel University or similar institutions. Here, the logistics are always a challenge. Even if the partner company is only two streets away, a carrier must be ordered for the transportation of the pump construction, which may weigh up to two and a half tons.

Development work and testing takes time: It took 24 months before the new version of the pump series which is used in Latvia was ready for series production. The dimensions of the pump were increased – the diameter of the pump outlet was increased from 100 to 125 millimeters.



Source: Edur

Fig. 3: Liquefied gas tanks, each with a fill capacity of 175 m<sup>3</sup> in Olaine / Latvia. Here, liquefied gas pumps are used.



### Stringent safety requirements

Propane, butane and their mixtures consist of hydrocarbons. Under normal conditions, these are gases. However, they become liquid under a relatively low pressure. In a liquid state, LPG only takes up a fraction of its volume as a gas. 260 liters of gas are reduced to one liter of liquid. This is an enormous advantage for use in vehicles. The LPG tank can be simply integrated into the vehicle – to provide ample energy in a small space. Through the use of two fuels – petrol and LPG – this results in almost double the range. In particular, the handling of LPG and other media is technically demanding and requires extremely high safety levels for the sealing of the systems. For example, the pump achieves this by the use of NPT threads (National Pipe Thread), an American screw thread standard for self-sealing pipe threads. In addition, the pressurised housing components are made from high quality materials such as EN-GJS-400-18-LT. Double mechanical seals ensure that there is no air pollution in the vicinity of the plant and provide the necessary protection against explosions.

The pumping conditions for liquefied gas are by no means simple: On the one hand, there is a constant danger that the liquefied gas will change into the gaseous state, while on the other hand, gas residues in the form of “gas pockets” are also a problem which can cause defects in the mechanical seals. Because of this, the pumps are designed so that they can also pump a certain amount of air without running dry.

The newly designed pumps use closed impellers. This is the only way to transfer the high drive powers to the pumped medium. Depending on the particular model, axial forces are compensated by a pressure compensating piston or are reduced, while radial forces are minimised by designing the pressure housing in the form of an annular housing. The NPSH value is determined by the first stage and has an influence on the installation position and the mounting of the pump in the customer’s plant. The suction impeller is specially optimised to reduce the NPSH value. All materials are ATEX-compliant. The designation ATEX is derived from the French abbreviation for “ATmosphères EXplosibles” and refers to the European Union Directive 94/9/EC (from 20.04.2016 – 2014/34/EU).

The various models of this type of pump achieve flow rates of up to 340 m<sup>3</sup>/h with pressures of up to 40 bars and a temperature range from –40 °C to +110 °C. The viscosity can be up to 115 mm<sup>2</sup>/s.

No matter whether in Latvia or Germany, drivers who use LPG fuel are not interested in such technical details. What is important to them is that the storage, filling and transfer processes are safe and efficient. They can also be sure that with every kilometer which they drive with gas fuel, they cause less damage to the environment and also save money.

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