Small and Mid-Scale LNG Pumps for an Evolving Market

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Natural gas has become more and more prominent around the globe as a key fuel source. The need for a more clean burning fuel and the abundance of natural gas has increased the need for smaller systems to deliver LNG to customers for their use. As more countries develop an infrastructure to utilize natural gas as a fuel for trucks, buses, small power stations and local buffer storage for small communities, the need for small and mid-scale equipment is increasing.

In its infancy, the LNG industry began as a means of delivering large volumes of gas from an export country with excess supplies to another location where the gas was needed. These systems required large equipment, large ships and large plant sites to liquefy and transport the LNG. Equipment was developed for this purpose and one of the key components in these systems is the cryogenic pumps used to move the liquefied gases at very low temperatures.

ADVANTAGES OF SUBMERGED MOTOR PUMPS

Due to the hazardous nature of handling natural gas, the type of pump developed for the LNG industry and now widely used for this purpose is the submerged electric motor pump (Figure 1). Since LNG is basically non-conductive, this pump type utilizes a submerged electrical motor which is installed inside a vessel or storage tank. With no oxygen present during operation, this is the safest design available. The entire pump and motor is submerged in the LNG and the liquid is also used for cooling the motor and lubricating the bearings. The alternative to this design is an external motor type pump using shaft seals between the motor and pump sections. The motor is outside in the hazardous area and while an explosion proof housing can be used to maintain a safe environment, there is still risk in having the motor in this environment with the potential for flammable gases present. The external motor type pump also uses a mechanical seal on the shaft where the shaft penetrates the vessel into the liquid and this design adds risk as there is the potential for leakage of the LNG into the atmosphere.

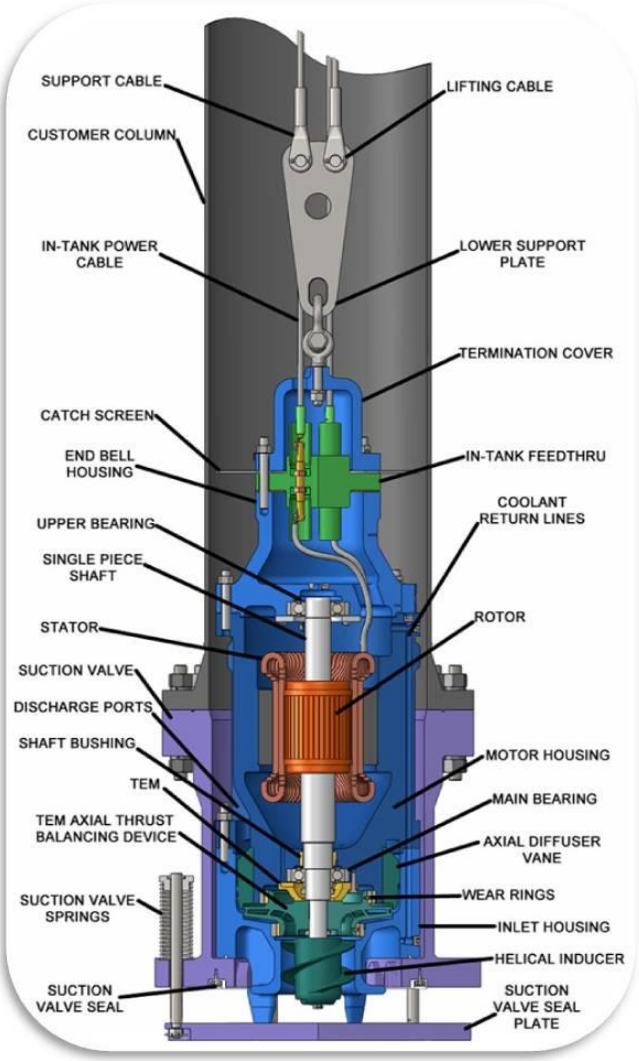

Figure 1: Typical In-Tank Retractable Type LNG Pump

Due to the safety advantages of the submerged motor pump design this pump type has become the most common type of pump used for pumping LNG as well as a variety of other liquefied gases which are non-conductive such as LPG, ethylene, ethane, propylene, LN2, etc.

THE NEED FOR MORE STANDARD SMALLER SCALE DESIGNS

The larger pumps used in many of the traditional LNG export, shipping and receiving terminal projects are typically designed to the project specifications and are manufactured when each project is built. This means that although many existing components in the manufacturer's inventory can be used, each pump is built for the project and is not a "standard" design. The delivery of these pumps is traditionally about one year from the time of order and can be very complex in their design. Many of these pumps are built in small quantities and do not lend themselves to standard manufacturing techniques. They are not built to stock and due to all of these issues, the costs are relatively high. However, the submerged electric motor

LNG pump designs have matured over more than 40 years of development and have become extremely reliable, often operating for as many as five years between overhauls.

Smaller scale LNG systems are being built with shorter delivery times and more standardized designs that require lower cost and more standardized equipment. These systems therefore require equipment that is less expensive and pre-engineered with parts that can be built to stock and assembled fairly easily and quickly.

Ebara International Corporation's Cryodynamics Division has recognized this need and has developed a line of submerged electric motor pumps which meet the increasing demand for the small to mid-scale market by adapting their experience from the larger scale pumps. This new pump model has no shaft seals like its larger cousin and uses Ebara's very reliable thrust balancing system (Thrust Equalizing Mechanism or TEM™).

EMPHASIS ON SAFETY

In the large scale LNG plants, the pumps and other equipment are monitored very closely by well-trained plant maintenance personnel. In most cases, the equipment has continuous monitoring systems which alert plant operators if any problems occur in the electrical systems or pump vibration. In smaller scale systems, which can sometimes be placed in more remote locations and may not be monitored continuously, the submerged motor design is an ideal choice as it lends itself to a very safe design with very low potential for leakage. You can imagine this type of system being similar to a gasoline station where the user is filling a vehicle with no personnel monitoring the system on a continuous basis. Although the liquid volumes are much smaller, using a pump with shaft seals and an external motor in small to mid-scale applications adds risk particularly when the equipment is not monitored in the same way as a large scale facility. This is particularly true in truck loading or other applications where a vehicle operator may be the one actually operating the system to fill a truck, bus, or other small tank.

The submerged LNG pumps developed by Ebara utilize pre-engineered and standardized designs to reduce cost and provide much shorter delivery times to customers building smaller scale systems while still providing the inherent safety and reliability of the larger scale pumps. These pumps can be assembled and shipped relatively quickly and while they can be shipped directly after assembly, if desired, they can also be performance tested in LNG in Ebara's test facility in Sparks, Nevada, in the western USA.

VARIABLE SPEED OPERATION

Another feature of the smaller scale pre-engineered pumps developed by Ebara is their ability to be connected to a variable frequency drive with no changes in the pump design or construction. In many smaller scale systems, wide ranges of pressure and flow are required due to variations in tank levels and temperatures particularly in applications such as truck trailers and truck and bus fuel tanks. When the tanks are close to empty, the temperature can be significantly warmer and a higher pressure is required during initial filling to collapse the pressure. Therefore, the pump needs to operate at a higher speed at first and after the temperature begins to drop in the tank, the pump speed can be reduced to continue filling the tank.

By introducing variable speed, fewer pump designs can be used to cover a wide range of flows and pressures using a relatively low number of common components which also helps reduce costs and parts inventory.

SMALLER SCALE PUMP APPLICATIONS AND TYPES

The LNG markets considered for this newly developed pump are as follows:

- Truck trailer loading
- Filling of truck and larger vehicle fuel tanks
- Peak-shaving
- Local municipal storage
- Small scale LNG ship or barge loading
- Small or mid-scale power plants

For many small scale systems, LNG storage tanks are built in the 5,000 to 20,000 m^3 size range. For this application, a removable type pump can be supplied in the same fashion as larger LNG storage tanks (Figure 2). This pump is installed in a pump column or tube with a suction valve mounted at the bottom. When the pump is lowered into the column, the bottom of the pump pushes the valve plate open allowing LNG to enter the pump inlet. The pump can then pump the liquid up to the top of the tank and into the discharge piping to its destination.

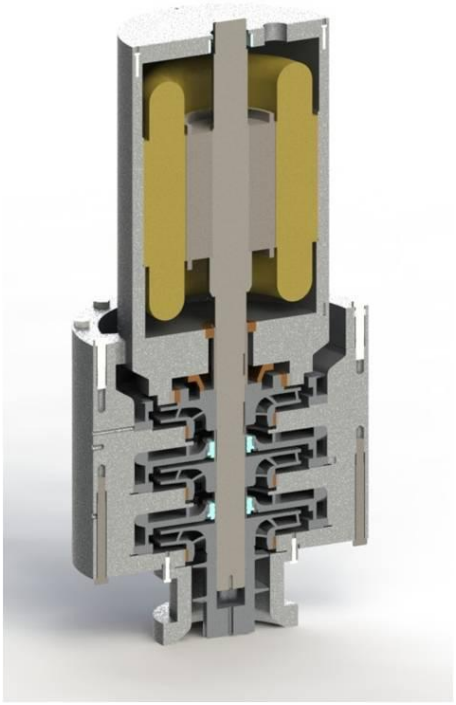

Figure 2: Small Scale In-Tank LNG Pump

If a pump is required for a pipeline type system the pump can be installed in its own stand-alone suction vessel which can be insulated using traditional insulation methods or can be supplied as a vacuum jacketed design. This type can be mounted anywhere in the piping system for LNG transfer.

In addition to the traditional land-based type pump systems, a variety of marine applications are also very suitable for the smaller scale pump designs. Ebara was the first manufacturer to introduce a design for the fuel gas pumping systems used on the Dual Fuel Diesel Electric (DFDE) LNG carriers being built today (Figure 3). This fuel gas pump can be easily adapted to any marine application where lower flows are required for off-loading LNG cargoes from barges or other smaller LNG marine vessels.

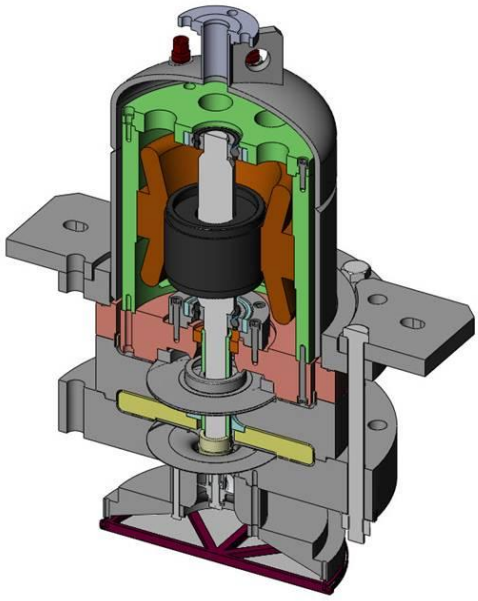

Figure 3: Small Scale Marine Pump

CONCLUSION

In conclusion, the newly developed submerged electric motor LNG pumps by Ebara International Corporation have been designed to provide safety, faster delivery and lower cost for the many customers building smaller scale systems. By providing the proven Thrust Equalizing Mechanism (TEM™) even in these lower cost pumps, customers can enjoy a significant level of reliability in addition to the inherent safety features of the submerged motor design with no rotating seals.