



Submerged Motor Pumps for Ammonia Applications

■ WHO WE ARE

Elliott Group, Cryodynamic Products is the premier manufacturer of cryogenic pumps and expanders for the worldwide liquefied gas industry. With over 40 years of continuous engineering advancement, and the largest cryogenic test stand in the world, Cryodynamic Products is the only manufacturer of its kind with the knowledge and expertise to provide the most complete catalog of both standard and custom cryogenic pump equipment in the world.

■ SAFETY IS BUILT INTO OUR DESIGNS

Cryodynamics® submerged motor cryogenic pumps incorporate the safest design for centrifugal rotating equipment in the industry. The motor is designed to be submerged in an oxygen-free cryogenic liquid, removing the potential for gas ignition. Therefore, the number of electrical components installed within the hazardous area is minimized.

Additionally, there is no need for rotating seals, eliminating a source for leaks, and allowing the design to safely accommodate caustic chemicals such as ammonia. Moreover, rotating components are contained within casings submerged within a secondary tank or vessel, further protecting personnel from potential hazards.



Ammonia pump.

■ AMMONIA APPLICATIONS

Liquid ammonia (LNH_3) is widely used in a variety of chemical and petrochemical processes including in the fertilizer and fermentation industries, as an antimicrobial agent for food products, for refrigeration and remediation of gaseous emissions, and as a fuel. It is a cryogenic fluid, normally stored in bulk at an atmospheric pressure of -33°C .

Transporting liquid ammonia presents unique challenges for rotating equipment to operate safely and reliably in the harsh environment. Ammonia is different from other cryogenic liquids as it is an extreme asphyxiate, and thus very hazardous to personnel working around it. It is also highly corrosive to copper and copper alloys and other materials, thereby requiring different material selections from traditional centrifugal pump design. It is difficult to seal, flammable, and has a huge affinity for water, leading to a high potential for conductivity.

■ THE CRYODYNAMICS SOLUTION

Cryodynamic Products tackles these challenges by offering a unique design solution for transporting hazardous liquefied ammonia — a design that allows for an isolated submerged induction motor with a magnetic coupler to increase safety, reliability, and performance, and provide a compact footprint.



High-pressure iron tank for ammonia storage.



Chemical plant for production of ammonia and nitrogen fertilizers.



Liquid ammonia storage used in food production.



Modern work plant to treat and pack ammonia.

■ HYBRID SUBMERGED MOTOR PUMP

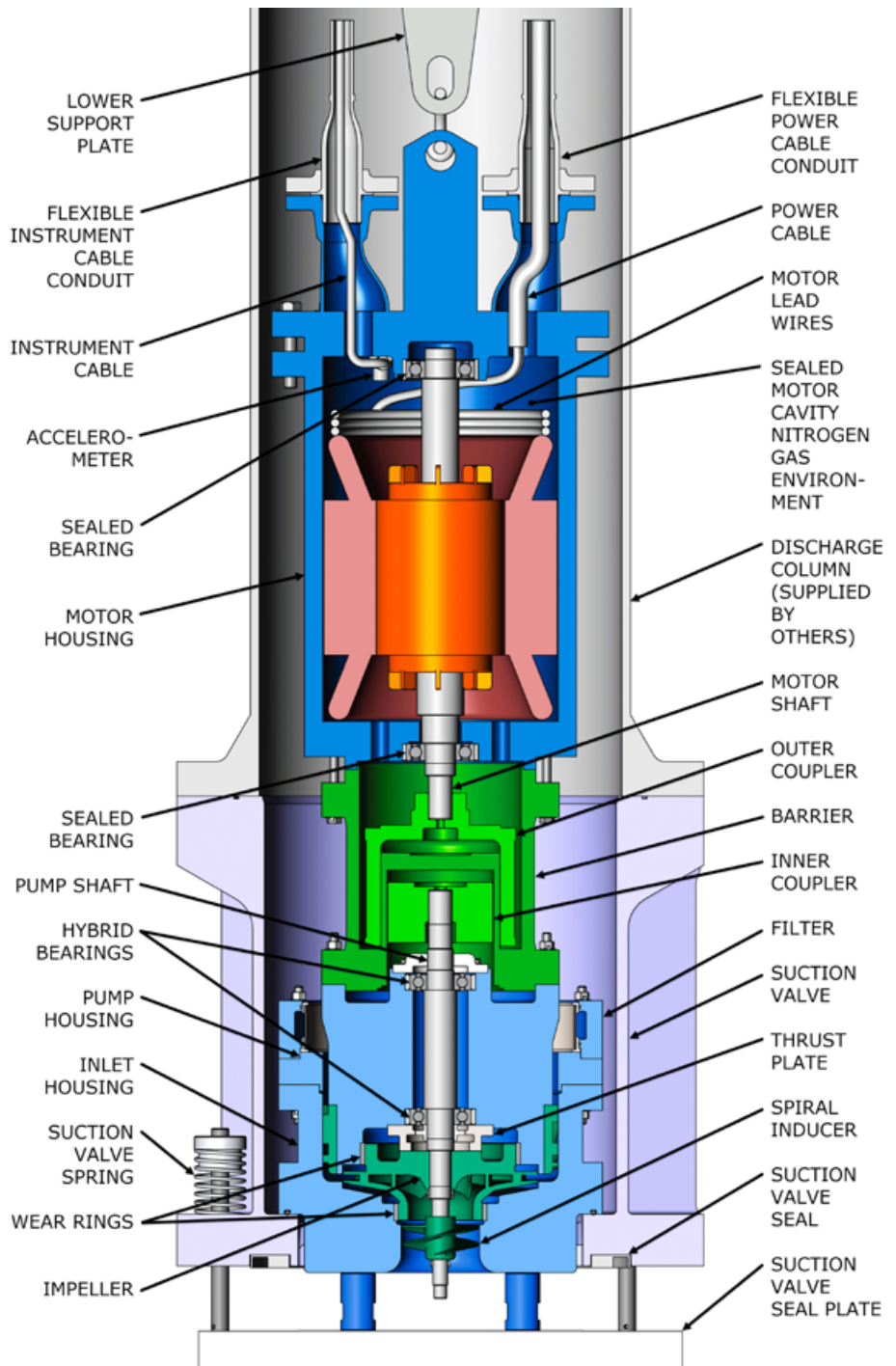
The Cryodynamics hybrid submerged motor pump combines a submerged induction motor design with a magnetic coupler to transfer torque between the motor (dry) side to the hydraulic (wet) side of the pump with no mechanical seal necessary. The benefit of this design is there is no safety risk of a leaking seal and the motor is safely operated in a non-hazardous area completely sealed from the pumped ammonia. Also, there are no alignment issues since there is no direct mechanical connection between the motor shaft and the pump shaft.

Motor Side

The pump motor is encased in a stainless steel sealed housing (per ASME Pressure Vessel Standards for Lethal Service Applications) that has nitrogen gas flowing into it from the top of the tank or suction vessel to keep the motor dry and inert, thereby providing a safe environment. The enclosed motor is cooled by the pumped liquid surrounding the motor housing and by fan blades fitted to the motor rotor. The motor rotor is supported by two deep groove bearings lubricated with low temperature grease.

Pump Side

On the hydraulic or pump side (wet side), the magnetic coupling, located between the motor and wet end upper shaft, transfers motor torque to the pump shaft. The hydraulic side is submerged in the pumping liquid. The motor side half of the magnetic coupling is housed inside the sealed motor housing adjacent to the stainless steel membrane. This allows the wet end to be driven while keeping the fluid out of the motor. The wear components, such as the bronze bushings and wear rings, are carbon or other material to prevent corrosion from the caustic liquid.

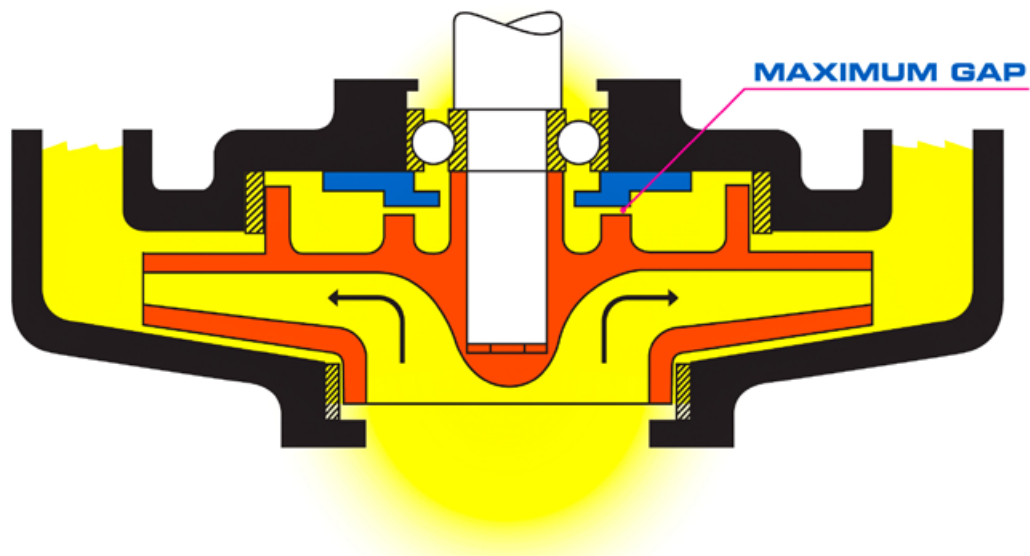


Magnetic Coupler

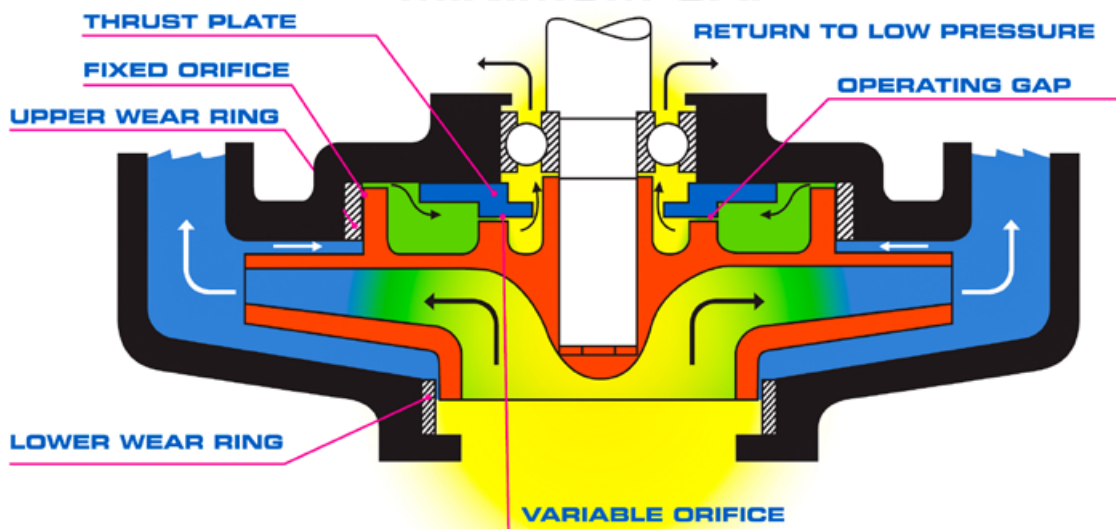
To increase reliability, the pump side features the Cryodynamics Thrust Equalizing Mechanism (TEM[®]) system to balance the hydraulic forces generated by the pump impellers. The TEM is a self-adjusting hydraulic balancing system that uses a small amount of pumped fluid routed to the balance chamber behind the TEM impeller to equalize the forces generated by the impeller stack. The pump (wet) main bearing thus operates with a net zero thrust load, resulting in a long bearing life.

Because the pump uses a magnetic coupler, it is not limited to any specific duty as Cryodynamic Products can use our existing expansive hydraulic database to meet different process requirements for ammonia fluid transportation. This helps ensure established pump designs with TEM capability can be adapted with proven efficiency and hydraulic performance.

TEM IN NON-OPERATING CONDITION MAXIMUM GAP



TEM IN OPERATING CONDITION MINIMUM GAP



■ INSTALLATION CONFIGURATIONS

The magnetic coupler allows for a compact equipment design that can be installed in both vessel mounted (ACC model) and retractable (ACR model) installations. The ACR design allows rotating equipment to be installed into large, top-entry storage tanks. When combined with a Cryodynamics sealing suction (foot) valve, the pump can be removed or installed into a live storage tank while the column is in an inert and isolated condition, providing increased safety for maintenance personnel. An external motor design would not be practical in a top entry storage tank as it would require a shaft of 30 to 40 m in length, depending on tank height.

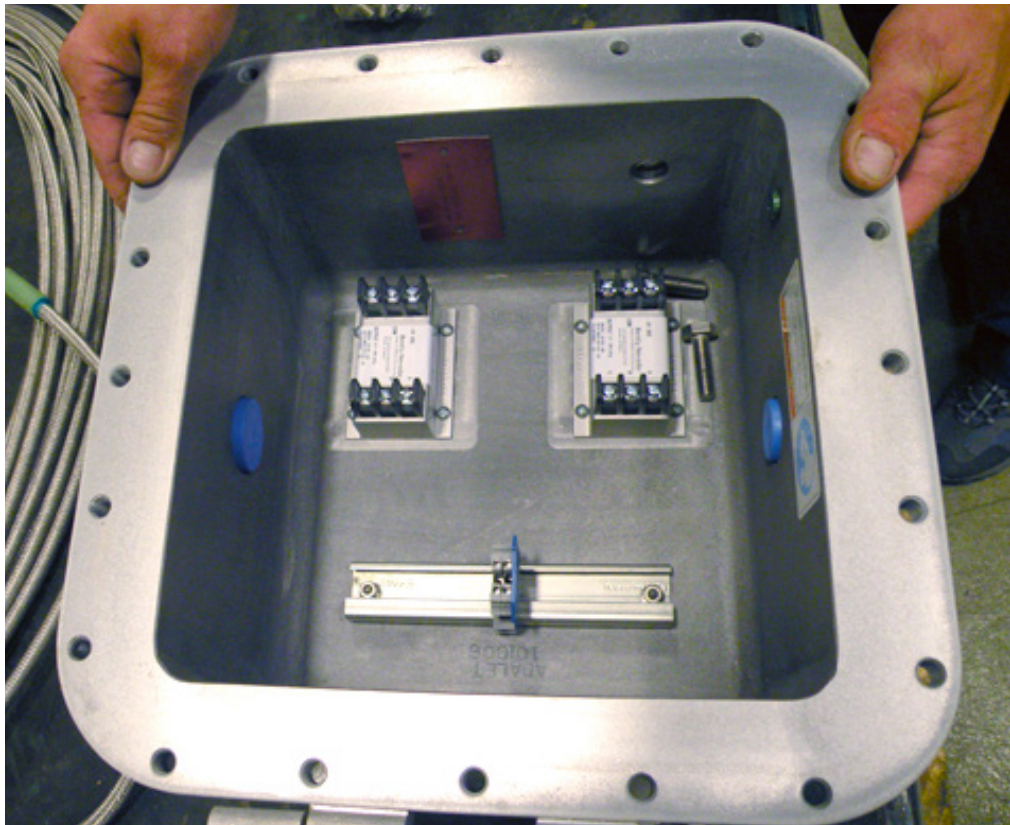
In a retractable (ACR) installation, the power cable and instrumentation cables are enclosed in flexible stainless steel conduits that have custom ANSI flanges, allowing for a gasket and secondary O-ring seals. The conduits span the entire length of the column from the motor cavity to the headplate, and are the lifeline that connects the motor cavity to the outside of the tank, providing the path for flow of the nitrogen purge gas. The headplate is equipped with nozzles that allow for monitoring of the flow and pressure of nitrogen gas inside the motor cavity, or a gas detection system may be installed to monitor for the presence of oxygen or ammonia.

The external tank portion of the electrical system can be designed for NEC, ATEX, and IECEx hazardous area locations, depending on geographical location and rating desired by the end user. The designs feature a flexible multi-conductor power cable that can be connected to a cast flameproof (Exd) or stainless steel increased safety (Exe) junction box enclosure with certified cable glands. A flexible power cable provides many options for mounting the enclosure in the best position to optimize space in the plant environment. Finally, the system features an IP66 rating for protection against the elements.

■ VIBRATION MONITORING SYSTEMS (VMS)

Depending on the project, Cryodynamic Products can design a VMS with either a PCB 4-20mA transmitter arrangement or a Bently Nevada 3500 compatible interface module. These packages can meet all of your system or control room needs including:

- ◆ Accelerometers
- ◆ Cabling
- ◆ Feedthru(s)
- ◆ Junction box
- ◆ Instrument rack
- ◆ Power supply
- ◆ Monitors
- ◆ Cabinet



■ COMPARISON OF TYPICAL PUMP VS CRYODYNAMICS PUMP

	Typical External Motor VS6 Style Pump	Cryodynamics Submerged Motor Pump
Motor Cooling System	Typically, a cooling system is needed for the motor.	Continuously cooled motor casing nitrogen. No auxiliary system needed.
Bearing Cooling System	Typically, a cooling system is needed for the bearings.	Continuously cooled motor casing nitrogen. No auxiliary system needed.
Bearing Lubrication System	Auxiliary bearing lubrication system needed.	Pump side lubricated by pumping liquid. Motor side lubricated packed bearing. No auxiliary system needed.
Motor Hazardous Area Requirements	Ex-rated enclosure to protect the motor from hazardous area environment.	Since motor is not exposed to atmosphere or hazardous area, enclosure ratings are not required.
Motor/Pump Coupling Device	Coupling device and baseplates may be needed in some cases.	Magnetic coupling cooled by pumping liquid. No auxiliary system needed.
Shaft Sealing Device	Mechanical seals typically used.	None.
Shaft Thrust Load/Thrust Bearing	Thrust bearings required on pump shaft to coupling unit.	Pump shaft continuously balanced by Thrust Equalizing Mechanism®.
Motor Temperature Monitoring	Winding temperature detectors are used and monitor continuously with alarms and shutdown logic.	Motor is continuously cooled by nitrogen; winding temperature detectors are not used.
Pressure Systems for Lubricating and Cooling Systems	Auxiliary pressure systems may be needed to maintain lubricating or cooling systems.	None.
Gas Leakage	Potential leakage from mechanical seal if not monitored.	No mechanical seals; electrical system sealed and purged with N2.
Electrical System	ATEX, NEC, IECEx compliant.	ATEX, NEC, IECEx compliant.
Vibration Systems	Vibration system for bearings and shaft available.	Pump mounted vibration sensors near bearing locations.
Auxiliary Instrumentation	Condition monitoring systems for all instrumentation and sensors.	No additional systems.
Start-up from Standby	Ready at cold standby.	Ready at cold standby.



Elliott Group is a global leader in the design, manufacture, and service of technically advanced centrifugal compressors, steam turbines, power recovery expanders, cryogenic pumps and expanders, and axial compressors used in the petrochemical, refining, oil & gas, liquefied gas, and process industries, as well as in power applications.

Elliott Group is a wholly owned subsidiary of Ebara Corporation, a major industrial conglomerate headquartered in Tokyo, Japan.



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T H E W O R L D T U R N S T O E L L I O T T



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