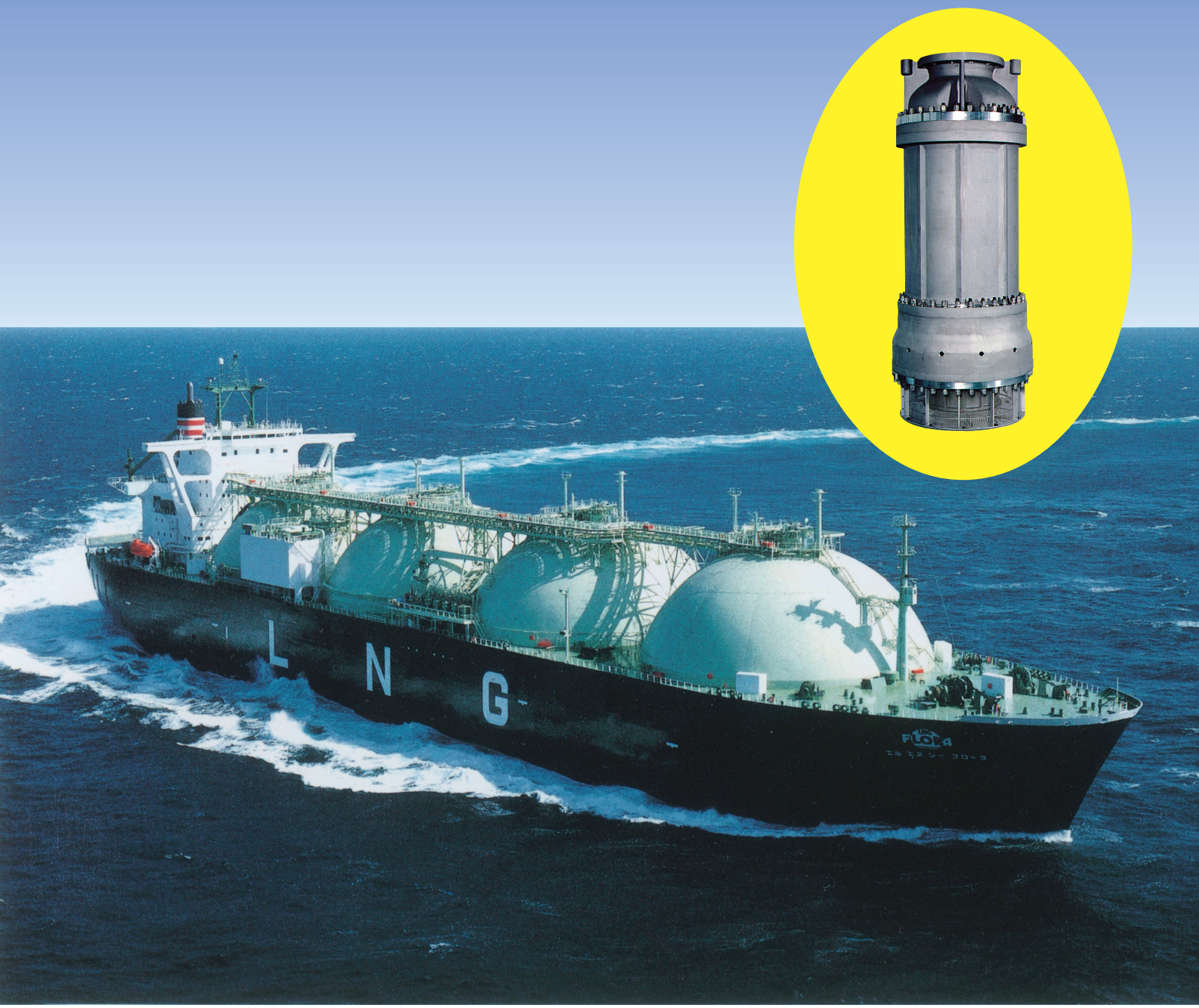
C-127H

SHINKO SM

SUBMERGED LIQUEFIED GAS PUMPS



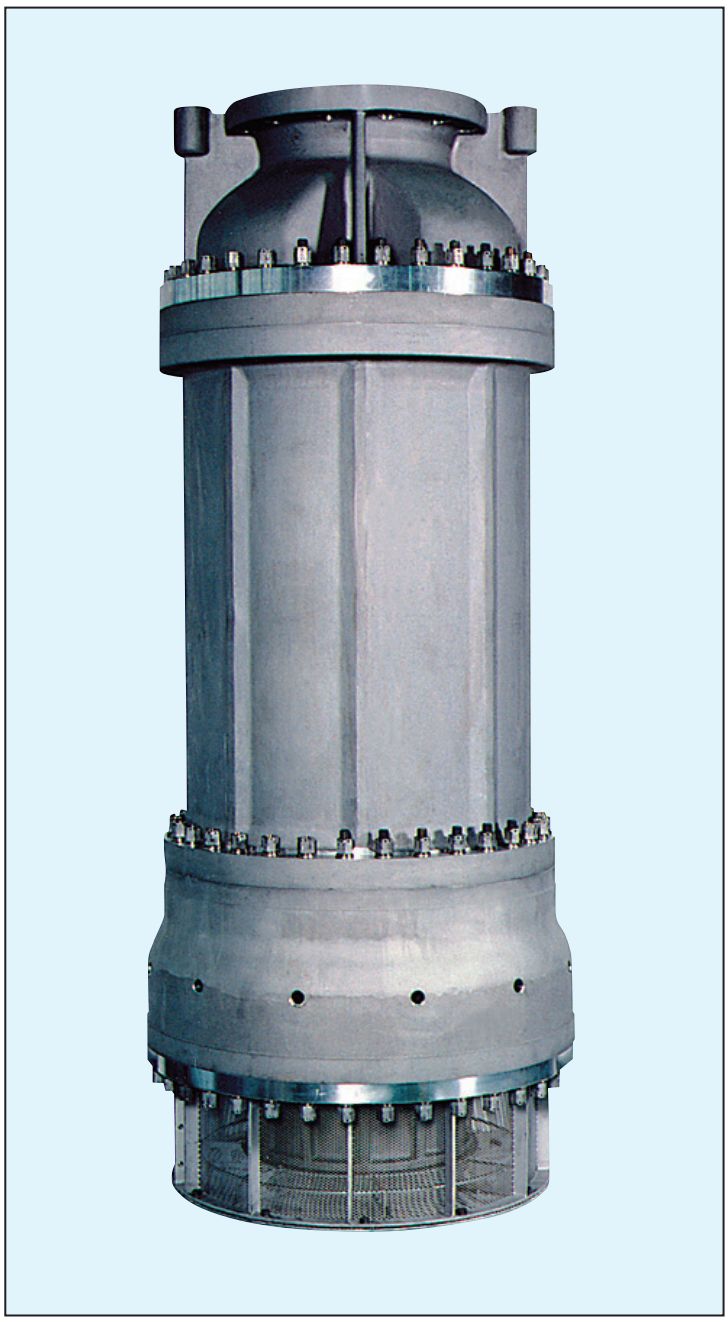
SHINKO IND. LTD.
Hiroshima Japan

SM SUBMERGED LIQUEFIED GAS PUMPS

Shinko-Nishishiba "SM" submerged liquefied gas pumps have been developed as cargo pumps for LNG, LPG, DME carriers based upon our rich experience in designing, manufacturing, and operating a large number of discharge pumps, pressurizing pumps, and circulating pumps used at LNG terminals or in LNG cryogenic power generating plants.

In order to operate submerged properly in cryogenic liquefied gas under harsh conditions, the pumps have been designed with the following various features:

- The pump and motor are constructed as to form a single unit and be submerged in the pumping liquid. Thus, there is no fear of liquid and gas leakage because no sealing devices are required.
- The motor is operated in liquid, and is completely isolated from the atmosphere. Hence, there is no fear of an explosion.
- Ball bearings are lubricated via the pumped liquid, which is also used for cooling the motor.
- An auto balance mechanism is located on the back of the impeller to balance the axial thrust in all operating ranges.
- An inducer with high suction performance is equipped underneath the impeller. So, full capacity operation is possible while unloading, leaving as little residual liquid as possible.
- The stator coil is constructed with a form wound type having a high insulation property and rigidity. Materials with a high insulation property, durability and cryogenic resistance property are used for the motor insulation and varnish.



GENERAL CHARACTERISTICS

The vertical SM models are submerged liquefied gas pumps having 1～2 stages, and the following standard 11 models are available:

	Item \ Model	SM 50	SM 50-2	SM 65	SM 65-2	SM 100	SM 150	SM 200	SM 250	SM 300	SM 300H	SM 350
Pump	Max. capacity (m^3/h)	30		60		135	300	600	1000	1500		2100
	Total head (m)	90～165	145～195	90～165	145～195	90～170				90～160	145～195	90～190
	Liquid temperature (℃)	40～—196										
	Discharge bore (mm)	50		65		100	150	200	250	300		350
Motor	Max. output (kW)	22		45	30	75	132	250	400	630	560	630
	Synchronous speed (min^{-1})	3600						1800				
	Voltage (V)	440									3300, 6600	
	Frequency (Hz)	60										
	Coil	Form wound type										
	Insulation	Class F										
	Rating	Continuous										
	Starting method	Full voltage start or soft start										

PERFORMANCE CHART

Pump model and approximate motor output can be determined from the following charts based upon the handling liquid, total head, and capacity:

DME

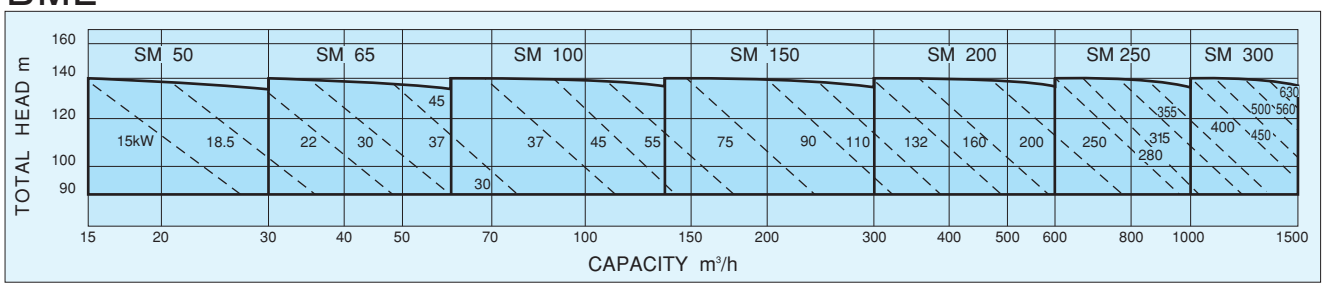


Figure in the chart shows output of motor (Specific gravity:0.73)

LPG

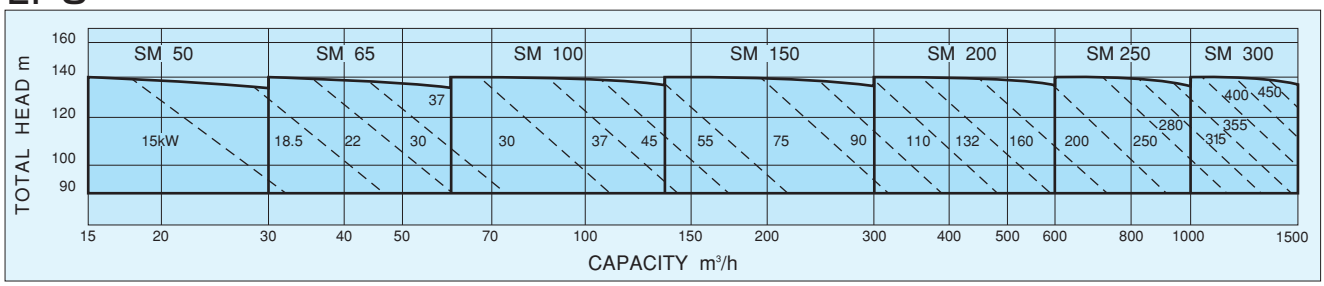


Figure in the chart shows output of motor (Specific gravity:0.61)

LNG

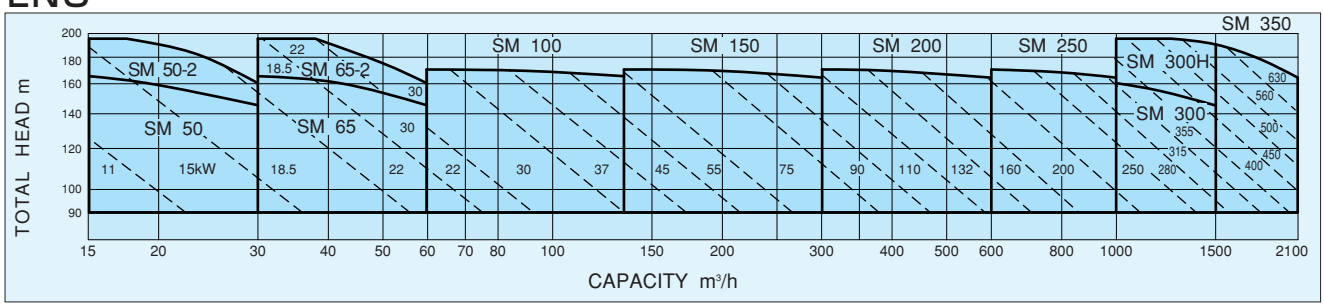


Figure in the chart shows output of motor (Specific gravity:0.5)

DESIGN & MATERIALS

The pump casing and outer frame of motor are combined with a flange joint as one unit. The impeller and inducer are secured to the lower shaft end, and the rotor core of the motor is shrink-fitted in the middle of shaft. The entire rotor is supported by 2 sets of ball bearings located at the upper and lower ends of the motor.

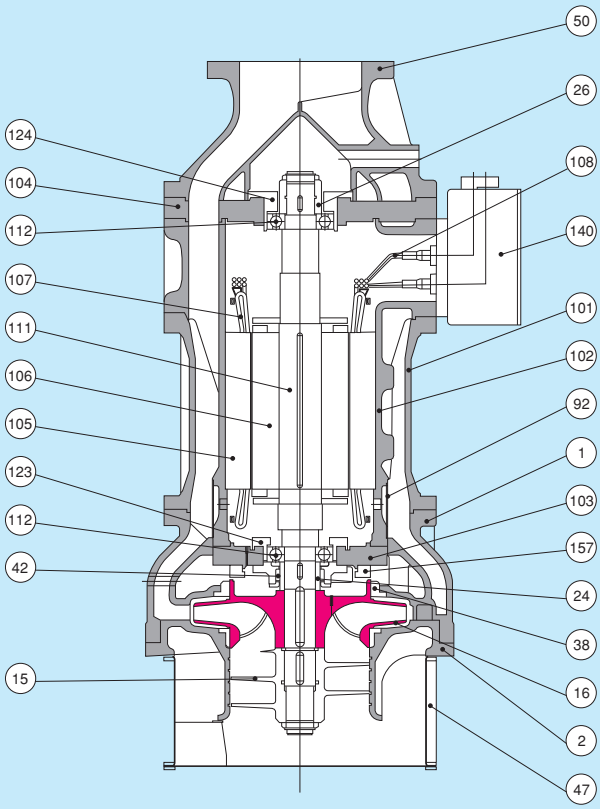
The pump casing is of multi-volute construction in order to prevent excessive vibration due to rotating stall when approaching minimum flow range.

The pump can shift from maximum flow to minimum flow smoothly following a stable head/capacity curve, even when shutting down, to ensure stable operation without noise and vibration.

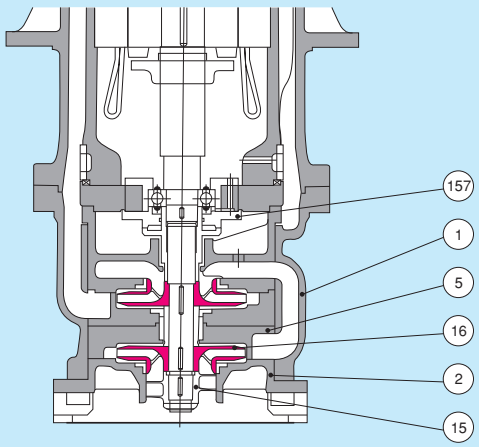
The materials used have been chosen, giving extra consideration to low temperature brittleness.

PART NO.	NAME OF PART	MATERIAL		REQ.NO.	
		NAME	JIS	STAGE 1	STAGE 2
1	PUMP CASING	AL ALLOY CASTING	AC4C-T6	1	
2	SUCTION COVER	〃	〃	1	
5	VOLUTE	〃	〃	—	2
15	INDUCER	〃	〃	1	
16	IMPELLER	〃	〃	1	2
24	SLEEVE	STAINLESS STEEL	SUS304	1	
26	SLEEVE	LEAD BRONZE	CAC604	1	
38	MOUTH RING	〃	〃	2	
42	BUSH	CARBON	—	1	
47	SUCTION STRAINER	STAINLESS STEEL	SUS304	1	
50	DISCHARGE COVER	AL ALLOY CASTING	AC4C-T6	1	
92	SELF CLEANING FILTER	STAINLESS STEEL	SUS304	1	
101	OUTER FRAME	AL ALLOY CASTING	AC4C-T6	1	
102	INNER FRAME	〃	〃	1	
103	FRAME COVER	AL ALLOY	A6061FH-T6	1	
104	FRAME COVER	〃	〃	1	
105	STATOR CORE	SILICON STEEL	—	1	
106	ROTOR CORE	〃	—	1	
107	STATOR COIL	COPPER	—	1	
108	LEAD WIRE	TEFLON, COPPER	—	3	
111	SHAFT	STAINLESS STEEL or 9% Ni STEEL	SUS304 —	1	
112	BALL BEARING	STAINLESS STEEL	SUS440C	2	
123	BEARING CASE	〃	SUS630	1	
124	BEARING CASE	〃	〃	1	
140	TERMINAL BOX	AL ALLOY CASTING	AC4C-T6	1	
157	BALANCE SEAT	LEAD BRONZE	CAC604	1	

Single-stage pump

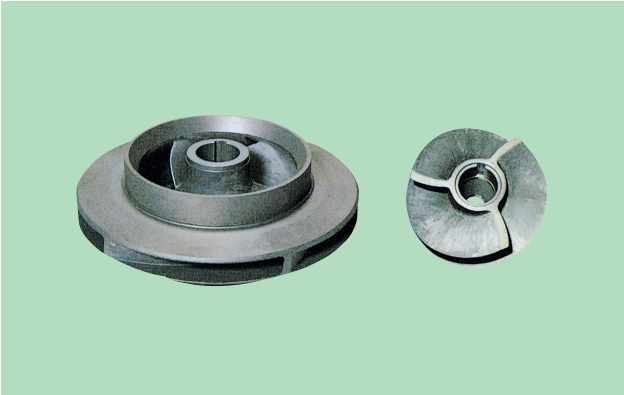


Two-stage pump



●Impeller & Inducer

The impeller is the single suction type having three dimensional vanes, and is designed to stabilize its characteristic curve. The inlet of the impeller is provided with an inducer with spiral blades in order to minimize the NPSH value of the pump, leaving as little residual liquid as possible in the tank.



●Ball Bearings

In order to support the rotating element, each set of single row deep-groove ball bearings (customized for submerged pumps handling extremely-low temperatures) is positioned at the upper and lower side of the motor. The inner and outer races of the bearing and the balls are made of stainless steel, while the cage is made of Teflon which has a self-lubrication ability.

●Shaft

The common shaft of the pump and motor is durable with a diameter wide enough to prevent distortion of the shaft in the course of machining, overhauling, and assembling.

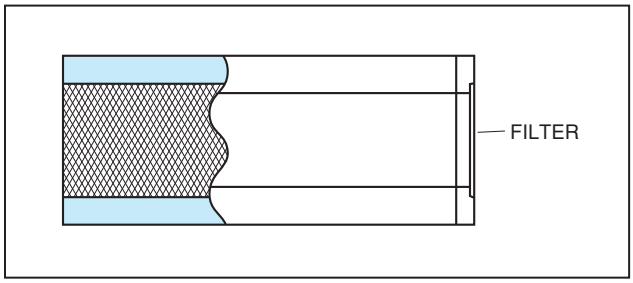
●Suction Strainer

To prevent the inducer and the impeller from being damaged by foreign matter sucked inside the pump, a suction strainer with a durable punching plate is positioned on the underside of the pump casing.

●Filter

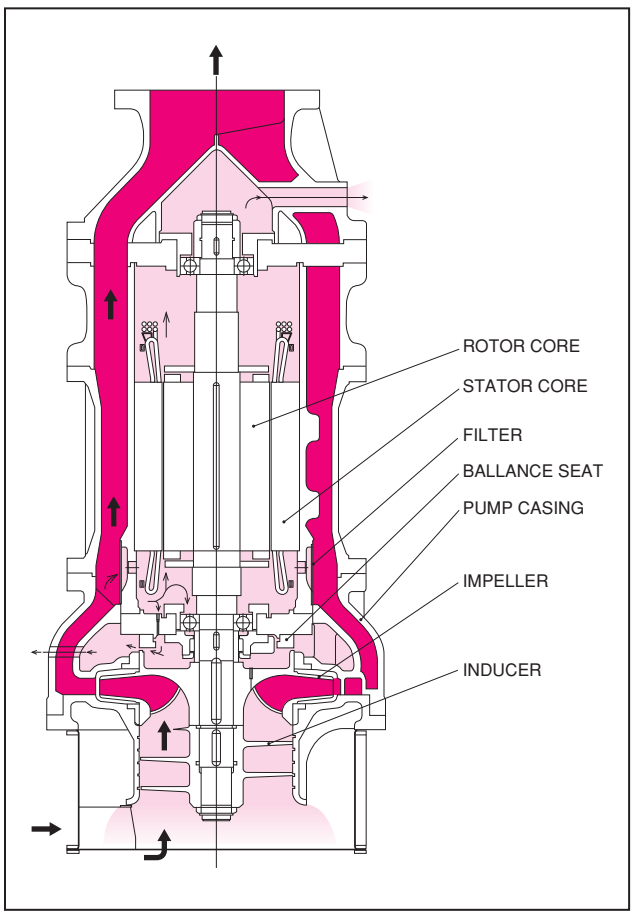
In order to extract the liquid for lubrication of ball bearings and cooling the motor, a self-cleaning filter has been installed at the bottom of the motor's inner frame.

As the discharge liquid streams are parallel to the filter, the foreign matter on the net is pushed away with the streaming discharge liquid, so that clogging can be automatically prevented.



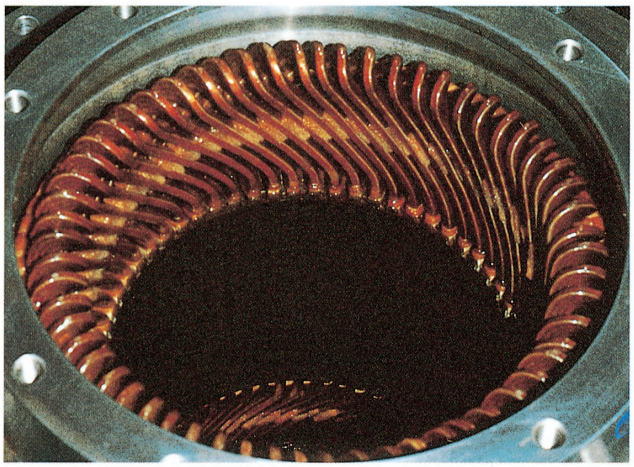
●Bearing Lubrication & Motor Cooling

A forced self-lubrication system is utilized and a small amount of discharge flow is led inside the motor to lubricate the ball bearings and cool the motor.



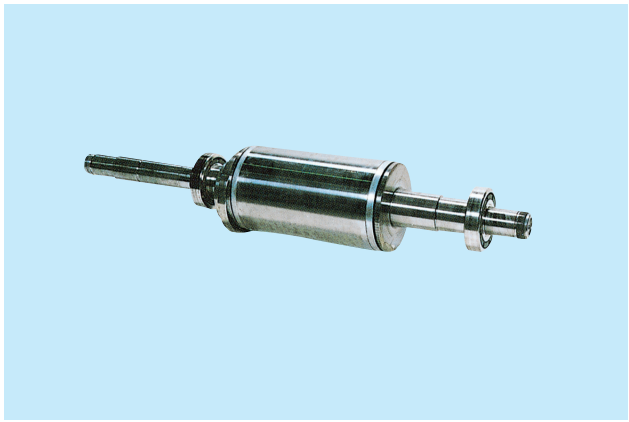
●Stator Coil

Consideration has been given to insulation, due to the fact that the coil is used in cryogenic liquid. For the stator, form-wound coil wires have been given a mechanically-and-electrically integrated design using special insulation materials.



●Rotor

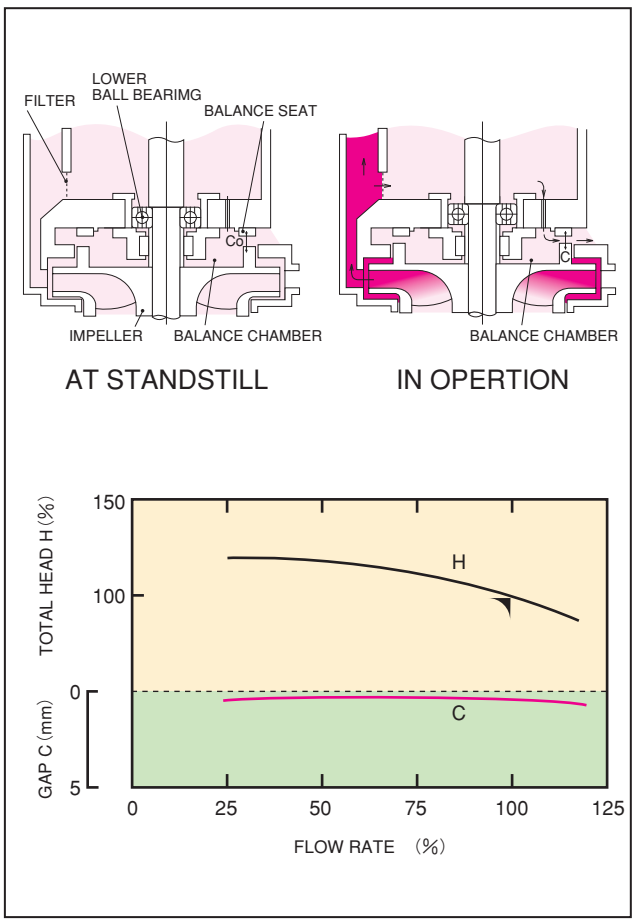
In order to minimize the vibration and to keep the bearings in good condition, the rotor is dynamically balanced with an impeller, inducer, and other rotating elements.



●Auto Balancing Mechanism

An auto balance mechanism is located on the back of the impeller to increase the life of the bearings. The axial thrust is always balanced in all operating ranges thanks to the clean pumped liquid through the filter.

1. When idle, the lower bearing supports the weight of the rotating element. And, when the pump is started up, the bearing floats up along with the upward thrust and the gap between the balance seat and impeller is reduced from C_0 to C.
2. The pressure inside the balance chamber is increased, and is adjusted to equalize the upward thrust.
3. The balance gap C varies with the level of the upward thrust, creating zero thrust onto the ball bearing.
   The chart on the right shows an example of variation in gap C in relation to the flow rate.



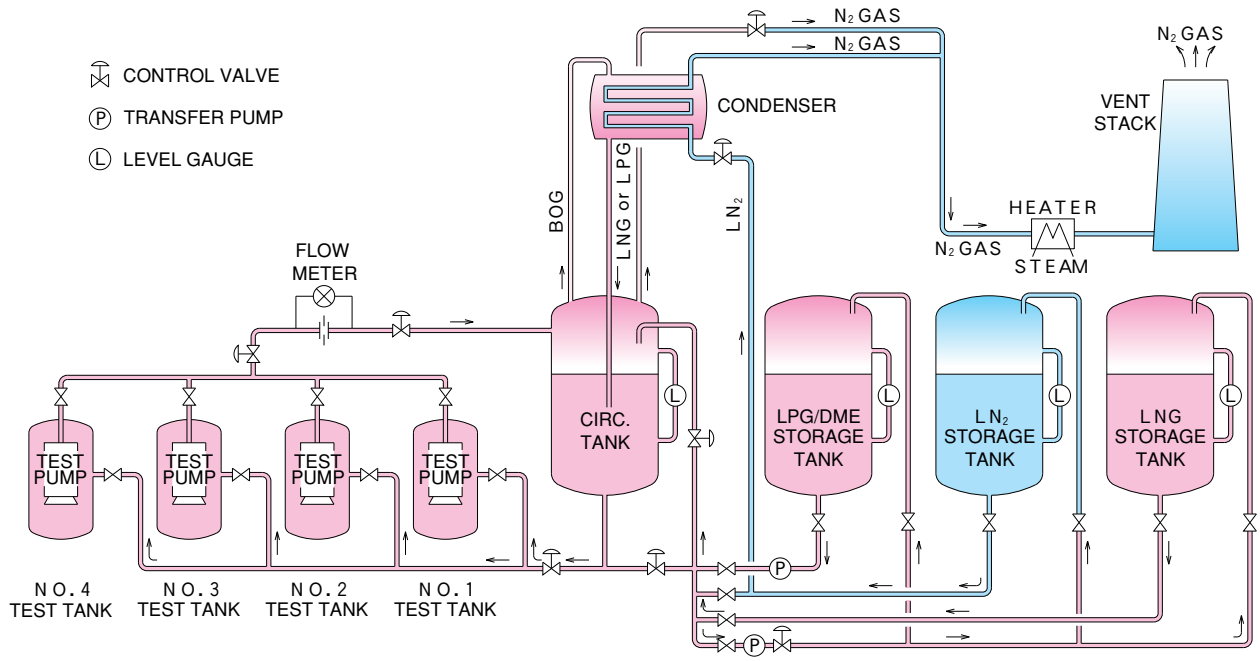
PEROFRMANCE TESTS

●Testing Facility

Max.capacity of test pump	: 2500㎥/h
Test liquid	: LNG, LPG, DME
Lowest liquid temperature	: −196℃
Design pressure	: 0.98MPa
Volume of LNG storage tank	: 50㎥
Volume of LN_2 storage tank	: 50㎥
Volume of LPG storage tank	: 26㎥
Volume of circulation tank	: 23.5㎥

●Testing Methods

A shop test is carried out using LPG for LPG/DME pumps and LNG for LNG pumps to measure the performance, and the NPSH level, and many other points. In the case that several pumps with the same specifications are supplied to a plant/ship, a full performance test is performed on only one pump, and an one point performance test at the rated flow for the remaining pumps.



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