FRAMO OIL AND GAS PUMPING SYSTEMS

Technical description

Reliable technology for continuous operation

Framo cable-free electric submersible pumps

The Framo advantage

At Framo, we're driven by the simple idea that pumps should never be isolated from the task they perform. It's a belief that revolutionized marine cargo handling. And today it's creating new possibilities for faster, safer and more profitable business in the oil and gas industry.

It's also an idea backed up by experience. Framo has proud roots that stretch back to 1938, and marine customers have put their trust in our unique pumping technology for over 50 years.

But even more important is the trust that customers place in us. That's why we see our designs through from start to finish at our own facilities in Norway, where we test each project in full scale before delivery.

Framo customers know they receive full support throughout the service life of their equipment. No matter the problem, our experts can be dispatched 24/7 to any location worldwide, and they stay until the issue is resolved.

With a global organization of 1200 dedicated employees, we are a partner you can rely on.

Think outside the pump room

Pumps are the heart of oil and gas processes. But traditional solutions with a central pump room mean wasted space, added risk and higher operational costs.

Framo pumps are different. Submerged in simple side-mounted caissons, they eliminate both hull penetrations and the need for a massive internal pump room and extensive piping.

Powered with the unique electric Framo cable-free concept, submersible pumps also ensure increased uptime. This is thanks to a short, stiff rotating shaft that avoids excessive wear and tear.

The total result is an oil and gas pumping solution that reduces risk while saving both space and money. That's what it means to think outside the pump room.

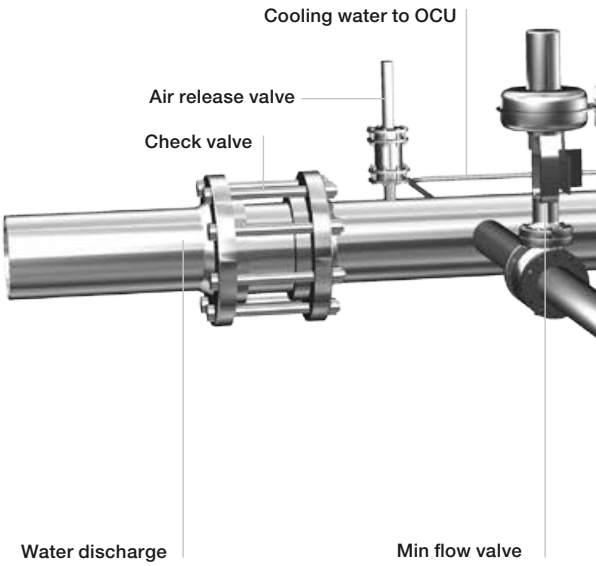
List of contents

Cable-free electric submersible pump

The Framo electric submersible pump comprises four main parts:

Pump/motor unit with end suction

- Pipe stacks with integral electric power transmission system (riser pipes)
- Top plate arrangement with el. junction box
- Oil circulation unit



The Framo electric submersible pump is an electrically driven close-coupled end suction centrifugal pump with one or two stages. The suction inlet of the pump is the lowest point of the pump assembly.

The power transmission system integrated in the pipe stack is a unique feature for the Framo Electric Submersible Pumps. In lieu of a conventional solution with a cable running down the outside of the riser pipe to the motor, the electric conductors are located inside a protective pipe and provide power supply to the motor.

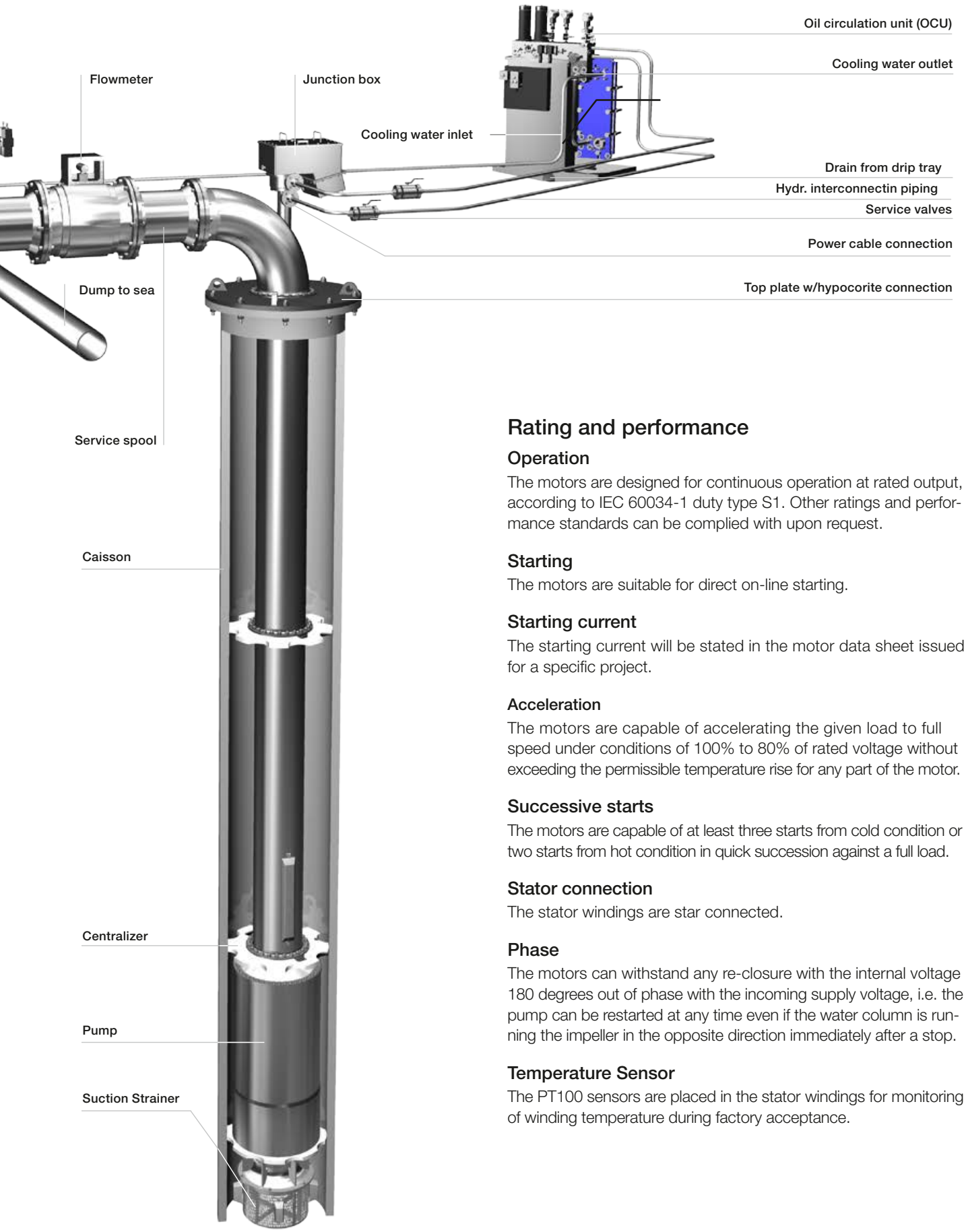
The conductors are mounted inside a protective pipe (oil pipe) by means of insulation pieces. The electric conductors are hollow copper pipes that allow the conductors also to be the return line of the circulation oil. The oil pipe assembly is mounted concentric in the water pipe forming a complete section of the pipe stack.

The riser pipe sections are flanged together to make up the required length of the pump. When the pipe stacks are connected, the electric transmission system is connected automatically, i.e. there is no additional handling of cables or separate conductors.

The electric connections are made with male/female sliding band connectors, fitted to each end of the conductor pipes.

A forced oil circulation system is applied for cooling, insulation, lubrication and overpressure protection.

Oil is circulated by use of a circulation skid located close to the pump. Overpressure is maintained statically during stand-by and gives seal leakage control by monitoring oil level in the tank.



Rating and performance

Operation

The motors are designed for continuous operation at rated output, according to IEC 60034-1 duty type S1. Other ratings and performance standards can be complied with upon request.

Starting

The motors are suitable for direct on-line starting.

Starting current

The starting current will be stated in the motor data sheet issued for a specific project.

Acceleration

The motors are capable of accelerating the given load to full speed under conditions of 100% to 80% of rated voltage without exceeding the permissible temperature rise for any part of the motor.

Successive starts

The motors are capable of at least three starts from cold condition or two starts from hot condition in quick succession against a full load.

Stator connection

The stator windings are star connected.

Phase

The motors can withstand any re-closure with the internal voltage 180 degrees out of phase with the incoming supply voltage, i.e. the pump can be restarted at any time even if the water column is running the impeller in the opposite direction immediately after a stop.

Temperature Sensor

The PT100 sensors are placed in the stator windings for monitoring of winding temperature during factory acceptance.

The solution

Framo electric submersible pumps are close-coupled, end-suction centrifugal pumps with one or two stages, driven by an integrated oil-filled induction motor that is designed for direct on-line starter (DOL) or variable speed drive (VSD) operation.

In operation, the pump is suspended from a riser pipe that contains a built-in electric power transmission system, eliminating the need for hanging electric cables and submerged penetrations, while also providing mechanical protection. The pumped seawater is delivered up through the riser system. Seawater is prevented from entering the motor and conductors by internal overpressure, created by circulating lubrication/cooling oil from a small external oil circulation unit. The hydraulic oil also cools, insulates and lubricates the system.

Integral power transmission

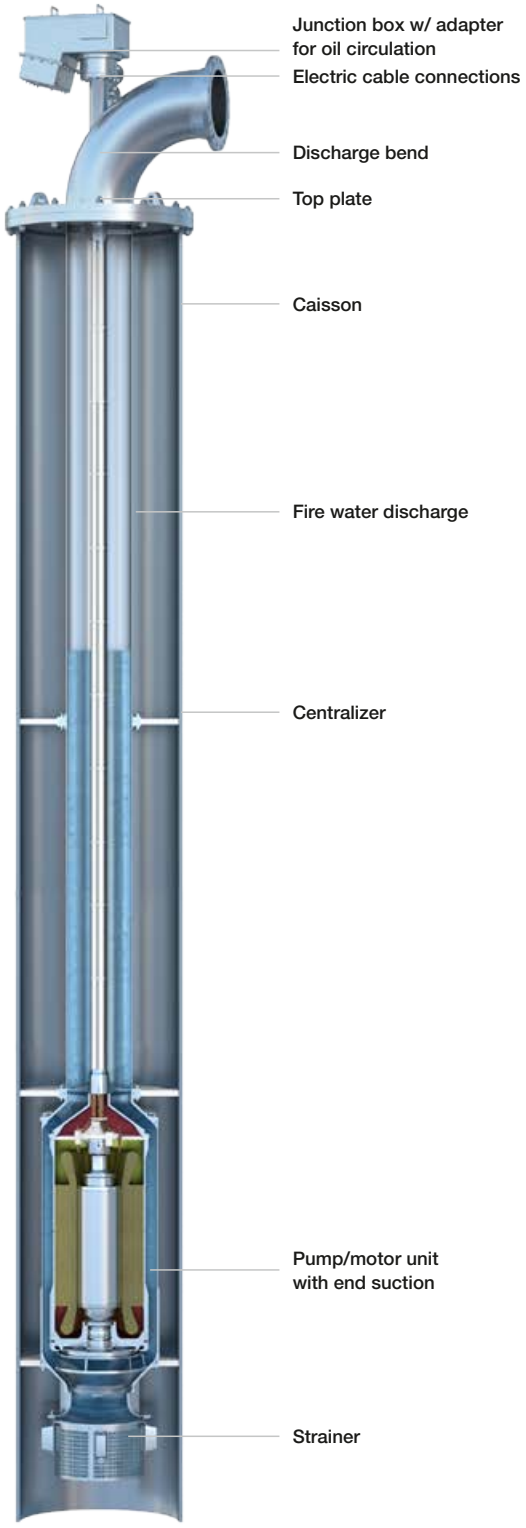
Each section of riser pipe is flanged at both ends and contains the power conductors and cooling system. They consist of a concentrically mounted oil-filled pipe through which pass the copper conductors carrying power to the pump motor. The three conductor pipes are spaced at 120 degrees by means of insulation pieces, and spring-loaded sliding connectors on the conductors ensure a safe and reliable electrical connection. The oil pipe sections are fitted with stab-in connectors. The system is assembled by simply bolting the riser pipe compact flanges together. A top plate supports a junction box for termination of the power transmission system.

Circulation system

In addition to circulating oil around the system, the circulation unit also provides continuous condition monitoring of the submerged pump and motor unit. Temperature, pressure, cleanliness and seal leakage data are read by sensors and relayed to the monitoring unit. Supply and return connections for the circulation unit are mounted on the top plate.

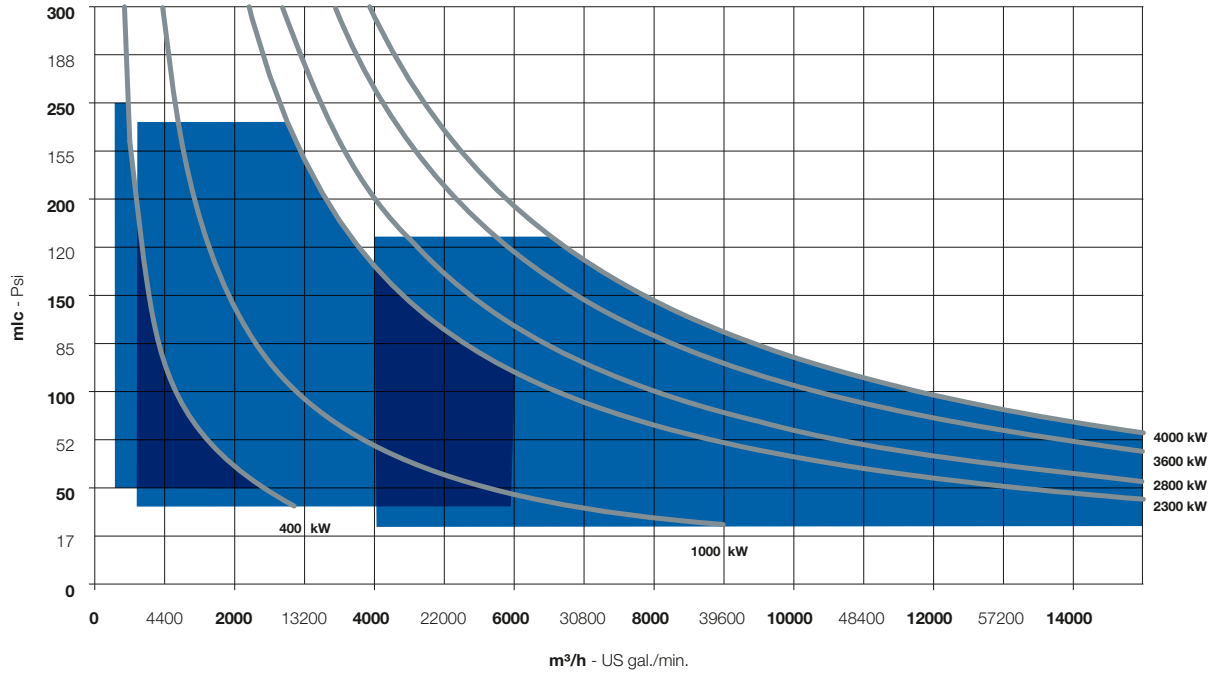
Compact, low-weight design

Circulating oil lubrication combined with the integrated pump and motor configuration makes the unit very compact, with a high power-to-weight ratio.



Technical data

Performance domain



Submerged lift pump

	Small		Medium			Large			
PUMP TYPE	**SE200**	**SE225**	**SE280**	**SE315**	**SE355**	**SE400**	**SE450**	**SE500**	**SE560**
Required caisson diameter	18”	26”	30”	34”	40”	46”	52”	58”	62”
Flow range [m³/h] (BEP)	200-500	300-1000	600-2400	700-3200	1400-6200	2800-8500	3000-10000	4000-12000	4000-15000
Pipestack diameter min/max	6”	10”/14”	10”/18”	14”/20”	18”/28”	24”/32”	24”/44”	24”/44”	24”/44”
Max power (50/60Hz) [kW]	175/220	400/400	800/1000	1000/1200	2100/2500	2200/2800	2900/3600	3300/4000	3800/4000
Max power (50/60Hz) [kW] 11kV	NA	NA	NA	NA	1400/1750	1800/2150	2200/2700	2600/3150	3800/4500
Voltage min/max [kV]	0.40/0.69	0.40/0.69	0.40/4.16	0.40/6.6	0.40/11	3.3/11	3.3/11	3.3/11	3.3/11
Weight pump/ motor unit max [kg]	900	1500	2700	5000	6600	8500	10200	12000	13500
Weight per 6m pipestack min/max dia [kg]	200	394/500	394/591	500/720	591/915	770/1150	770/1300	770/1300	770/1300
Weight top-bend and top-plate min dia/max dia [kg]	*	380/415	430/500	535/651	670/1050	1200/1250	1380/1500	1600/1700	1750/1850

* Application dependent

Note: The range chart and the data table show the normal operating range. However, for special cases, the pumps can be modified to cover duties outside this range.

Submerged pump/motor unit

The electric motor is a low or high voltage, oil filled, induction motor.

The shaft with the rotor is supported at the top (non-drive end) by a roller bearing for radial support. The drive end is supported by combined radial and thrust bearings. They can be either double angular ball bearings or spherical axial roller bearings combined back-to-back with a conical roller bearing, pending ratings and motor speeds. The bearings are designed to take maximum axial forces and have a design life in compliance with API 610 latestedition.

Both drive end and non-drive end bearings are lubricated and cooled by the forced oil circulation, which gives optimal working conditions for the bearings.

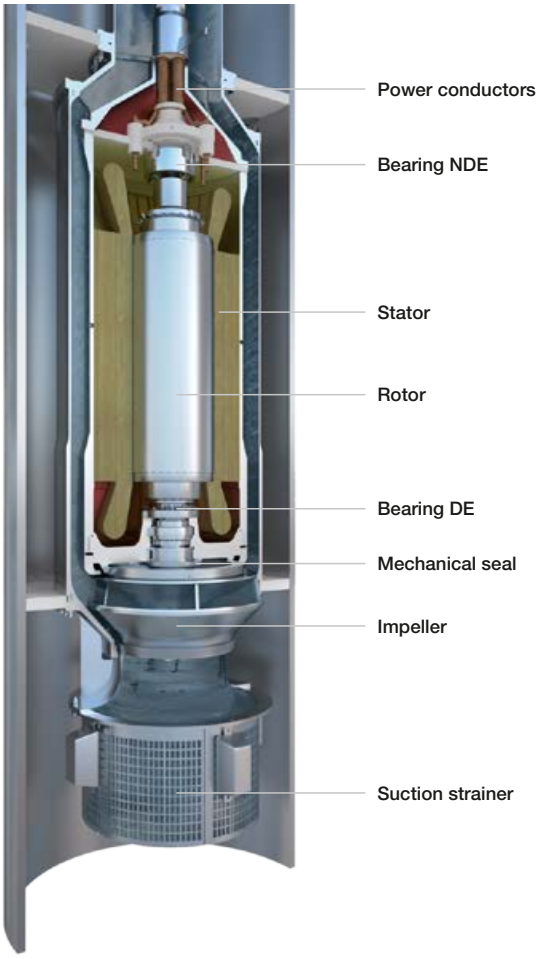
The axial thrust load is controlled by the impeller wear ring diameter and by draining the chamber above the impellers.

The seal arrangement consists of a balanced mechanical seal riding on a sleeve. The seal spring is inside the seal, protected by the lubrication oil. The arrangement is designed such that the seal is continuously lubricated and cooled by the forced oil circulation system.

The pump impellers discharge into the outer shell of the pump housing, concentric of the motor housing. The diffusor design is with guide vanes, ensuring good radial balance and minimum diameter. The suction is through a strainer, bolted to the end cover of the pump. The impellers are shrink-fitted to the motor shaft and locked with an impeller nut.

The oil circulation enters the motor via the outside of the conductor pipes (inside cofferdam pipes) and is directed to the lower part of the motor via a bore in the rotor shaft. A part flow is taken to the mechanical seal and through the bearings.

The oil returns through the rotor/stator gap before returning via the conductor system. The motor housing and bearing brackets are designed to give a good and even spread of the oil flow ensuring optimal cooling and lubrication for all rotating parts.



Pipe stack/power transmission

The pipe stack assembly consists of sections with length according to project requirements.

Each section comprises three copper conductor pipes, spaced 120 degrees by means of insulation pieces mounted inside of a protective pipe (oil pipe). The oil pipe assembly is fixed to one end of the pipe stack section and supported radially on the other end so that when the sections are assembled, differences in thermal expansion can be accommodated. The oil pipe is mounted concentric inside the water pipe. The water pipe and the oil pipe make up a complete pipe stack section.

The water pipe sections are flanged together, while the oil pipe is a male/female sliding connection with double o-ring seals used to separate the oil and pumped media. The three copper pipes have spring-loaded sliding connectors (male/female) on each end.

The pressure and return side (outside and inside) of the copper pipes are separated by o-rings on the connectors.

Top plate arrangement

The top plate consists of a 90-degree bend for discharge and a junction box for the electric power supply. The top plate (mounting plate) will be supplied to meet client caisson flange diameter and is designed to carry the complete pump weight.

The power conductor system is terminated in a junction box mounted on the discharge bend. An adapter is used for separating the pressure and return side of the circulation system.

The junction box has IP66 protection and is ex certified for hazardous area (zone 1) operation as standard.

Oil circulation system

The oil circulation system serves the following purposes:

- Lubrication and cooling of pump bearings and mechanical seal
- Overpressure protection of the electric motor and power transmission from outside leakage
- Cooling of the electric motor
- Electrical insulation condition monitoring

The oil circulation system consists of an oil reservoir, a pressure amplifier and a statically pressurized closed circuit. A positive displacement pump circulates the oil in the closed circuit. The oil is filtered on the discharge side, downstream of the oil circulation pump. Oil is further discharged from the top bend oil inlet to the pump head through the concentric oil pipe inside the pipe stack.

The pumped liquid that flows in the water pipe normally cools the oil. After passing through the motor in the pump head, the heated oil flows back inside the power conductors in the concentric oil pipe.

In cases where there is large installed motor power, a relatively short pipe stack or when warmer liquids are being pumped by the SE pump, the circulation oil will be cooled in a separate cooler integrated with the oil circulation system.

The closed circulation loop is pressurized by a small electrically driven pump, taking suction from an atmospheric tank. This pump maintains the correct pressure in the closed circuit and compensates for the very low leakage of oil over the mechanical seal in the SE pump. It is designed to maintain a constant pressure in the oil circulation loop at all time.

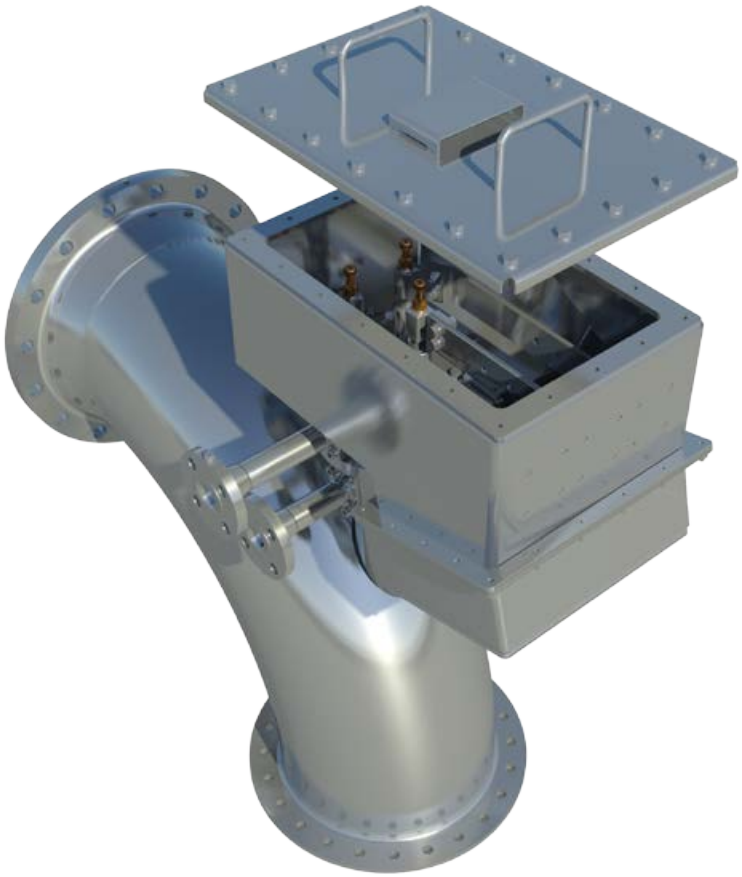
Instrumentation of the oil circulation unit includes the following parameters:

- Pressure in closed loop – alarm and shut-down in case of both high and low pressure
- Temperature in return line from SE pump - alarm and shut-down in case of high temperature
- Level in atmospheric tank - alarm and shut-down in case of both high and low level
- Magnetic chip detector in return line from SE pump – manual check

The central control system of the facility will normally perform the monitoring and control of the SE pump system.

The complete oil circulation unit including tank, pumps, filters, accumulator, valves and instruments are assembled on one common skid, to be installed close to the pump top.

The oil circulation unit has as standard Ex rating for operation in hazardous area (Zone 1).



Spec for three phase induction motors, SE type

General scope

This specification covers the basic design, manufacture and testing for three phase oil cooled induction motor used in offshore/onshore applications.

Standards and codes

Motor design materials and performance comply with the following list of codes, standards and regulations, (where applicable for oil submerged motors)

Code/std/Reg.	Designation Title	Reference
IEC*	Rotating electrical machines	IEC 60034
IEC	Dimension and output ratings for rotating electrical machines	IEC 60072
IEC	Recommendations for the classification of materials for the insulation of electrical machines	IEC 60085
IEC	Electrical installations in ships	IEC 60092-101
IEC	Classification of degrees of protection proved by enclosures	IEC 60529
IEC	Mobile and fixed offshore units - Electrical installations	IEC 6189
Norsok	Electrical systems	E-001

*IEC - International Electro-technical Commission

FRAMO
an Alfa Laval brand

Head office
P.O. Box 23, NO-5329 Florvåg, Norway
Phone: + 47 55 99 90 00
Telefax: + 47 55 99 93 80
E-mail: oil&gas@framo.no

framo.com

FRAMO Nederland
Edisonweg 18
P.O. Box 305
NL-3200 AH Spijkenisse
The Netherlands
Phone: + 31 181 619311
fm.nederland@framo.no

FRAMO USA
3002 East 13th Street
La Porte, Texas 77571, USA
Phone: + 1 281 884 4800
fm.houston@framo.no

FRAMO Singapore
17 Tuas View Circuit
Singapore 637575
Republic of Singapore
Phone: + 65 6210 2400
fm.sin@framo.no

FRAMO Japan
Kotsu Building 5F, 15-5
Shinbashi, 5-chome
Minato-ku
Tokyo 105-0004, Japan
Phone: + 81 3 5776 2405
fmnippon@framo.co.jp

FRAMO Korea
Rm 608, Centum Sh Valley
35, Centum Dong – Ro
Haeundae – Gu, Busan
Korea, 612-020
Phone: + 82 51 743 6942/3
fmk@framosk.com

FRAMO Shanghai
Building No.5, 123
Lane 1165, Jin Du Road
Min Hang District, Shanghai
China 201108
Phone: + 86 21 6115 5000
fmcn@framo.com.cn

FRAMO Brasil
Av. Presidente Vargas, 463
/19° andar, Rio de Janeiro
CEP 20071-003, Brazil
Phone: + 55 21 2507 7898
framobr@framobr.com.br

FRAMO Services AS
P.O. Box 44
NO-5329 Florvåg, Norway
Phone: + 47 55 99 92 00
service@framo.no

FRAMO Fusa AS
Venjaneset
NO-5641 Fusa, Norway
Phone: + 47 55 99 96 00
marine@framo.no

FRAMO Holsnøy AS
Rosslandsvegen 933
NO-5918 Frekhaug, Norway
Phone: + 47 55 99 75 00
piping.marine@framo.no

FRAMO Flatøy AS
Flatøyvegen 24
NO-5918 Frekhaug, Norway
Phone: + 47 55 99 94 00
oil&gas@framo.no