

Subsea cooler systems

Active cooler pump

In the oil and gas industry, thermal management of fluids plays a critical role during production, transport and refining. NOV supplies both passive and active coolers to the oil and gas industry.

PRODUCT BENEFITS

ACTIVE COOLER

Lowering production temperature

- Optimum and predictable cooling performance

Flow assurance benefits

- Turbulent flow by active cooling limits deposits, i.e. scale control by lower surface temperature

Field proven technology

- Use field proven topside cooler technology with simple start-up and operation

Compact, light and cost efficient

- Designed compact and light, utilizing technology and space
- Sufficient cooling capacity

High reliability

- Controlled active cooling through the incorporation of temperature sensors and control of forced convection by pump speed
- Temperature and pressure monitoring

Improved safety and reliability

- Lower surface temperature of the tubes gives reduced risk for scaling
- Provides a closed environment

Enclosed active cooler room gives:

- Slower cool-down after a shut-down
- Faster warm-up after start-up
- Possibility for acid cleaning

PASSIVE COOLER

Lowering production temperature

- Cooling capacity specifications to be adapted customers need

Field proven technology

- The Passive Cooler is field proven technology

Improved safety and reliability

- Lower surface temperature of the tubes gives reduced risk for scaling
- Temperature and pressure monitoring

Subsea cooler systems - Key elements

Typical applications for the NOV subsea cooler system are inlet cooling to increase compressor efficiency, outlet cooling to prevent pipeline overheating and interstate cooling. Managing fluid temperature by cooling can offer an overall cost efficient solution for greenfields and brownfields. A subsea active heat exchanger of shell and tube design with subsea pump module is developed and qualified, i.e. Active Cooler. It is developed based on extensive topside experience and was qualified through a Joint Industry Project (JIP). The JIP focused on pump, motor and control. The Active Cooler is the first of it's kind; compact design, light and it

Subsea active cooler

The Active Cooler comprises the following key elements:

- Conventional shell and tube cooler/heat exchanger
- Pump Module; separately retrievable for ease of maintenance
- Centrifugal pump with integrated magnetic coupling
- Oil-filled pressure compensated subsea motor (typically 40 – 50 kW)
- Redundant VSD (Variable Speed Drive)
- Dropped object protection

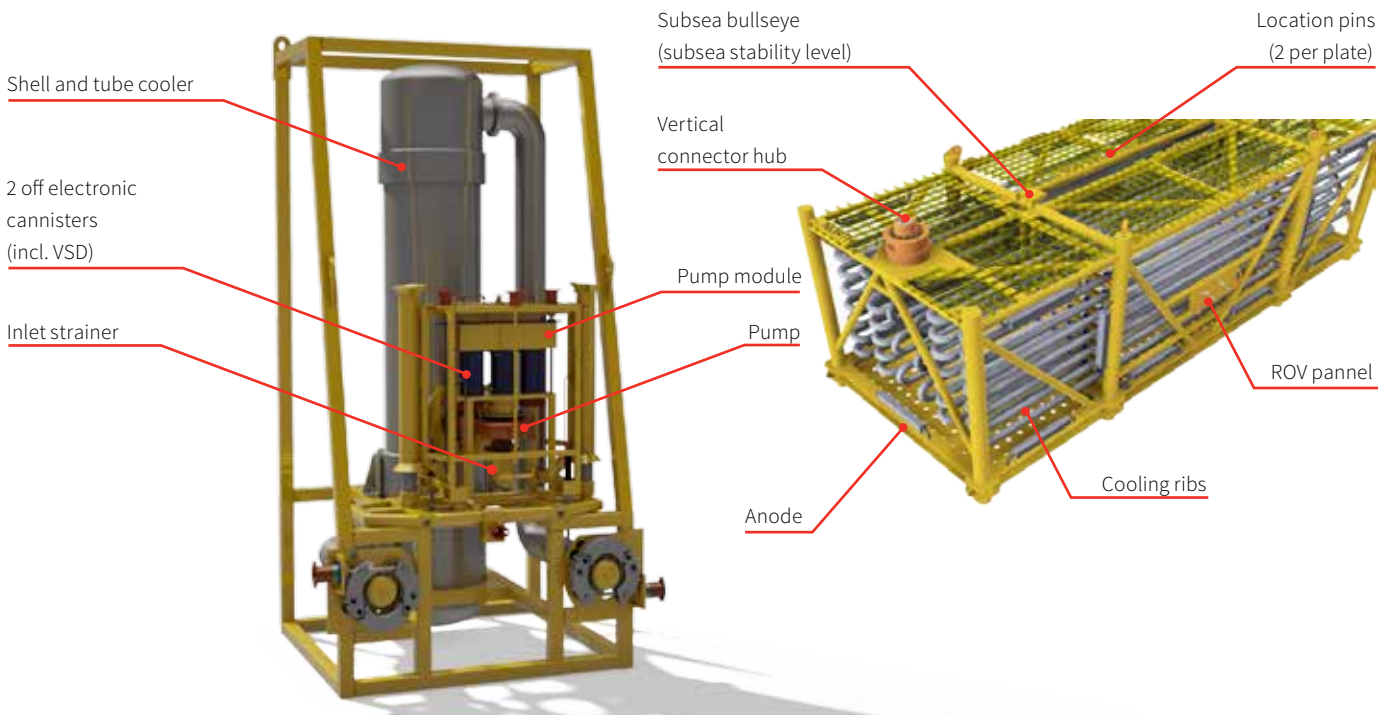
offers a high degree of temperature control. Product applications are ample; enhanced subsea gas dehydration and gas/liquid separation, enabled use of low(er) temperature rated downstream equipment and increased compressor efficiency.

NOV has delivered a passive (tubular) heat exchanger designed to lower production gas temperature for improved service life. The thermal performance was determined by a combination of LedaFlow™ and 3D flow simulations (CFD).

Subsea passive cooler

The Passive Cooler comprises the following key elements:

- Tubular cooling pipes, matrix stack (row/column)
- ROV Panel with 2 off parking receptacles and 2 off PTT receptacles. PTT Electrical Harness
- Pipe guards; 2 at each Vertical connector hub and 70 at each pipe support
- Subsea Bullseye (Subsea Stability Level)
- Location Pins (2 per plate)
- Vertical Connector Hubs
- Integrated mudmat
- Dropped object protection



Subsea cooling applications

- Subsea gas dehydration
- Wellhead/flowline outlet cooling to increase compressor efficiency
- Anti-surge cooling
- Inter-stage cooling
- "Cold flow"
- Pipeline inlet cooling to prevent over-heating
- Offshore wind power park

Subsea cooler systems - Active

The subsea Active Cooler is a shell and tube cooler based on forced convection. The pump, motor and power control is the first qualified subsea design of its kind, where the oil filled motor is isolated from the pump by a magnetic coupling. The pump module including variable frequency drive motor controller, is designed for a subsea installation down to 3000m. The motor is speed controlled, which makes it possible to operate the cooler within a predefined temperature range. The VSD and control system is fully redundant, and is qualified according to ISO 13628-6.

The proposed vertical arrangement of the heat exchanger allows for safe mixing of MEG into the production stream, essential for preventing hydrate formation. The arrangement also minimizes the footprint, compared with a passive cooler.

The subsea Active Cooler has a wide range of possible applications. Some of these applications are presented below:

- Subsea gas dehydration
- Inlet cooling to increase compressor efficiency
- Post-cooling to prevent pipeline overheating
- Inter-stage cooling and / or anti-surge cooling
- Enhanced gas/liquid separation

Subsea active cooler



FEATURES

- Conventional shell and tube design using seawater as coolant
- Can be arranged horizontal or vertical. A vertical cooler arrangement is preferred as it minimizes the footprint
- Offer MEG mixing and flow stream advantages.
- Process inside or outside tubes
- Field proven analytical tool
- Fully controlled Tout by VSD pump motor
- A qualified a 45 kW pump module w/VSD
- Gas inlet and outlet pipe at the same level
- Titanium tubes gives good corrosion resistance, heat transfer properties and strength

TECHNICAL SPECIFICATIONS

COOLING RANGE:	Typically down to 10°C above seabed temperature
COOLING CAPACITY:	Typically 10 MW TO 20 MW per. unit
DESIGN LIFE:	20 years
DIMENSIONS* (HxWxL):	9.7 m x 4.2 m x 3.7 m
WEIGHT* (INCL. PUMP MODULE AND RUNNING TOOL):	71 tonnes (dry weight) 64 tonnes (submerged)
MAXIMUM DEPTH:	3000 m
STRUCTURE MATERIAL:	Carbon Steel
VSD AND CONTROLS:	ISO 13628-6 qualified

*Specification will be adapted to customer needs

Subsea cooler systems - Passive

The passive heat exchanger (cooler) provides a thermal processing function, i.e. cooling. The Passive Cooler features field proven technology. Heat transfers from the hot medium (gas or liquid) inside a pipe to the less warm water outside of the pipe. The Passive Cooler overall dimensions (length, width and height), pipe dimension and stacking configuration are all chosen to amplify natural convection and introduce minor forced convection. The analysis was conducted by iterating between Ledaflow for the internal pipe flow and CFX for the natural convection currents in the sea water.

The Passive Cooler is a tubular structure with an integrated mudmat. The tubular design offers low drag force in cross-flow current and omnidirectional strength for structural members. The cooler is qualified for deployment through the splash-zone in $H_s = 2.0$ m.

Utilizing our subsea cooler expertise we have designed a robust cooling system. The Passive Cooler design is flexible and easily field adaptable.

Subsea passiv cooler



Subsea Production Systems develops, produces and markets some of the strongest and most advanced subsea systems. Subsea Production Systems is a Business Unit in National Oilwell Varco (NYSE:NOV) which supplies customer-focused solutions that best meet the quality, productivity, and environmental requirements of the energy industry.

FEATURES

- Field proven technology
- Flexible and easily field adaptable design
- Cooling capacity according to customer need
- The pipe system is designed in accordance to ASME B31.8
- Temperatures and pressure readings are monitored by ROV
- The tubular design offers low drag force in cross-flow current and omnidirectional strength for structural members
- 2 Part Epoxy coating on structure
- Dropped object protection cover in GRP, can absorb 2 kJ subsea impact
- Sufficient weight for in-place stability
- Tubular structure with an integrated mudmat

TECHNICAL SPECIFICATIONS

COOLING RANGE:	from 100 °C to 60 °C
COOLING CAPACITY:	more than 6 MW at 27°C ambient temperature
DESIGN LIFE:	20 years
DIMENSIONS (HxWxL):	5.6 m x 5.8 m x 14.7 m
PIPE LENGTH*:	950 m
WEIGHT*:	100 tonnes (dry weight) 87 tonnes (submerged)
MAXIMUM DEPTH*:	110 m
STRUCTURE MATERIAL:	Carbon Steel
PIPING MATERIAL:	Carbon Steel
DESIGN CODES:	Structure API RP 2A Pipe ASME B31.8

*Specification will be adapted to customer needs

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