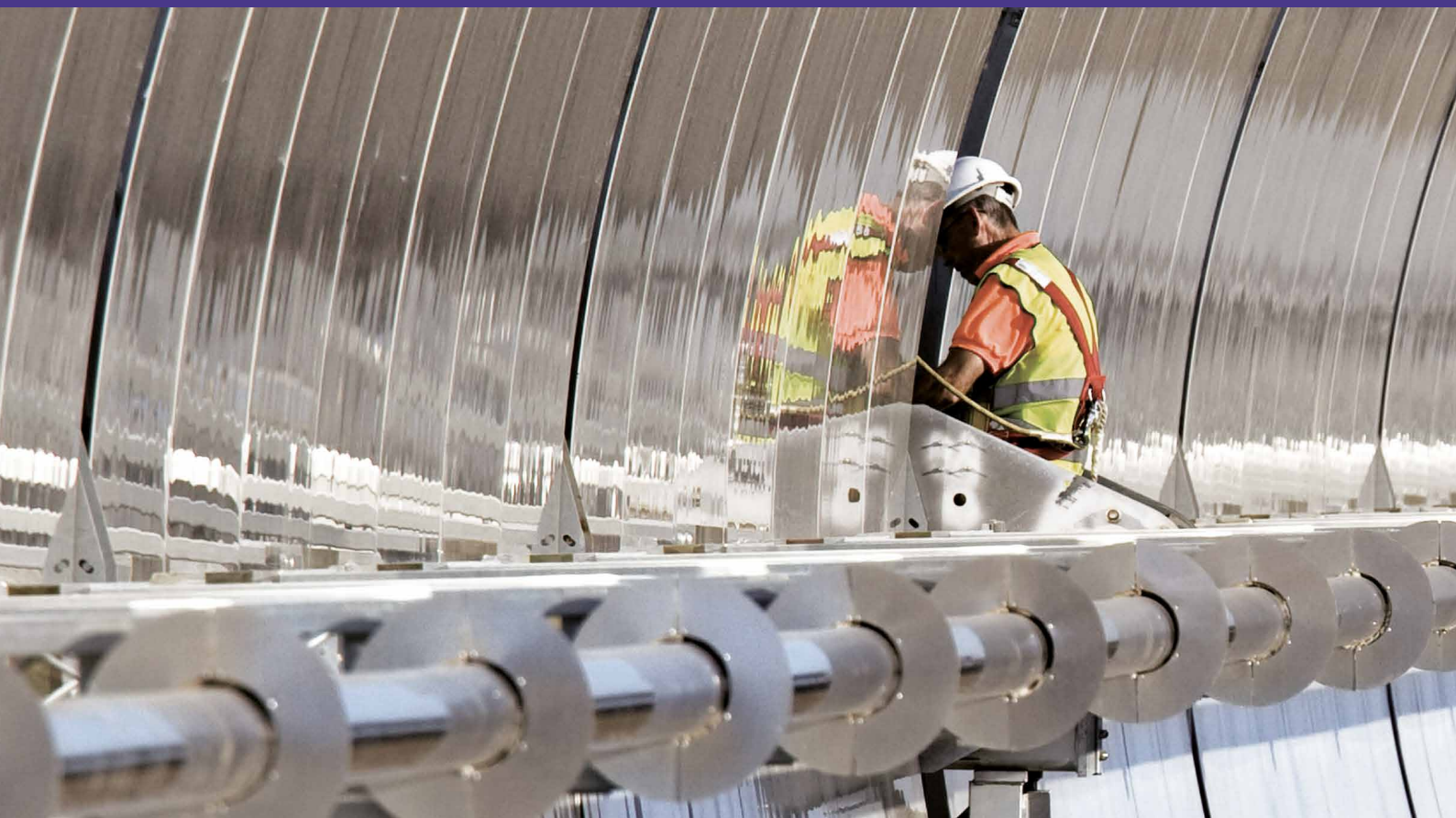


Concentrated Solar Power

Special long shaft pumps





Special Pumps for Concentrated Solar Power

The intelligent energy mix with regenerative energy sources is important to insure our global energy needs. Fossil energy generators and atomic power will be complemented to an increasing degree by regenerative energy on an industrial scale. Solar power generation in the Earth's Sun Belt represents the most important energy source. Daily levels of sunlight exceed the annual energy consumption of the entire human race. This infinite supply of solar energy can only be effectively exploited through the continuous optimisation of large-scale solar power plants.



Picture by courtesy of paul-langrock.de /Solar Millennium AG

The key to high-efficiency solar power plants lies in the efficient thermal distribution of solar energy and its storage in thermal energy storage systems (TES). High temperatures and innovative thermal storage concepts already enable the realisation of efficient CSP power plants (CSP = Concentrating Solar Power) in the 100 MW range today. Next-generation power plants will be capable of providing greater than 250 MW per plant.

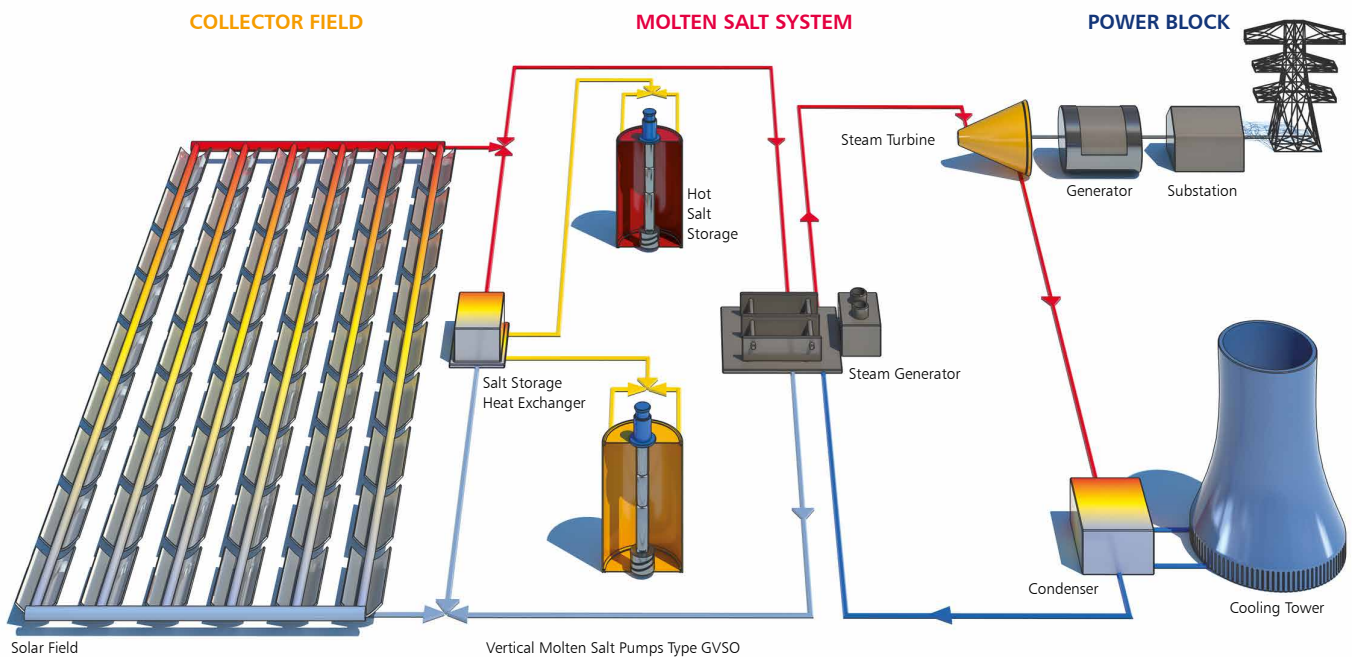
TES systems utilising extremely hot molten salt form the core element of CSP power stations. Heat exchangers transmit the energy to the downstream conventional steam turbine process. Solar thermal power plants embodying the highest efficiency potential are represented by the power tower concept with a central focal point

and heliostat field, along with extensive collector power plants with decentralised collector fields (parabolic trough or linear Fresnel collectors).

Only reliable, robust and proven supply pump technology in TES systems can sustain this hot molten salt cycle on a planned level – even when the sun is not shining. Inexpensive power generating costs assured by availability not dependent on daylight will also help to cover rising future base and peak load supplies. A solar thermal power plant can supply more than 200,000 people with environmentally-friendly power while simultaneously achieving CO₂ economies of over 150,000 tonnes per annum.

Solar thermal power plants

Technical know-how is essential in the area of special material combinations for high-temperature applications in TES systems. Eutectic molten salt mixtures at temperatures exceeding 500°C consisting of sodium nitrate (NaNO_3) and potassium nitrate (KNO_3) therefore require reliable pump concepts. Thus we support the constant supply of energy – day and night.

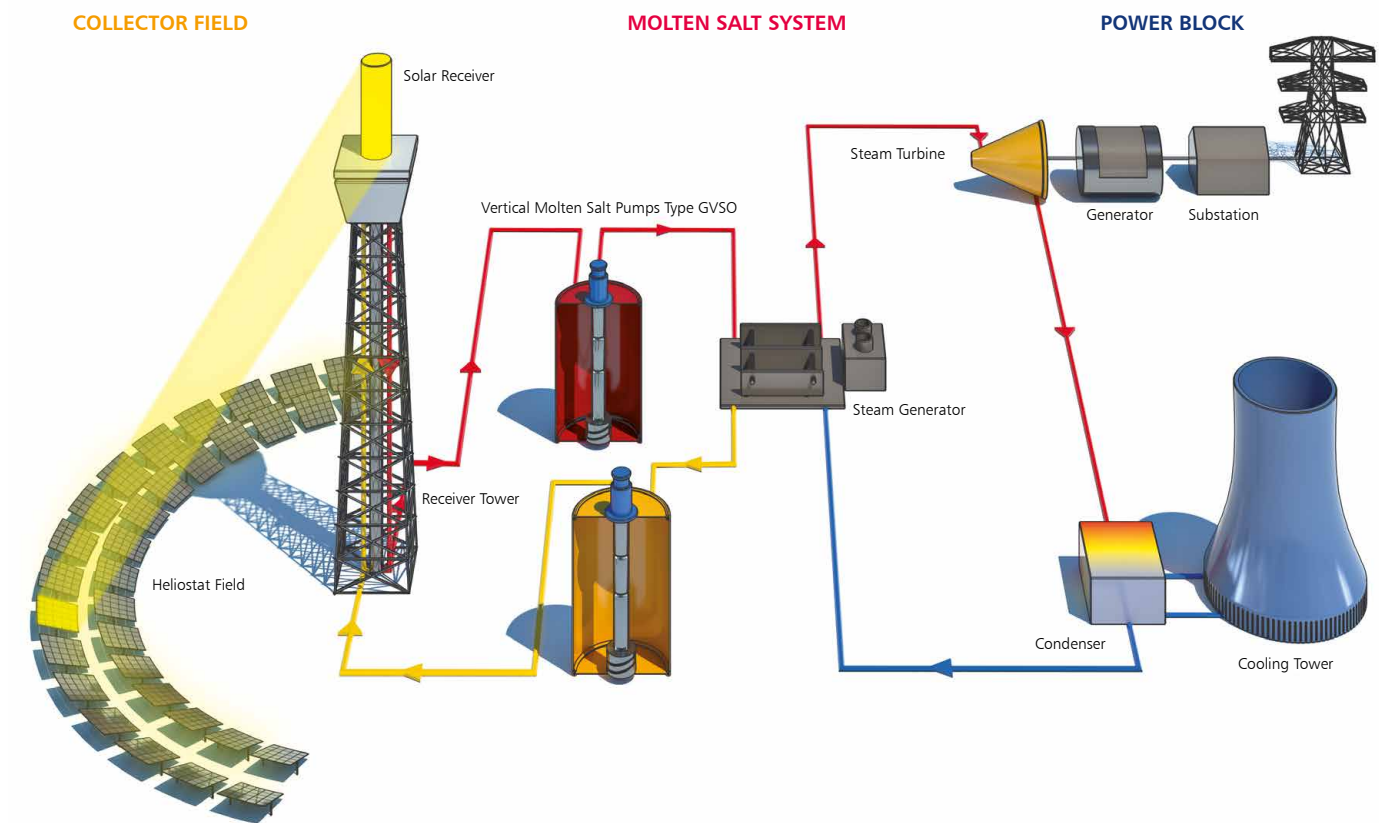


Parabolic trough systems

The characteristic features of these power plant designs are the extensive decentralised collector field with parallel-configured collector columns. The heat transfer fluid (oil or salt) is heated within the focal line. Direct and indirect thermal transfer to the TES system is employed, depending on the plant design. Temperature ranges from 200°C up to greater than 565°C and large tank dimensions not only demand specialised know-how when

it comes to selecting materials, but also special design requirements of these critical supply pumps.

The unique pump design and balanced ratio between size and delivery capacity enable use of pumps for applications ranging from test systems up to large-scale industrial plants - from main pumps to drain pumps in all forms of plants.



Power tower systems

Power tower systems are distinguished by a central structure: the central receiver tower. Solar energy is collected in a central focal point located at a high altitude on the tower. High-efficiency supply pumps are therefore required for the receiver in the TES system. The convincing performance of our vertical pumps is also demonstrated here through perfectly-coordinated multi-stage hydraulics and the pressure levels achieved. This special design

enables the achievement of minimal machine vibrations and fully-variable submersion depth adaptation.

Their operation can be fully controlled at all times, even where variable speeds are involved. Our special pump concept thus enables long-term plant availability; high efficiency and delivery pressures and therefore minimal losses are the result.



The GVSO

Flexible use in the solar industry systems

The sophisticated pump design provides users and designers flexibility and security. 28 different pump sizes offer maximum freedom when it comes to the choice of hydraulics. With its special design and innovative details for high-temperature applications, our vertical GVSO has always persuaded users through their long-term availability, corrosion resistance, high reliability and quality.

Options (refer to page 10/11)

- Expansion Joint System with Sole Plates for installation
- High Pressure Multistage Design
- Monitoring and Diagnose System
- internal Bypass

Material

1.7357: High temperature ferritic cast steel, can be used up to 450 °C (842 °F). The most frequent application is the pumping of molten salts.

1.4581: High temperature austenitic chromium nickel molybdenum steels, can be used also over 450 °C (842 °F).



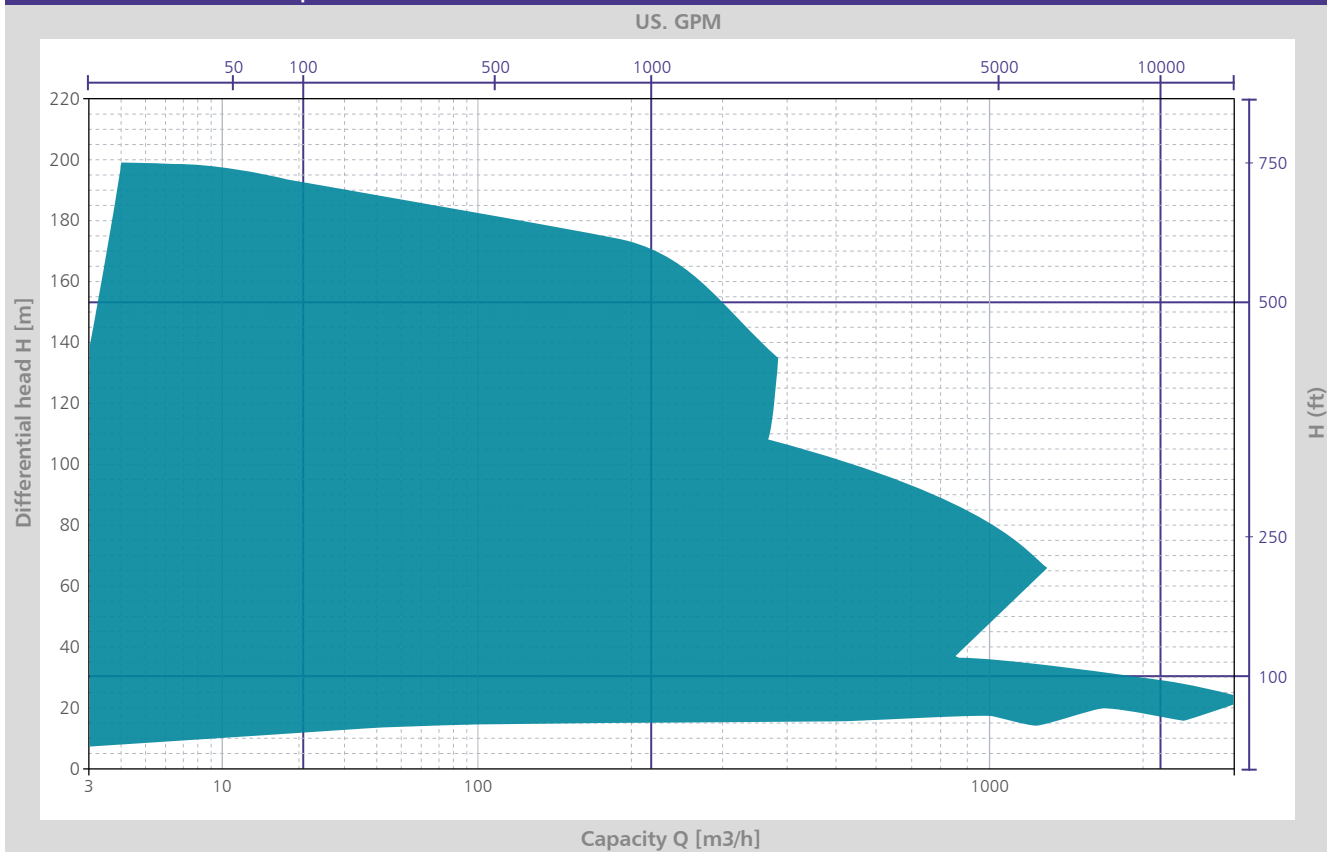


Picture: Installation of the GVSO in a solar power plant

Technical data

GVSO	
Size DN	40 to 450
PN	up to 40 bar
Q_{\max} m ³ /h (gpm)	3000 (13200)
H_{\max} m (ft)	200 (660)
Submersion depth _{max} m (ft)	17,5 (57)
Temperature °C (°F)	-40 to +600 (-40 to +1112)
Standards	ISO 5199
Flange motor design	Standard
Closed impeller	Standard
Foot bearing	Standard
Seal	Stuffing box packing

GVSO : $n < 1800$ 1/min / rpm



Fact benefits for customer

1.Fact

The discharge-pipe for the entire flow-capacity has been separated from the column-pipe and the pump main-shaft inside this column-pipe.

- Space saving compact pipe design suited for very small container openings and prevents unequal longitudinal expansion.
- No distortion / alteration of the ideal flow-form and flow-speed inside of discharge pipe by Bearing-Holders or by Bearings itself.
- No pressure losses including subsequently reduced hydraulic efficiency caused by Bearing-Holders in the flow path.
- Due to plenty of space for the Bearing in the column pipe the Bearing design has not to be restricted with regard to it's radial dimensions and is therefore able to cover a higher load, especially at large temperature differences within a short time period where thinner Bearings tend to crack.
- Defined lubrication of Bearings independent from pumps differential pressure. No increased bearing wear by dry-running conditions in case of an interrupted pump flow.

2.Fact

Intermediate sleeve bearing

- Lubrication of the sleeve bearings is defined
- No additional losses by sleeve bearing concept
- Defined, bearing lubrication for every flow condition
- No additional wear
- Heavy duty design
- CFD optimized design
- Shaft connection with screws and keys allows reverse rotation.

3.Fact

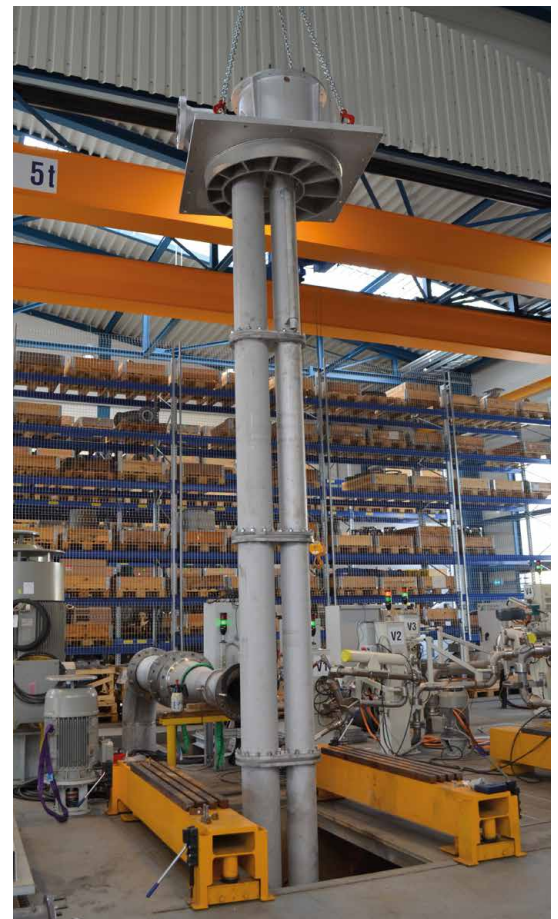
Discharge nozzle.

- Available in all variations (Size, DIN / ASME Standard, Gasket systems) as demanded by Customer.
- Allowable loads up to 2 x API-values as standard. Higher values available upon request.

4.Fact

Test bench / test facility.

Implementation of a new test facility in year 2016 for molten salt pumps with the possibility to test even pumps with a pipe length (insertion length) up to 20 m. New test bench concept offers possibility for customers and third-party Inspectors to supervise the entire test process.



5.Fact Cooling Fan

- Fan in bearing lantern for cooling down the trust bearing, for all molten salt applications in standard.



6.Fact Dry and low-pressurized Shaft-Sealing

- During normal operation pumped liquid won't approach the area of upper shaft-sealing, which is standardly designed as a robust stuffing-box with outstanding MTBF-figures (Mean Time Between Failures).
- Pressure towards Shaft-Sealing is not higher than the pressure in Gas-Phase of tank.
- Floating Ring Seal for reduced N2 Gas consumption available as option.

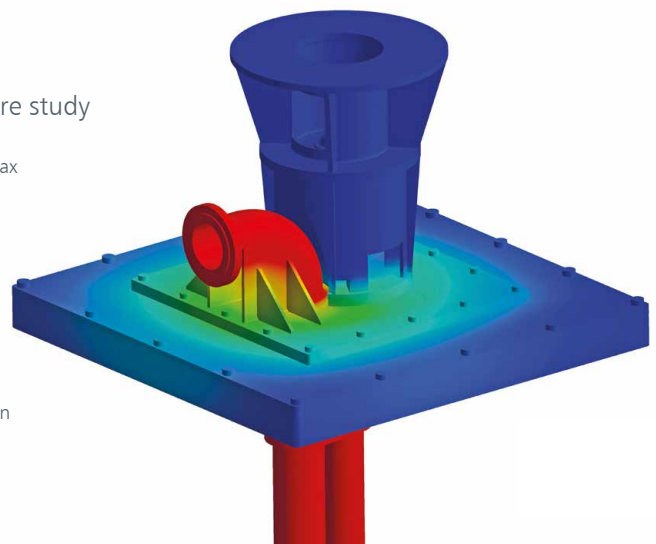
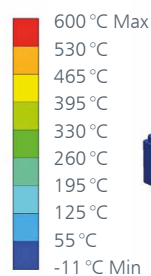
7.Fact Proven Pump design

- Although CSP applications (Trough-Type or Power-Tower) in a large industrial scale are market-relevant just since 15 years, our experiences with pumping of nitrate salt melts as a high efficient heat-transfer medium can be traced back to the 1950's.
- The outstanding long history of Rheinhütte Co. since 1857 in City of Wiesbaden at River Rhine and the leadership in several segments in pump-market combined with the permanent endeavour for improvement of our products offers to Customer the guarantee that your expectations as valued business partner will be fulfilled.
- Over 1000 pumps supplied in molten salt applications.

8.Fact Scientifically based studies for molten salt pumps.

Studies regarding thermal situation of pump in tank are possible as well as studies regarding critical frequencies under utilization of "state of the art" FEM software.

Temperature study



Options

High Pressure Multistage Design

- Segregation of shaft piping and pressure piping - Stability at greater submergence depths
- Medium lubricated, corrosion and abrasion resistant sleeve bearings
- Compact multistage design



Expansion joint system with Sole Plate for installation

- Sole / Mounting Plates for pump installation can be designed and manufactured in our workshop as per requirements and structure of customers tank / vessel.
- Compensators which have the function to decouple the pump from the tank are optionally available. These compensators ensure, especially at large pumps and high temperatures, that thermal induced movements in lateral or vertical direction will not lead to higher forces and/or moments towards tank / vessel shell.
- The compensator unit is installed once and can remain installed for repairs and maintenance.

Monitoring Systems

To complement our superior product quality with specific customer consulting, we also provide systems for monitoring and enhancing pump availability. Individual pump instrumentation settings, enable reliable monitoring of the core element of your plant at any time.

Our monitoring systems are individually adapted to suit customer requirements. In addition to standard industrial sensors for temperature and vibration acceleration, velocity sensors and rotation direction detectors are also available. Perfectly adapted high-temperature sensors round off the array of elements available for status monitoring. The integrated digital display in the monitoring system even enables on-site control and monitoring of all relevant pump parameters.

All sensor signals are calibrated to the industrial standard and the control room provided to enable perfect system integration in existing monitoring and measurement environments.

That which applies to our pumps is also standard for our monitoring systems: individual systems tailored to suit individual customer requirements, which can be freely expanded, and distinguish themselves through superior quality and user-friendliness.

Specification Measurement System

Characteristic Operation Monitoring / Conditions displayed with optical alert- and alarm function	
Insulation & Protection Class	IP65
Casing Dimension (Standard) Dimension (Standard) Mounting	Monitoring Terminal box 300x300x200 Monitoring Sensor Transfer box 200x200x120 stainless steel bracket
Signal conditioning Sensor Operating Signals Output Signals to DCS	4 up to 20mA/Voltage (analog), galvanic severed 4 up to 20mA (analog), galvanic severed
Additional features Direction of Rotation Signal Local Display Signal Lights	Failure- and Direction of Rotation Signal Configurable Plain Text Display with 3 lines Adjustable Blinking Range for Alerts yes

Monitoring system

System		Sensors					Signals (4-20MA)					PFC	Power supply 60/50 HZ (115/230V)
		ball bearings											
		RMS			T _B	CW/ CCW	RMS			T _B	N	CW/ CCW	
		1	2	3			1	2	3				
K	1.1	●	●		●		●	●		●			●
	1.2	●	●	●	●		●	●	●	●			●
	1.3	●	●		●	●	●	●		●	●	●	●
	1.4	●	●	●	●	●	●	●	●	●	●	●	●

K = specific value system, display shows only rms 1+2 and TB
1,2,3 = rms radial and axial direction

cw = clockwise (speed direction)
ccw = counterclockwise (speed direction)
PFC= Potential Free Contact

The Pumps are available with an internal by-pass-flow.

Allows to operate the pump down to a discharge capacity of 0 m³/h at the case of a closed discharge valve.



— An ITT Brand

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