INNOVATIVE SOLAR THERMAL POWER PLANTS
CLEAN ENERGY WITH RHEINHÜTTE PUMPEN

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.

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RHEINHÜTTE PUMPEN
If you want to solve demanding pumping tasks in the chemical industry efficiently, permanently and economically, you need more than just a coherent technical concept. Experience of application, material knowledge and dialogue with you ultimately lead to the optimum solution. A way which Rheinhütte Pumpen has been following for over 160 years.
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.

RHEINHÜTTE PUMPS FOR CONCENTRATED SOLAR POWER

Picture by courtesy of paul-langrock.de /Solar Millennium AG
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 (NaNO₃) and potassium nitrate (KNO₃) 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 carrier material (HTF) 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 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.
FACT 1
The discharge-pipe for the entire flow-capacity has been separated from the column-pipe and the pump main-shaft inside this column-pipe.

- 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 its 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.

FACT 2
Pumps are available with an internal bypass-flow.

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

FACT 3
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.

FACT 4
New 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.

FACT 5
Sole Plates for installation / Compensation of thermal distortion

- 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.
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.
- 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 / History of Rheinhütte

- 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 all blends of molten-salt 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 endeavor for improvement of our products offers to Customer the guarantee that your expectations as valued business partner will be fulfilled.

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.
GVSO IN DETAIL

PERFORMANCE DATA

GVSO – FOR FLEXIBLE USE IN THE SOLAR INDUSTRYING SYSTEMS

The sophisticated pump design provides users and designers flexibility and security. 38 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.

<table>
<thead>
<tr>
<th>Sizes</th>
<th>38 different pump sizes</th>
</tr>
</thead>
</table>
| Materials     | Up to 470 °C: steel with strength at high temperature  
                 Over 470 °C: stainless steel with strength at high temperature |
| Seals         | Packing Gland, Floating Ring Seal |
| Options       | Expansion Joint System  
                 High Pressure Multistage Design  
                 Monitoring and Diagnose System  
                 Gas Barrier Systems |

Technical Data

<table>
<thead>
<tr>
<th>DN</th>
<th>40 to 450 / 1.5” - 18”</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN</td>
<td>up to 40 bar (higher PN upon request)</td>
</tr>
<tr>
<td>Q</td>
<td>max. 3,000 m³/h (13,200 gpm)</td>
</tr>
<tr>
<td>H</td>
<td>max. 200 m (660 ft)</td>
</tr>
</tbody>
</table>

GVSO: 50-60 Hz  \( n = 1450-1750 \, \text{1/min / rpm} \)
MOLTen SalT PUMPS
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.

MONITORING SYStEMS

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

<table>
<thead>
<tr>
<th>Characteristic Operation Monitoring / Conditions displayed with optical alert- and alarm function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulation &amp; Protection Class</td>
</tr>
<tr>
<td>Casing</td>
</tr>
<tr>
<td>Dimension (Standard)</td>
</tr>
<tr>
<td>Mounting</td>
</tr>
<tr>
<td>Signal conditioning</td>
</tr>
<tr>
<td>Sensor Operating Signals</td>
</tr>
<tr>
<td>Output Signals to DCS</td>
</tr>
<tr>
<td>Additional features</td>
</tr>
<tr>
<td>Direction of Rotation Signal</td>
</tr>
<tr>
<td>Local Display</td>
</tr>
<tr>
<td>Signal Lights</td>
</tr>
</tbody>
</table>

MONITORING SYStEM

<table>
<thead>
<tr>
<th>SYSTEM</th>
<th>SENSORS</th>
<th>SIGNALS (4-20mA)</th>
<th>PFC</th>
<th>POWER SUPPLY 60/50 Hz (115/230V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ball bearings</td>
<td>rms</td>
<td>cw/ccw</td>
<td>rms</td>
<td>cw/ccw</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>T_a</td>
</tr>
<tr>
<td>1.1</td>
<td>•</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>1.2</td>
<td>•</td>
<td>•</td>
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<td>•</td>
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<tr>
<td>1.3</td>
<td>•</td>
<td>•</td>
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<td>•</td>
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<tr>
<td>1.4</td>
<td>•</td>
<td>•</td>
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</tr>
</tbody>
</table>

K = specific value system, display shows only rms 1+2 and T_a
1,2,3 = rms radial and axial direction
cw = clockwise (speed direction) ccw = counterclockwise (speed direction)
PFC= Potential Free Contact
OUR SERVICES
AT A GLANCE

PUMP DESIGN
The success of an installation starts with selecting the right pump. The type, size and seal must satisfy the requirements presented by the pumped medium. Thanks to modern, computer-optimised hydraulics, Rheinhütte pumps are ideally suited to meet any applications.

OPERATING CONCEPT
Whether you want to monitor centrifugal pumps or operate complex vacuum installations, we will work with you to devise the right operating concept which meets your needs – from manual to fully automatic.

INDIVIDUAL APPROVAL
All Rheinhütte centrifugal and vacuum pumps as well as Rheinhütte vacuum compact installations are tested at our factory before they are delivered: Together with our customers, specific details, processes and basic principles are tested and discussed.

MATERIAL ADVICE
Which materials are best suited to your particular application? Whether you require pump materials, seal materials or changes in process affecting the pumps – our material specialists will offer you an individual recommendation, with full commitment.

DOCUMENTATION
You need specific documentation? Whether standard or project – according to your requirements we create your individual project documentation.

ON-SITE SUPPORT
Whether it is for initial start-up or for training your personnel – our engineers are also available to assist you on site.

We offer the right solution for your project.
SUCCESS IS BORN OF EXPERIENCE

160 YEARS OF RHEINHÜTTE PUMPEN

As pump manufacturers to the world, Rheinhütte Pumpen is your expert for demanding pump applications – and has been for over 150 years. Our experience for designing pumps for conveying abrasive, corrosive and toxic media, our product innovations and the supreme product quality have made Rheinhütte Pumpen a proven component of many major plants – all over the world.

YOUR INDIVIDUAL REQUIREMENTS ARE OUR BENCHMARK

Our customers benefit from our customized advisory services on materials, sealing systems and maintenance concepts. Experienced project teams will draw up individualized documentation in line with your requirements. Our customers specifications are what counts for us and are integrated in our Quality Management systems, testing processes and the official approval procedure for pumps and installations.

YOUR RELIABLE PARTNER FOR PUMPS IN THE SOLAR INDUSTRY

Innovative and reliable pump technology combined with leading material know-how ensure a high degree of safety, greater maintenance efficiencies and long-term plant availability.

The success of our molten salt pumps is based on consistent research and product innovation. The unique pump design (proven technology up to 19m) enables use of pumps for applications ranging from test systems up to large-scale industrial plants. The submerged chemical pumps are used as main pumps in salt based heat storage systems as well as system components in melting and filling (charging) processes of salt systems and in peripheral areas of plant protection.

With our customized solutions for pumping molten salt, in particular the extensive documentation requirements and testing of the pumps we along with our customers are constantly setting new benchmarks.

RHEINHÜTTE PUMPEN – your specialist for sophisticated pumping applications.
RHEINHÜTTE PUMPEN
GLOBAL EXPERTISE