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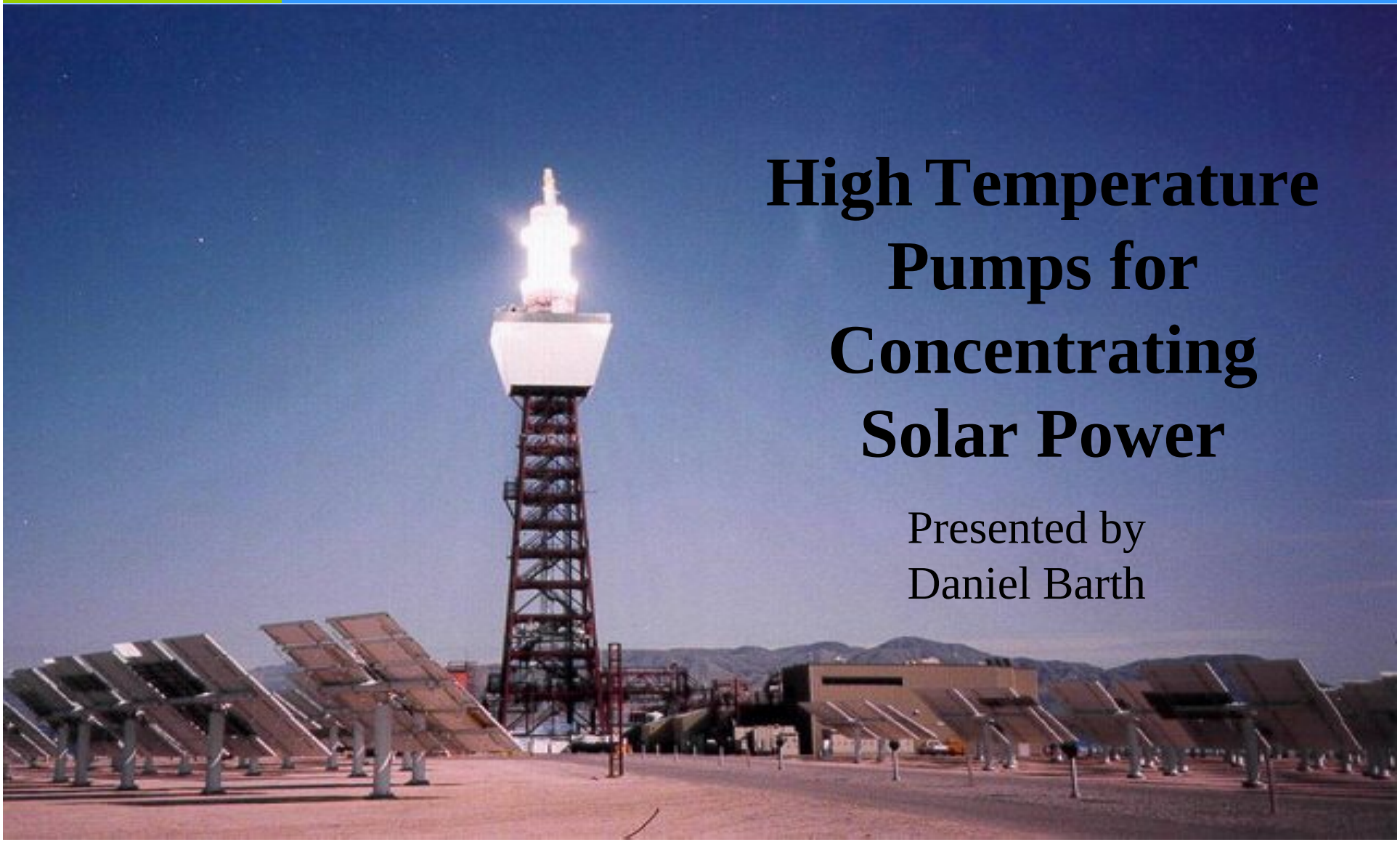
# WORLD OF PUMPS

FRIATEC-Rheinhütte, Germany

FRIATEC-Rheinhutte Pumps and Valves, LLC ~ USA

RHEINHÜTTE PUMPEN



# High Temperature Pumps for Concentrating Solar Power

Presented by
Daniel Barth

# We keep your business running...

## FRIATEC-Rheinhütte, Germany

## FRIATEC-Rheinhutte Pumps and Valves, LLC ~ USA

Daniel L. Barth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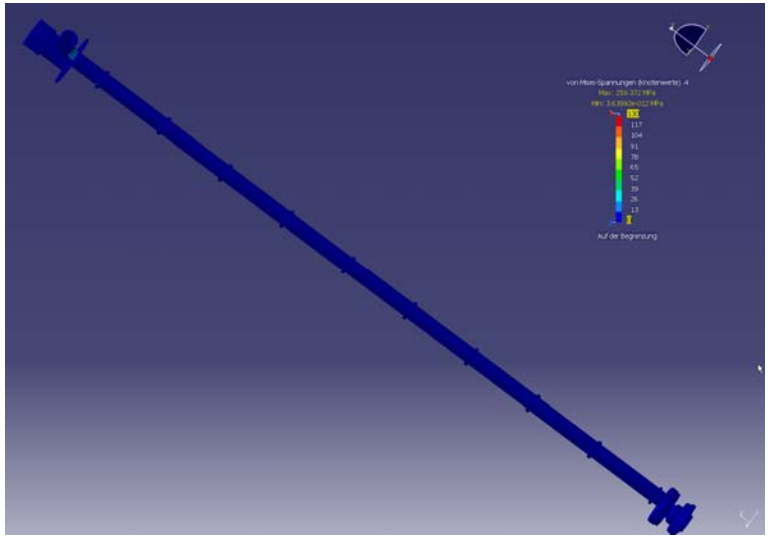
# 35 Years of Proven History in Pumping Molten Salt

Friatec has gained the expertise of designing Molten Salt Pumps from hundreds of applications over thirty five years of service. Only through years of experience can proven technology be offered to customers facing such difficult applications. Critical application using molten salt can not take RISKS!

Above is a 17 Meter long High Temperature pump Molten Sulfur



FEM Model of a Solar Pump

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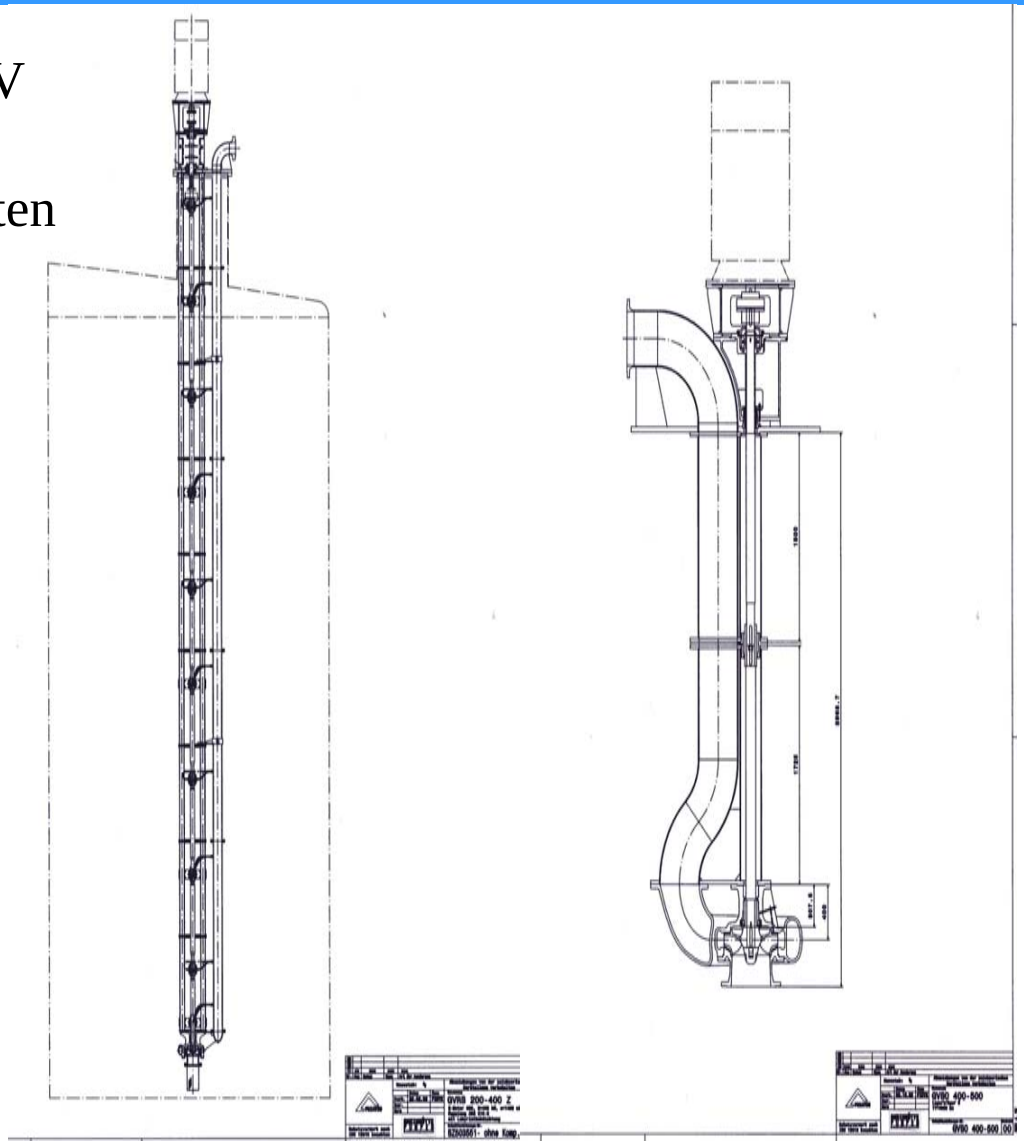
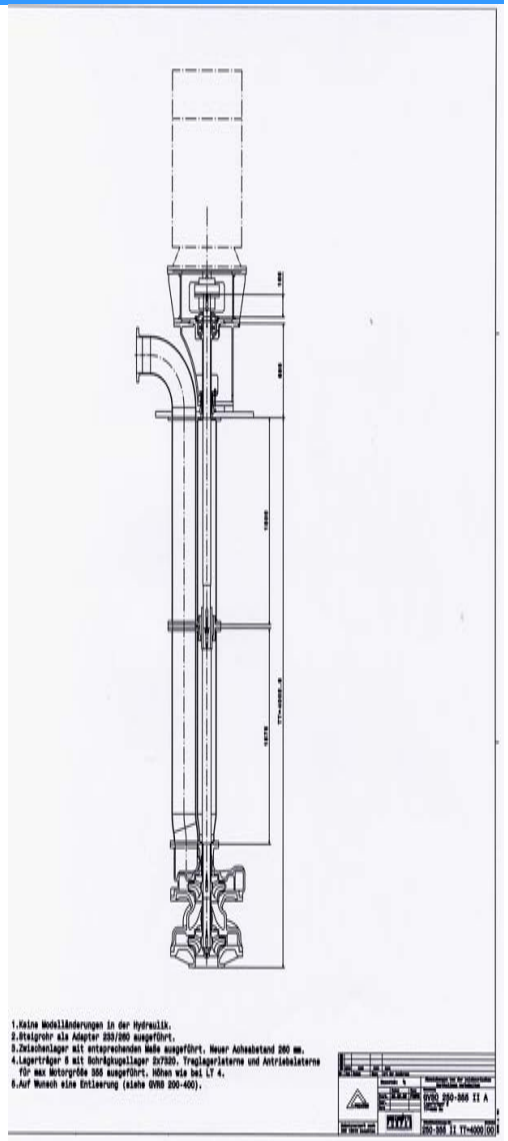
# Basic Molten Salt Pumps

GVRS GVSO GVSO II

GVRN and RCEV designs are also available for molten salt applications





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# Typical Molten Salt Pumps

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# Multi-Stage Molten Salt Pump

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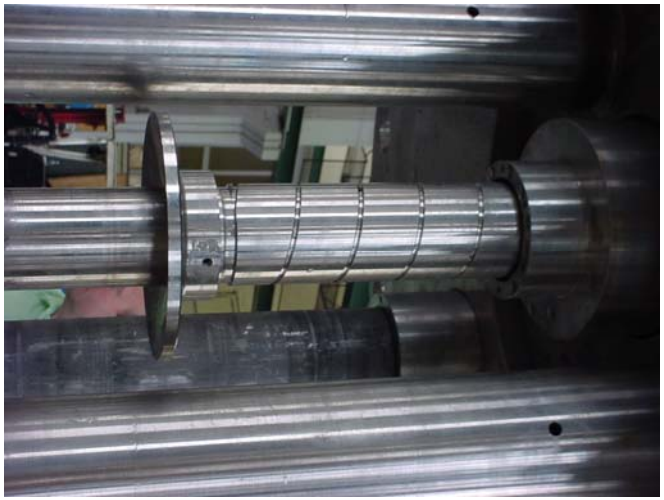
# Special Design Features

**Proven design features provide O/M Cost Savings over the life of the equipment**



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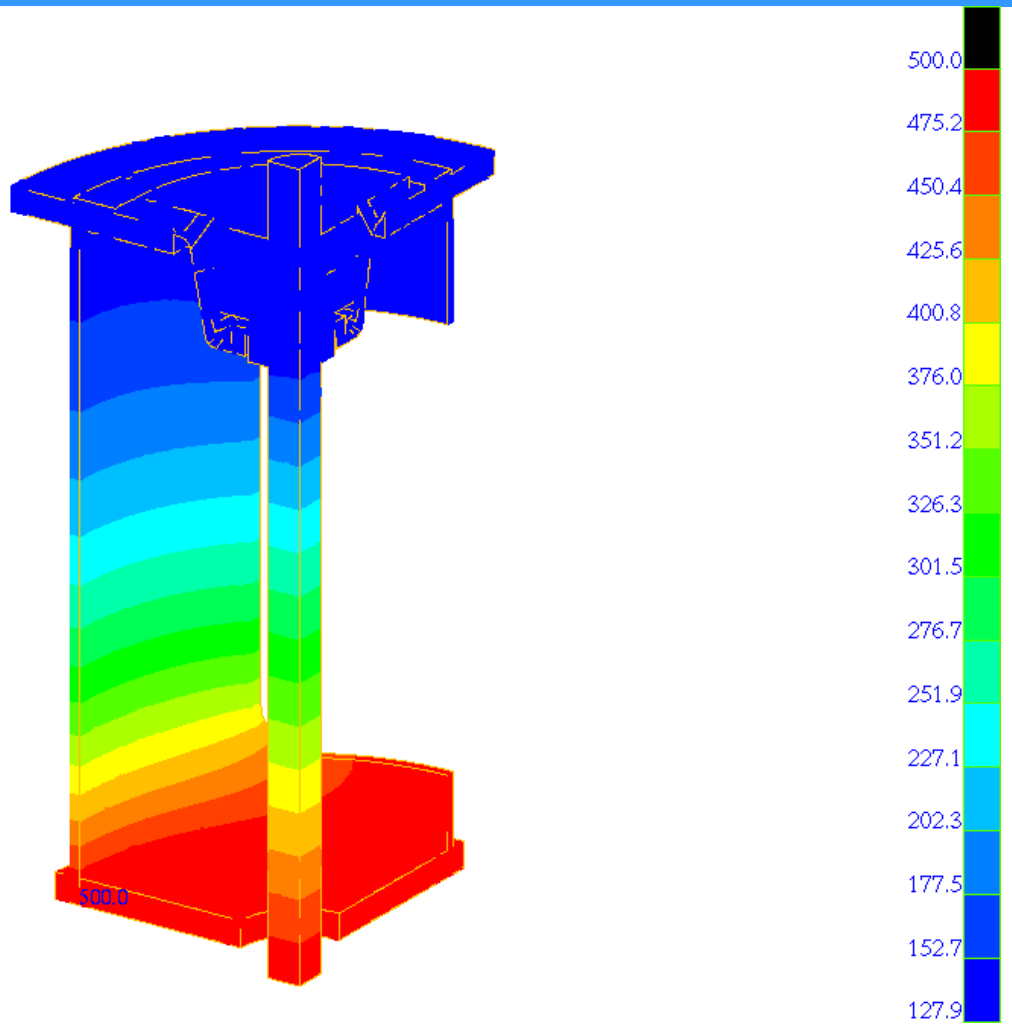
# Heat Dissipation Studies

**Thermal studies of the heat dissipation areas are critical to understanding the effects on the thrust bearings and supporting components.**

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# Key Pump Considerations

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~ Safety is the most important aspect!
~ High Reliability of such critical equipment is mandatory to the success of the plant. These pumps are the Heart of the Molten Salt System. If these pumps do not run, the plant is shut down.
~ Proven field experience and/or a comprehensive testing program must be used to validate all of the critical components in the Molten Salt System.
~ The working relationship between suppliers of the Pumps, Valves, Tanks, Heat Exchangers and Receiver will be critical in insuring the end user a proven system that is highly reliable.

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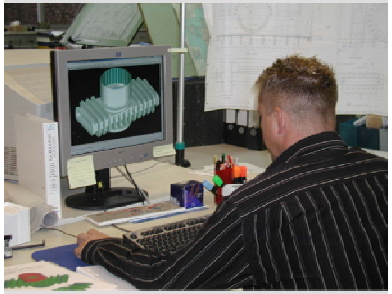
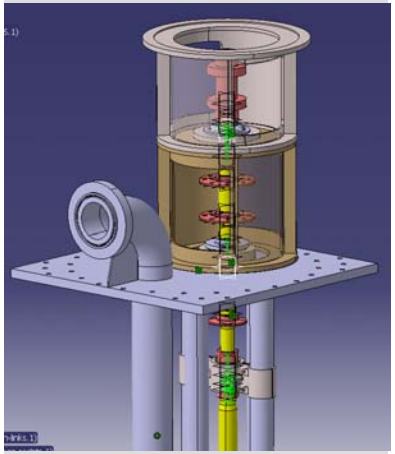
# Design and Materials



**It is critical that the design and materials of construction support and strengthen each other. Extremely High Temperature applications take both of these elements to their limits. From the standpoint of design, we need simplicity and ruggedness, plus flexibility to meet the longevity in life that these critical pumps require.**



**It is recognized that the conditions under which High Temperature Pumps are installed in industrial and process plants are highly variable and that no single design is adaptable to all of them. The combined experience and knowledge from building and testing of High Temperature Molten Salt pumps for various applications with a very broad range of customers has given Friatec a very broad understanding of the special requirements needed for this type of equipment. The use of such resources insures a successful R&D program as well as Commercialization of such equipment.**

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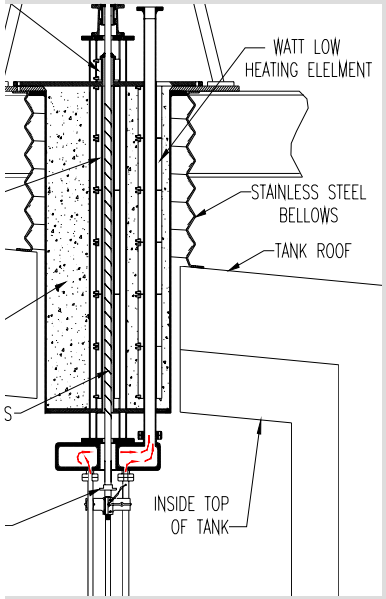
# Mounting and Sealing Molten Salt Pumps




**Understanding how to seal a molten salt pump to either a tank flange or a structure mounted above the tank is very critical for several reason. The first is that this area becomes part of the cool down transition section of the pump. This area can become a major problem if it is not design properly. Molten salt will climb the shaft and work its' way into this area, solidifing and freezing up the rotating assemble if this area is too cool or spraying molten outside of the tank creating an unsafe and danagerous situation if the area is too hot. This area can be 4-6 inches in length for tank mounted pumps and as much as 4-10 feet for pump mounted on structures above the tank. The shaft must be cooled down before the heat reaches the main thrust bearings. This seal area is the first cooling zone but must maintain a temperature just above the melting point of the salt.**

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# Mounting and Sealing Molten Salt Pumps

**If Molten Salt is not stopped from migrating up the shaft prior to the first cooling zone, major failures can occur. The use of salt flingers and a counter flow screw machined into the main shaft will reduce the salt migration up the shaft. Based on the shaft speed and liquid levels in the tank a secondary screw maybe required. The size and design of the screws and flingers will vary based on the temperatures and type of salt used.**

**In the second cooling zone, just above the seal area heat fans are used to reduce the shaft temperature to 65 deg C before reaching the thrust bearings. The design of this area may require external fans to be used to cool the shaft if the pump sets idle for long periods of time.**

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# Failure Mode Analysis

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**Identifing the primary failure modes of your molten salt pumps will help define the Predictive Maintenance Program requirements needed to insure a trouble free system.**
**All systems are different. An evaluation of the design of pump used in your system, what the operational secquence is and the general site condition will define the failure modes. The major areas that need to be evaluated are the bare pump, coupling, motor , VFD drive, discharge assembly above the mounting plate and the sealing area of the pump to the tank. Once failure modes for each of these areas are identified, a stocking program needs to be put into place so that spare parts are on site to minimize repair time and lost production.**

**It is important to evaluate each of these components for their ease of maintenance. One example on the bare pump is the thrust bearings. A well designed molten salt pump will permit the thrust bearings to be replaced without removing the hot pump. This will save many hours of lost production.**

# Monitoring of Molten Salt Pumps

**Monitoring of Molten Salt Pumps is a critical part of a predictive maintenance program. Predictive Maintenance programs are cost effective option, since action is only taken when the equipment shows a progression of failure. Equipment may be shut down before severe and/or secondary damage occurs to the system. Required maintenance work can be scheduled or planned for normal plant shutdowns. A multi-technology approach to condition monitoring offers the best analysis of this critical equipment. Vibration analysis, thermal analysis of bearings, oil or grease analysis, alignment, horse power and visual inspections all provide necessary input to condition monitoring. Any successful predictive maintenance program, not only has a technical element, but also has a human element where experience and knowledge in evaluating the techical data work together to maintain a trouble free molten salt system.**

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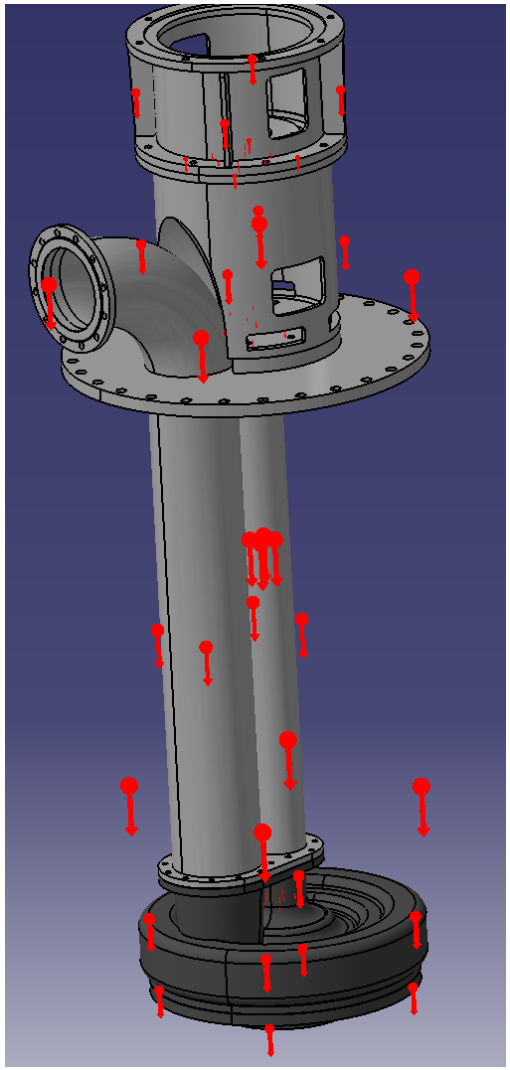
## Forces



Gravitational Forces

of 9.81m/s$^2$

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# GVSO Pumps

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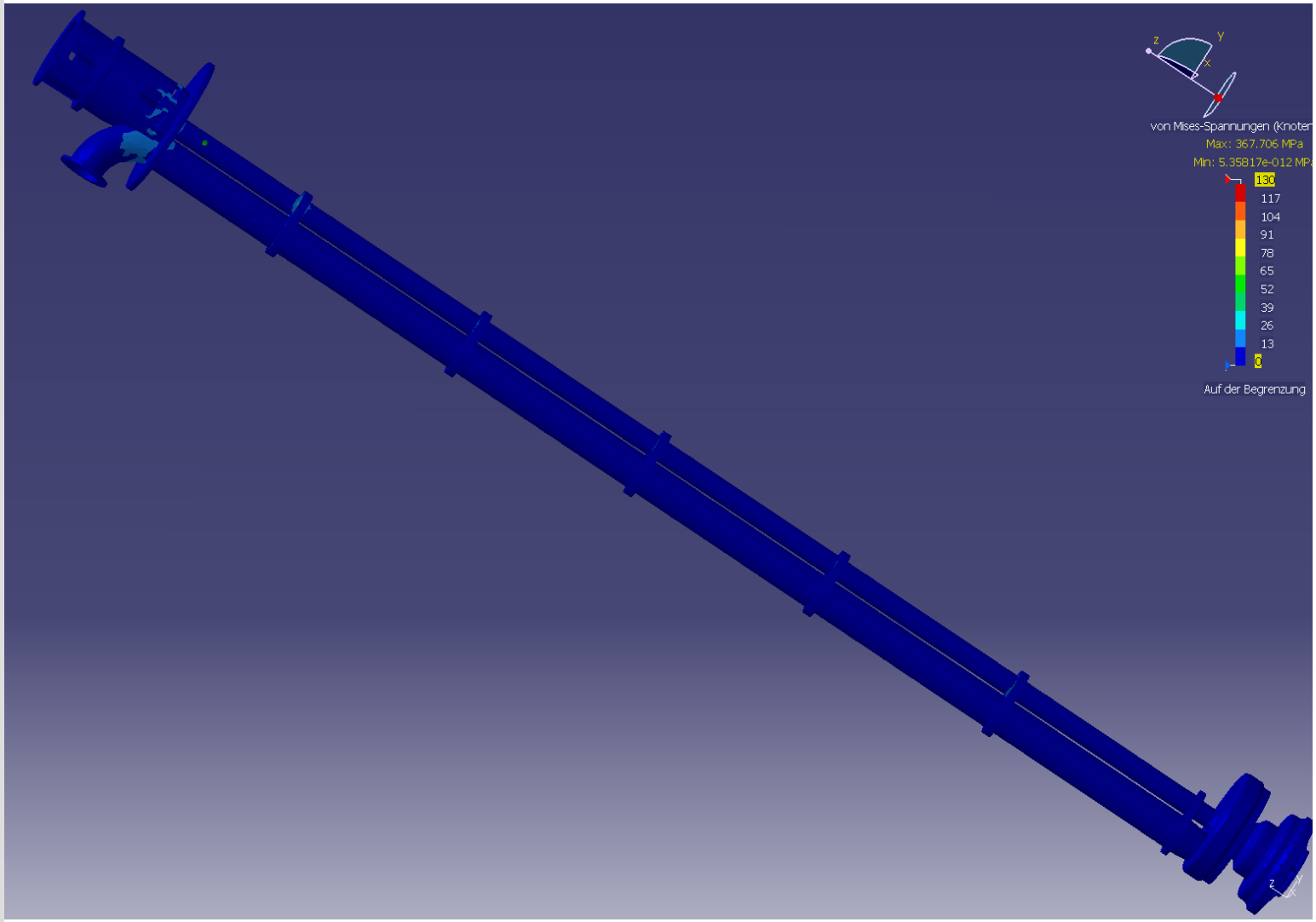
**Available in Lengths of 8 to 16 meter**

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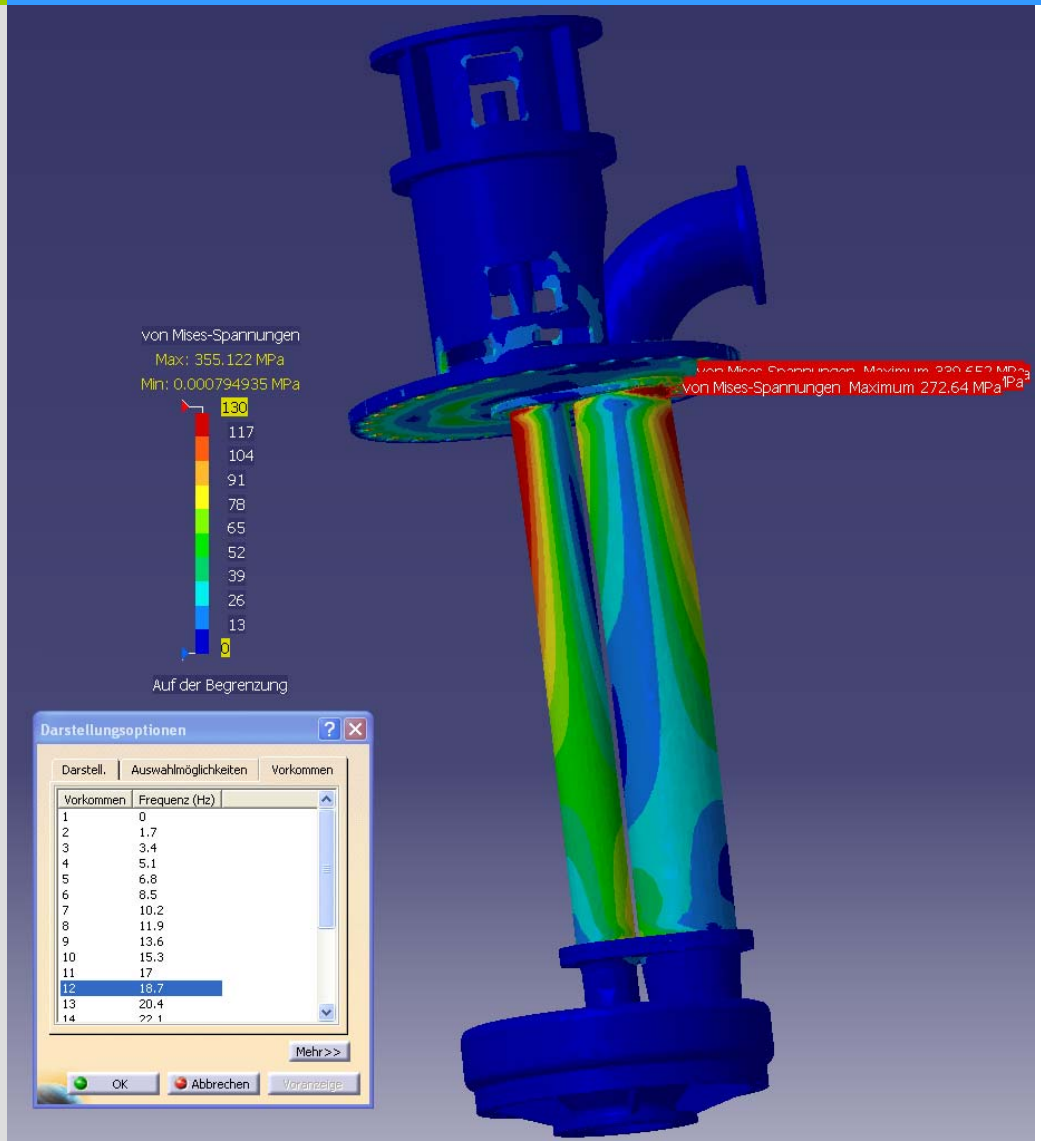
RHEINHÜTTE PUMPEN

# Van Mieses Forces Deflection

**18,7 Hz**
**1122 U/min**
**TT=2,10m**

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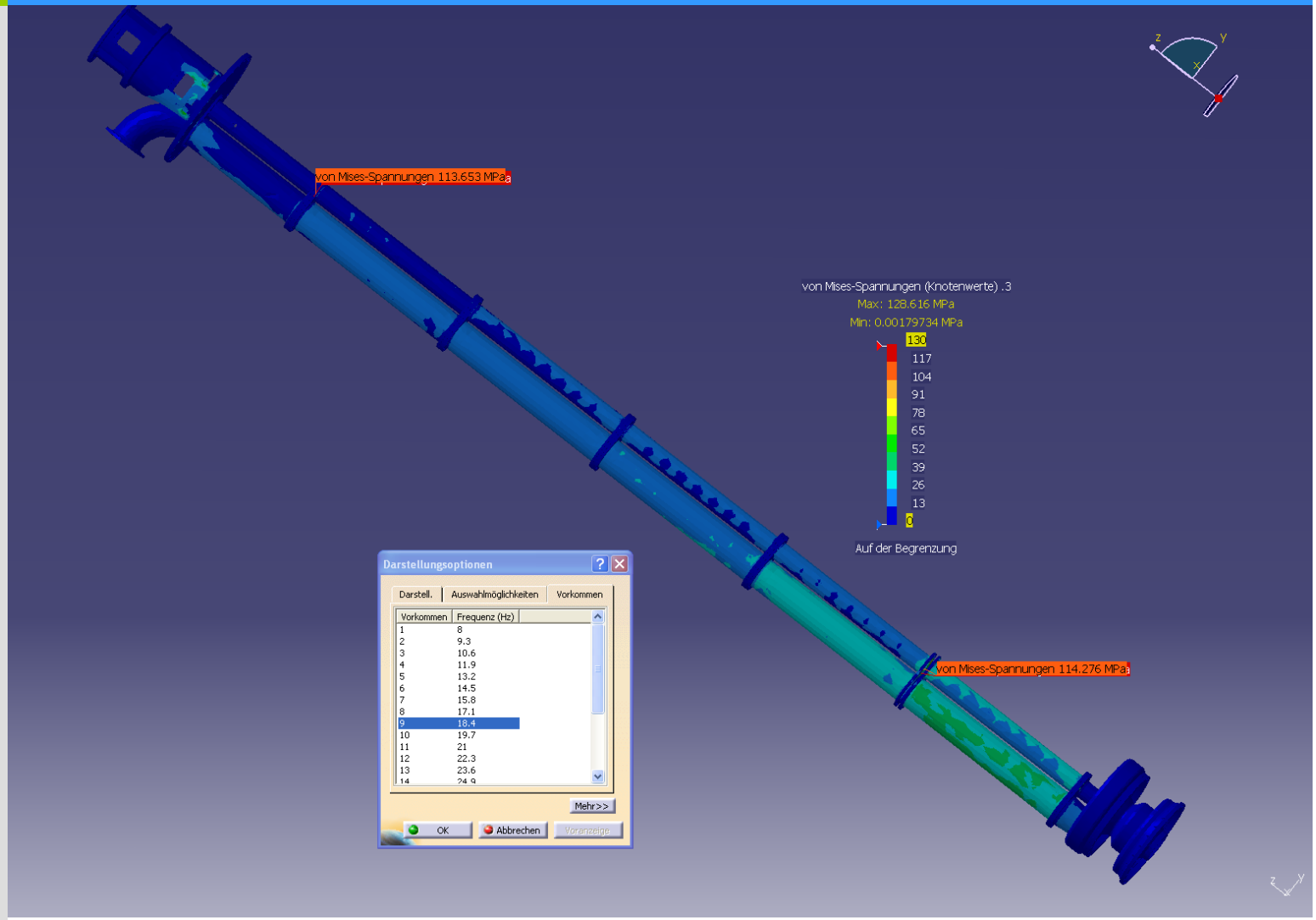
# Van Mieses Forces Deflection

**18,4 Hz**
**1104 U/min**
**TT=10m**

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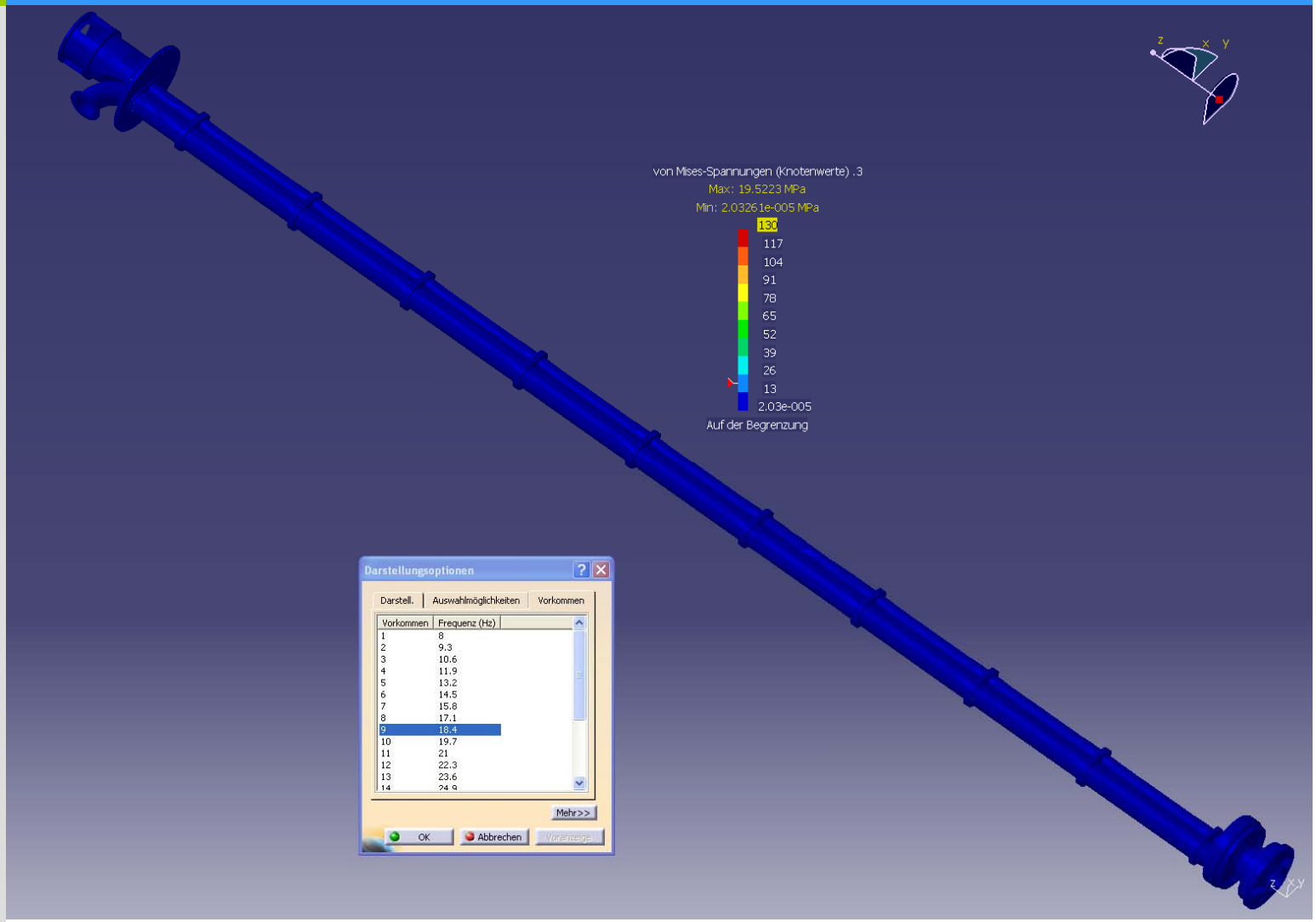
RHEINHÜTTE PUMPEN

# Van Mieses Forces Deflection

**18,4 Hz**
**1104 U/min**
**TT=16m**

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# GVSO Design Pumps

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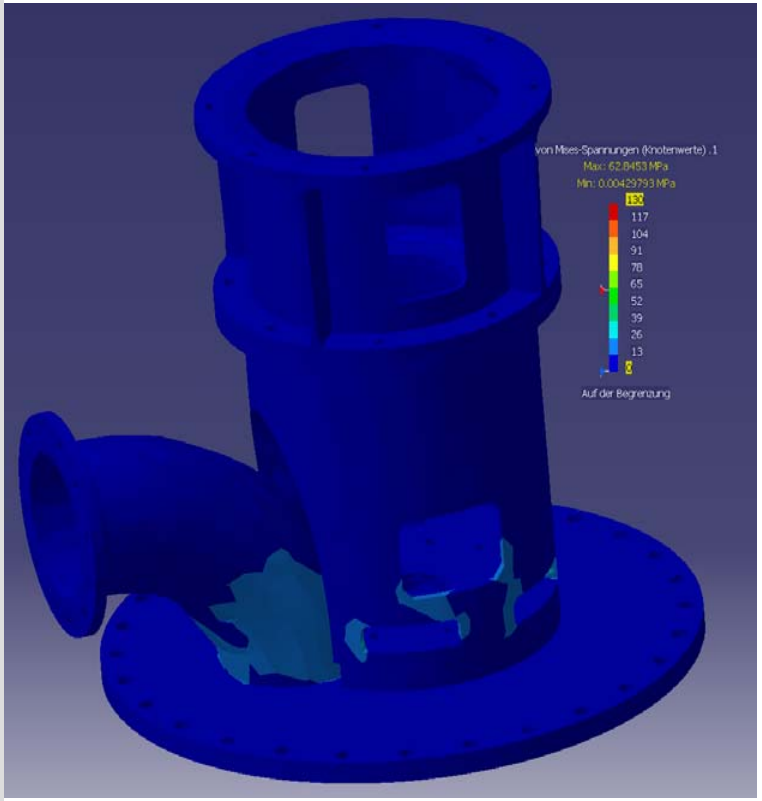


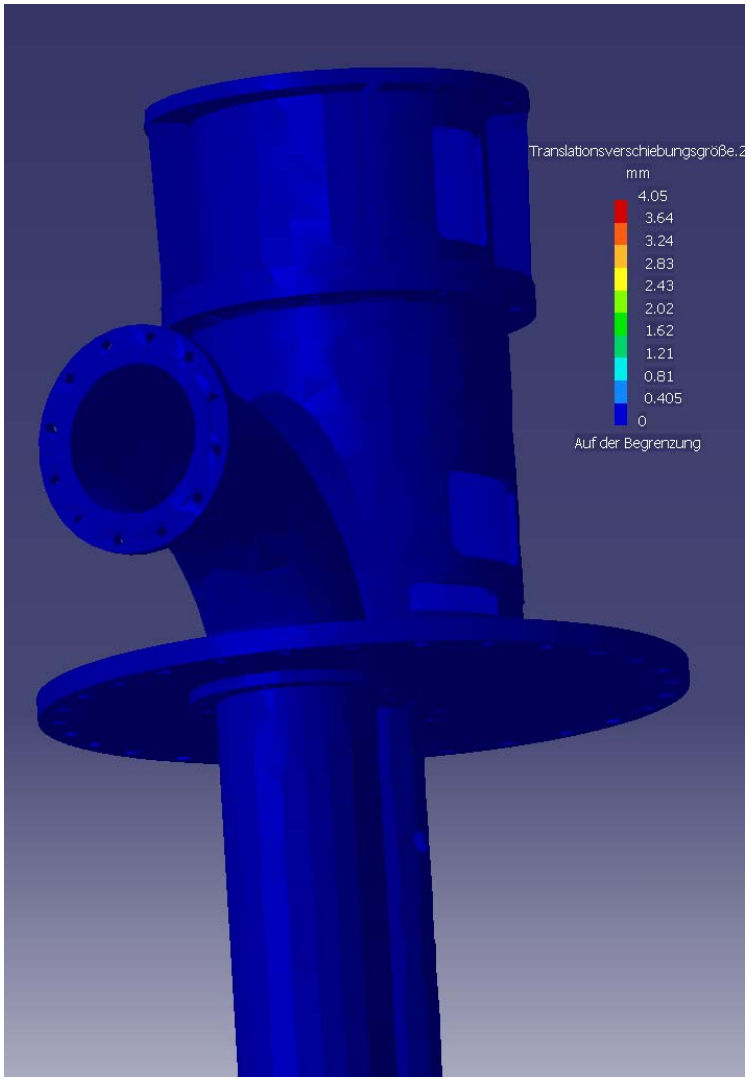


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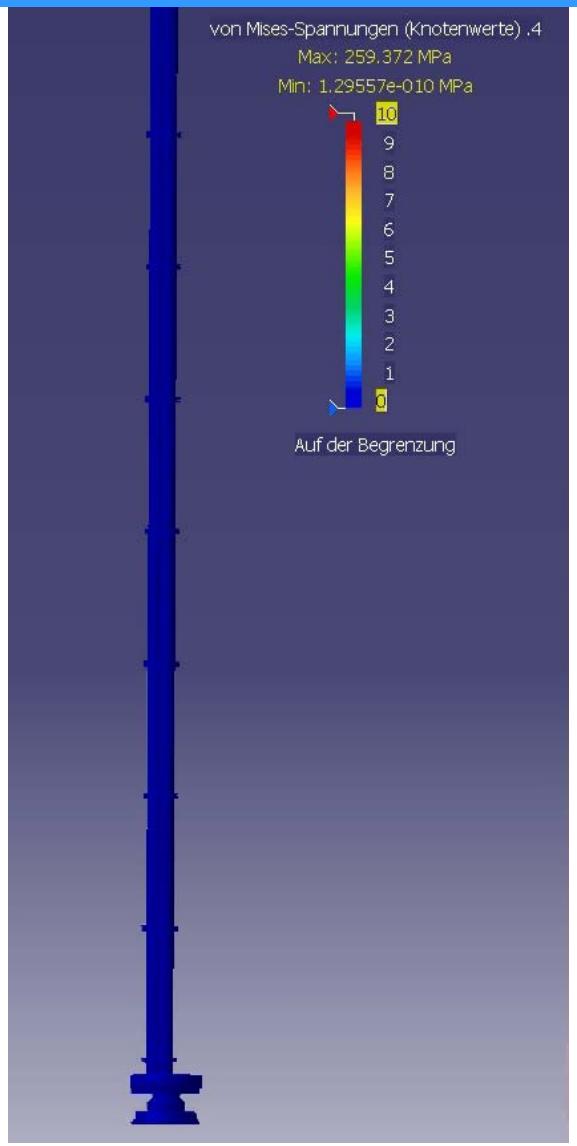


# GVSO Pumps

**GVSO Pumps are designed to be the most economical Long Setting Molten Salt Pump offered**

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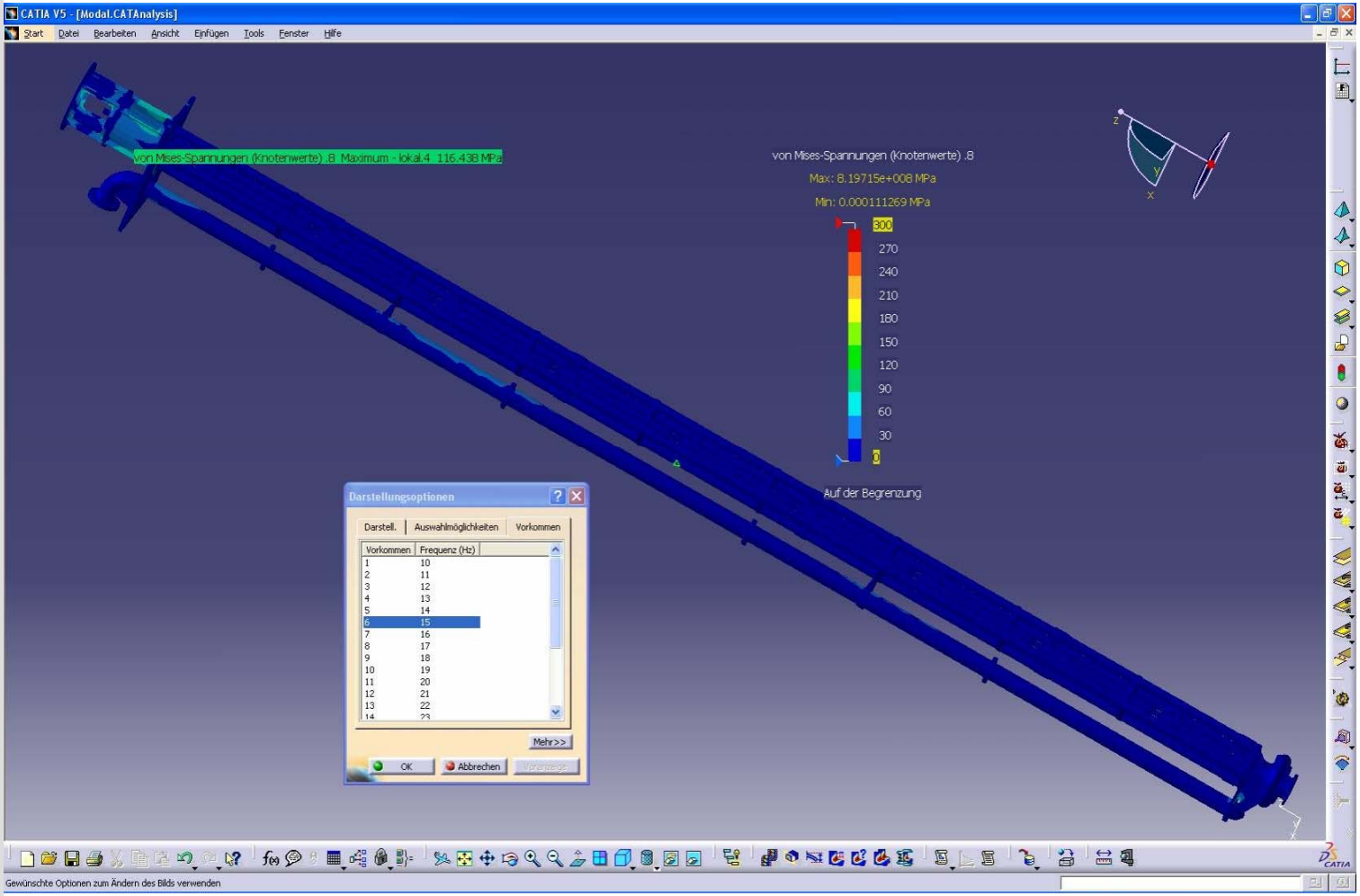
# GVRS Design

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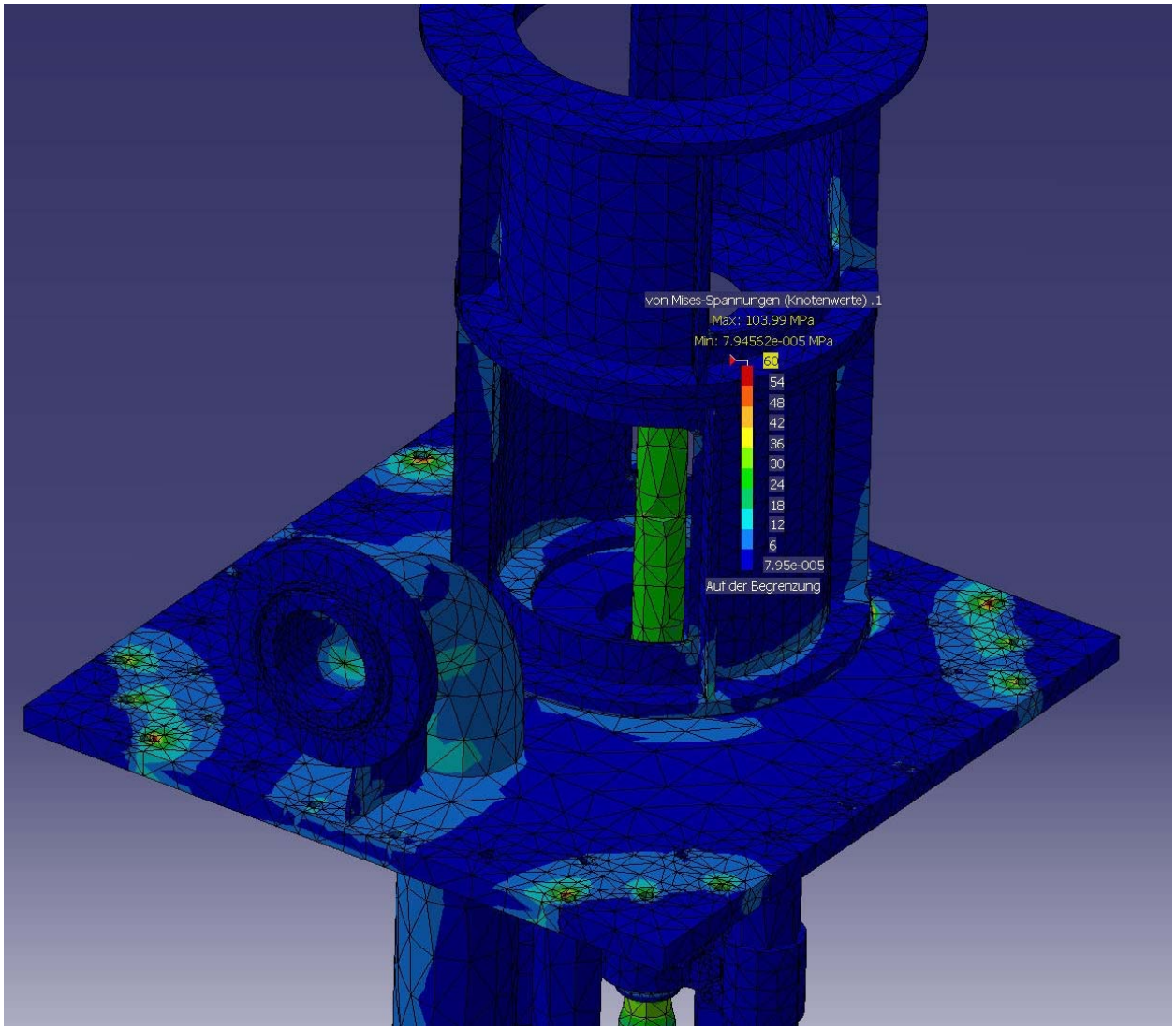
# GVRS Design

## Friatec Engineering

**FEA modeling will insure designs that will withstand the stresses created by such a difficult application.**

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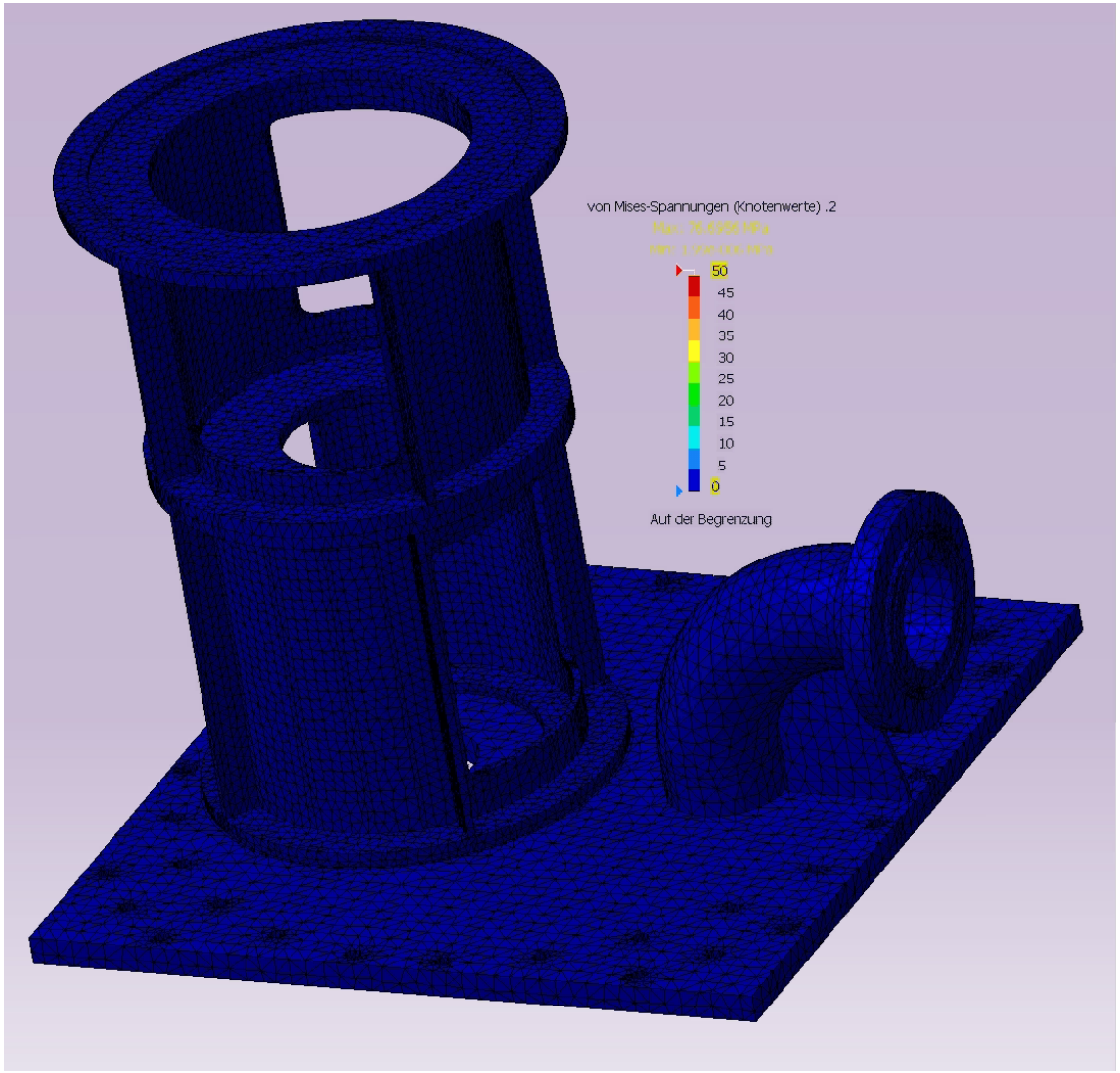
# GVRS Design




**FEM of GVRS Pump Mounting plate shows the typical movement that these pumps will have to withstand.**

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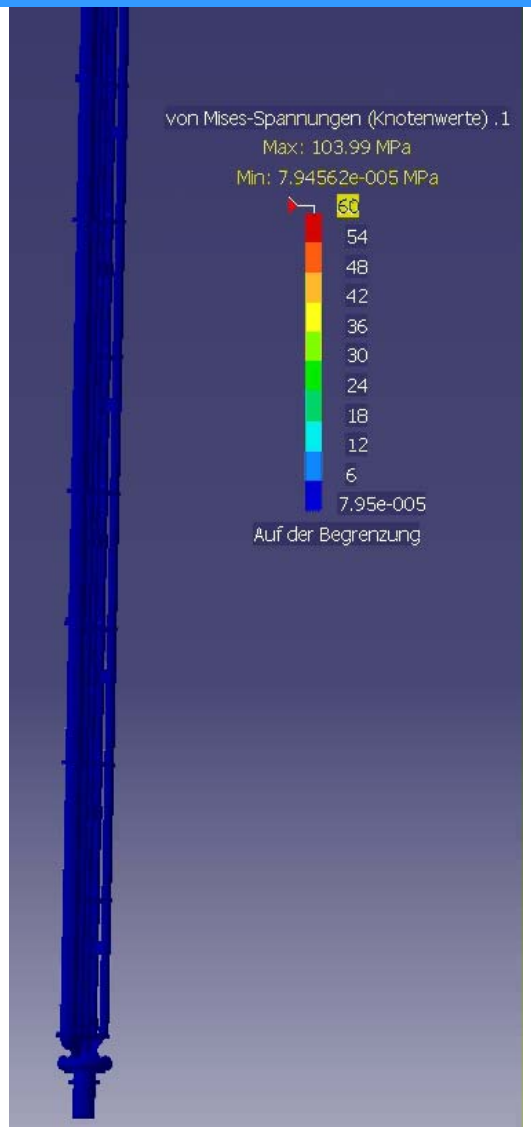


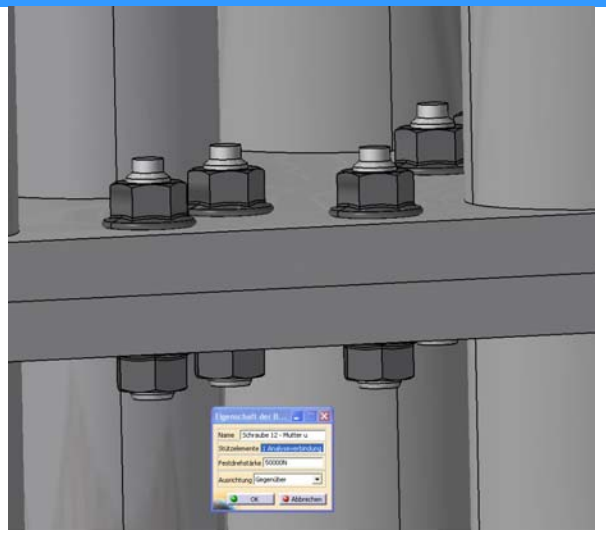

# GVRS Pumps

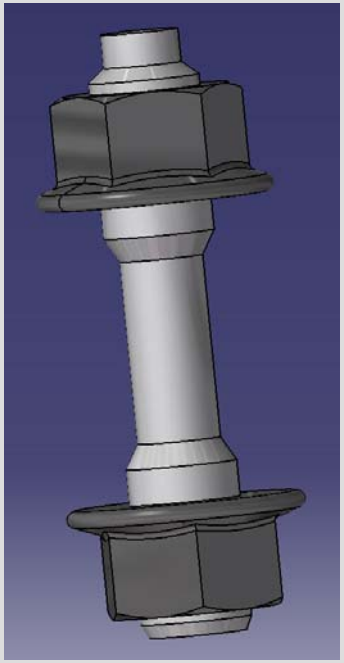
**GVRS Pumps are designed to be the most Maintenance Friendly Pump offered for Molten Salt Systems**

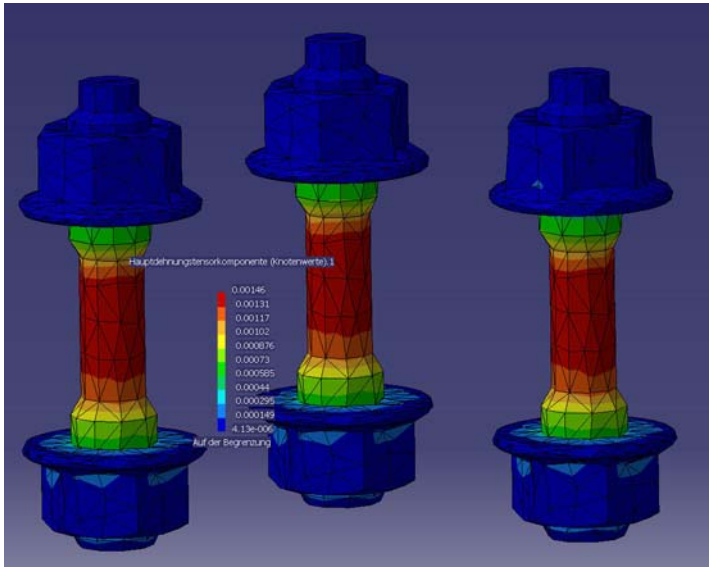
**FEM of GVRS Pump shows typical movement that these pumps will have to be designed to withstand.**

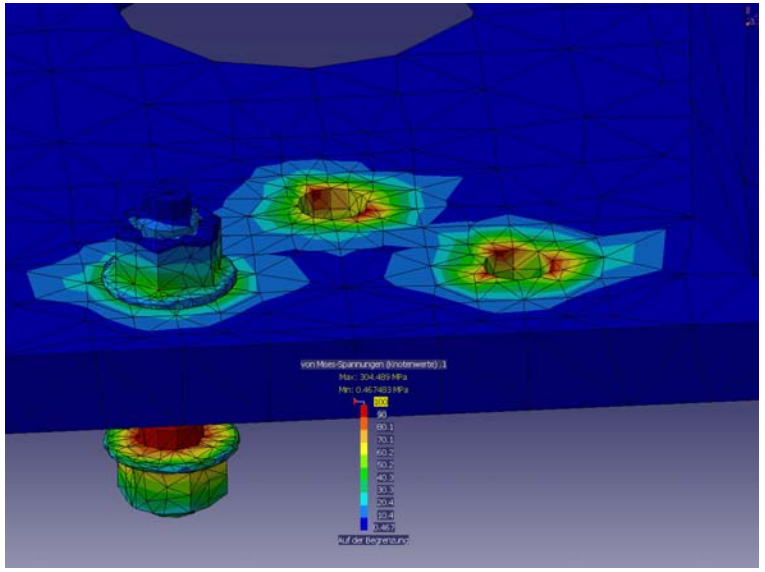
# Little but Critical

**Too often little things are over looked when designing critical equipment. Fasteners are one of these items. It is imperative that fasteners for molten salt pumps are evaluated as closely as the main components of the pump.**









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# Success in Thermal Storages Systems Testing at PSA

Installed 25 years ago at PSA

**Friatec has been involved in testing programs at PSA for over twenty five years.**

**Currently we have supplied pumps and valves for testing systems that will be used for Solar Power Towers and troughs around the world.**

**Test Facilities such as PSA, ENEA, NREL and Sandia insure owners of Solar Power Plants with proven technologies.**

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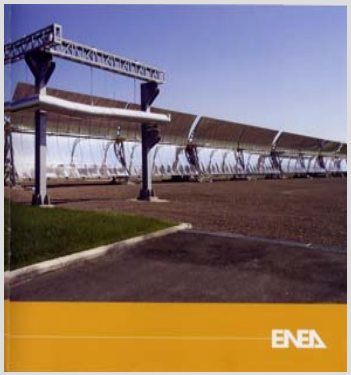
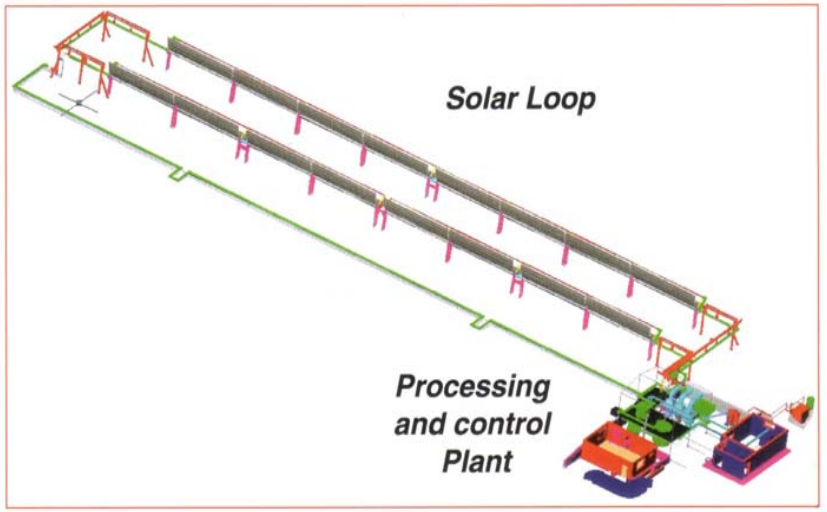
# Success in Thermal Storages Systems Testing at ENEA

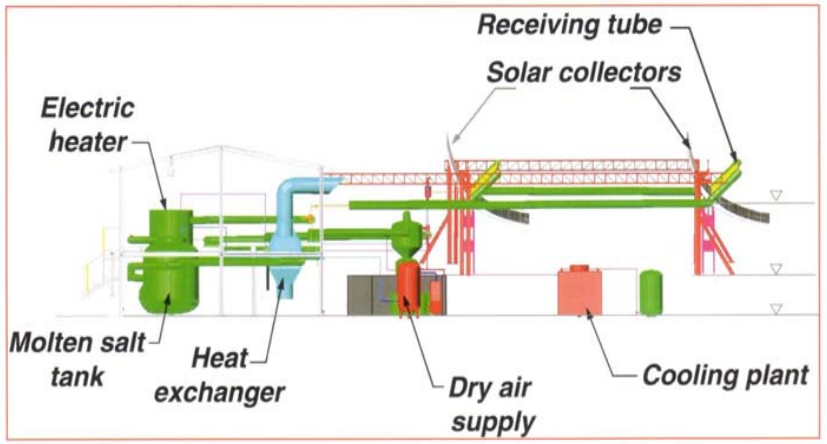



**Friatec has supplied pumps to ENEA from the start of their testing program using Molten Salt directly in the trough field.**

**The technology that is being developed by ENEA in Italy will one of the most advanced trough systems in the world.**

**Friatec is the world leader in Molten Salt Technology based on the experience they have gain from Testing programs from around the world.**

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# Important Things to Remember

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**When designing your molten Salt System, keep in mind that the pump will be the Heart of your system. This single piece of equipment is one of the most critical components of your system, if it does not operate properly, your system will have major problems or even fail. Having the pump manufacturer as part of your design team as early as possible will be very effective in eliminating costly mistakes. The experience of the pump manufacturer in handling various molten salt applications is the key to applying the proper design and proven technology to your system. Both the selection of materials of construction and the design must be based on actual experience and proven design features. Be sure that the pump manufacturer that you select has the experience in evaluating the chemical reactions between the type of salt, temperatures and materials used in the pump, CFD and FEA analysis design capabilities, specialized manufacturing techniques and can support you with the correct condition monitoring systems, predictive maintenance programs and proven repair procedures.**

# Success is Built on Relationships

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**Friatec-USA offers it's customers the most effective options for their Molten Salt Thermal Storage Systems by building relationships with companies such as Bertrams-Heatec, Inc. to supply complete turn-key**

**Bertrams-Heatec, Inc. offers all plant components and engineering services from a singe source – from project planning through fabrication, to site installation. Everyone of their systems is customized to meet your specifications. Friatec has been the main supplier of molten salt pumps for more than twenty-five years to Bertram-Heatec.**

# Success is Built on Relationships

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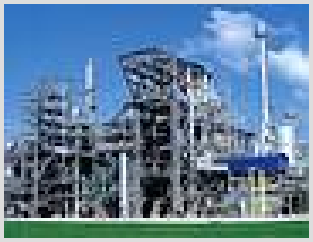
**Fraitec-USA and Bertrams-Heatec, AG have built relationships with Key Companies such as Nexant, Tank Industries Consultant, Caldwell Tanks, Inc, SQM and many others to offer the highest technology that can provide all of the components including salts for Melting Systems and Thermal Storage Systems for Troughs and Power Towers.**

**Courtesy of Caldwell Energy**
**Division Of Caldwell Tanks, Inc.**

# FRIATEC-Rheinhutte Pumps and Valves,LLC Represents Bertrams-Heatec in the USA Supplying Complete Thermal Storage Systems



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## Plants Throughout the World

**Steven Koning**

**Executive Sales Director**

**Over 3000 units have been put into service by more than 750 clients throughout the world. Bertrams-Heatec is an engineering and construction company which concentrates on technologies and plants for thermal process heating systems for any kind of processes and the related** technologies worldwide.

MOLTEN SALTS

Steven.koning@bertrams-heatec.com Direct Tel: 011 41 61 467 75 31