TREM Engineering:
MECHANICAL SEALS AND DRYGAS SEALS
FOR OIL AND GAS

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The technology is determined by our mission:
To provide the Customer with products and services of such a high quality that the Customer will rely on us as the main partner in mechanical seals and gas seals.

Where does quality come from?
- A lot of effort has been invested into mechanical seal design. Design starts with FEA calculations of critical components, for example, seal faces or welded metal bellows. As a result, TREM Engineering can boast outstanding performance of mechanical seals, be it lower heat generation in high pressure applications or long life of metal bellows assemblies (no fatigue cracking for at least 5-7 years).
- A lot of effort has been invested into the compact design so that the standard high performance seals fit most seal chambers. For example, our stationary metal bellows seal or dry gas seal are compact but sturdy. Also, being standard, they are not expensive.
Products
Proven sealing solutions for industrial use
- mechanical seals and seal systems
- dry gas seals and control panels for compressors

Our customers
- oil and gas producing companies
- oil and gas refineries
- oil and gas pipelines
- petrochemical plants
- chemical industry
- power generation industry

Manufacturing
- Our Manufacturing and Service facilities are located in Russia and occupies an area of over 7,000 square meters. manufacturing and service.
- For manufacturing mechanical seals, API 682 — specified materials and seal designs are used.
- CNC machining makes production efficient.
- Several test rigs have been installed to test mechanical seals and dry gas seals.
- Quality is assured by an ISO9001-2001 certified quality system.
- Customers enjoy product support of TREM Engineering, be it application engineering, product-specific training, mechanical seal installation, or repair.

Engineering
Our engineers support our customers starting from choosing proper seal design and up to installation, commissioning, performance monitoring, maintenance, and repair.
Leading mechanical seal manufacturer in Russia for Oil & Gas*

WE GAIN EXPERIENCE

Seals performance at more than 25 major refineries and petrochemical plants with overall refining capacity 390,000 cubic meters a day has been analyzed.

WE DESIGN

Design is based on FEA calculations and is backed up by more than 80 years of history of Russian mechanical seal industry.

WE MANUFACTURE AND TEST

Best western and domestic equipment are used for seal manufacturing and testing.

WE PUT INTO OPERATION AND TRACK OPERATION HISTORY

TREM Engineering and Customer engineers work together starting from seals installation and commissioning and up to "plant through" seal MTBR optimization program.

* based on the reports at the 2008 Annual Meeting of Senior Mechanical Engineers (of Russian oil refineries)
### Trem Engineering Advantages

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proven seal range for almost any pump at oil/gas exploration, transportation, refining and petrochemical industries. Deep knowledge of equipment operational conditions specifics.</td>
<td>Very good seal durability and standardization through all customer process units. Customer may implement &quot;company through seal/pumps maintenance costs optimization program&quot; with just one supplier.</td>
</tr>
<tr>
<td>Competitive pricing both for complete seals and spare parts kits.</td>
<td>Lower running costs of pumps</td>
</tr>
<tr>
<td>Comprehensive SD and RDT dual seal families for both hot and cooler applications for oil refinery units starting from atmospheric and vacuum distillation to hydrocracker and ethylene units.</td>
<td>The SD and RDT seals have won the trust of refinery engineers in Russia and nowadays about 70% of Russian major refinery critical process pumps are equipped with our seals.</td>
</tr>
<tr>
<td>Highly professional seal application engineers “trained” by pumps of more than 25 Russian and CIS refineries and petrochemical plants attend to customers’ needs.</td>
<td>Most of our customers have chosen TREM Engineering engineers as main consultants and trouble shooters for ALL seals, including seals of famous western manufacturers.</td>
</tr>
<tr>
<td>The compact design of our high performance seals and flexible manufacturing allows us to fit proven standard designs to almost any seal chamber of almost any pump.</td>
<td>The majority of oil refineries in Russia and CIS have switched most of their Flowserve, Sulzer, Borg Warner, KSB and other western pumps to Trem Engineering seals.</td>
</tr>
</tbody>
</table>
Mechanical seals for oil and gas refinery, petrochemical applications

**APITERM SD** Cartridge dual welded metal bellows “o rings free” mechanical seal (API 682, Type C)

**Description**
The APITERM (R) mechanical seal is the new addition to the SD family of welded metal bellows mechanical seals. These seals are mainly designed for sealing hot hydrocarbons at oil refineries and petrochemical plants. SD family seals correspond to API682, type C seal. The APITERM SD mechanical seal can be used both in tandem (API682 Arrangement 2) and double (API682 Arrangement 3) modes. Also, contacting wet and dry running outboard seal versions are available.

**Advantages**
- Almost the only stationary bellows tandem seal on the market fitting API 610 standard seal chambers (a stationary bellows seal offers many advantages to the end user);
- Double layer tilted edge inner bellows as standard;
- Same design for API Plans 52, 53, and 54;
- This seal shares many parts with APILITE RDT seal which makes production cheaper.

**Technical data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>From 70 up to +425°C</td>
</tr>
<tr>
<td>Dynamic Pressure</td>
<td>Up to 65 bar</td>
</tr>
<tr>
<td>Static pressure</td>
<td>Up to 90 bar</td>
</tr>
<tr>
<td>Linear speed</td>
<td>Up to 50 m/sec</td>
</tr>
</tbody>
</table>

**Materials**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal bellows</td>
<td>Inconel 718, Alloy 276, AM350</td>
</tr>
<tr>
<td>Seal faces</td>
<td>Tungsten carbide, Silicon carbide, Carbon, Trembide 85, Trembide 50</td>
</tr>
<tr>
<td>Secondary seals</td>
<td>Flexible graphite</td>
</tr>
<tr>
<td>Metal parts</td>
<td>SS304, SS316, SS321H, Special alloys</td>
</tr>
</tbody>
</table>

**Recommended API Plans for APITERM SD seals**

<table>
<thead>
<tr>
<th>API 682 Flush Plan</th>
<th>Description</th>
<th>Application guidelines</th>
<th>Seal systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>Non pressurized external fluid reservoir with forced circulation</td>
<td>Most of light and heavy hydrocarbons, alcohols, solvents, etc</td>
<td>Barrier fluid tank with heat exchange, SO 1 (high temperature applications) or SO 3, SO 12, SO 20 with ball valves and instrumentation</td>
</tr>
<tr>
<td>53</td>
<td>Pressurized external fluid reservoir with forced circulation</td>
<td>Fluids with high content of mechanical impurities, hazardous fluids, crystallizing fluids</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Circulation of clean fluid from external system</td>
<td>Fluids with solids, crystallizing fluids</td>
<td></td>
</tr>
<tr>
<td>11, 13</td>
<td>Recirculation from/to pump case through orifice to/from seal</td>
<td>VOCs</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Steam or nitrogen quench supplied after the inbord seal</td>
<td>Coking and solidifying fluids (mostly hydrocarbons)</td>
<td>Supply system for the dry running outboard seal</td>
</tr>
</tbody>
</table>
Mechanical seals for oil and gas refinery, petrochemical applications

APITERM SD mechanical seal diagram

APITERM SD seals were successfully designed for the pumps of many famous manufacturers:
- Sulzer
- Flowserve
- Worthington
- KSB
- Byron Jackson
- RuhrPumpen
- EBARA
- Nigata
- Ingersoll Dresser Pumps

All of the above systems can be supplied with:
- level sensors/indicators
- pressure switch, temperature sensor
- safety valve
- ball valves
- and other C&I devices and valves
SINGLE BELLOWS SEALS FOR HIGH TEMPERATURE APPLICATIONS (API 682, TYPE C)

Description
SO series welded metal bellows cartridge single mechanical seals are designed for sealing many fluids including chemically aggressive with temperature from 70 to +425 °C.

Advantages
- Welded metal bellows mechanical seals feature no rubber secondary seals; all seal components are made of advanced thermally and chemically resistant materials to substantially expand the range of application temperatures and fluids.
- The SO series mechanical seals are fitted with a throttle bushing as a secondary seal; it can be used to seal inflammable fluids in compliance with OST 26 06 2028 96.
- Being a single seal, the SO mechanical seal’s support system is by far less complicated than that of a double mechanical seal (but before use please check if you are allowed to use a single seal for the specific application).
- Compared to spring loaded mechanical seals metal bellows seals are more resistant to clogging and hang up.
- Shaft sleeve is sealed by a gland tightened graphite gasket. This provides for higher sealing safety especially with worn out or scratched/galled shafts.
- Metal bellows mechanical seals are balanced, so they have lower heat generation.

Materials

<table>
<thead>
<tr>
<th>Materials</th>
<th>Bellows</th>
<th>Seal rings</th>
<th>Secondary seals</th>
<th>Metal items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alloy AM 350, Hastelloy°C, Inconel 718</td>
<td>Tungsten carbide, silicon carbide, carbon graphite, Trembide 85, Trembide 50</td>
<td>Flexible graphite with or without stainless steel reinforcement</td>
<td>Stainless steel SS304, SS316, SS321H</td>
</tr>
</tbody>
</table>

Technical data

<table>
<thead>
<tr>
<th>Temperature</th>
<th>From 70 to +425°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Up to 65 bar (with reinforced bellows), 90 bar static</td>
</tr>
<tr>
<td>Linear speed</td>
<td>Up to 50 m/sec (with stationary bellows)</td>
</tr>
</tbody>
</table>

Recommended API Plans for SO seals

<table>
<thead>
<tr>
<th>API 682 Flush Plan</th>
<th>Description</th>
<th>Application guidelines</th>
<th>Seal systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>11, 13</td>
<td>Recirculation from/to pump case through orifice to/from seal chamber before the seal</td>
<td>VOCs, crystallizing fluids, fluids with solids</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Steam or nitrogen quench, applied between main seal and throttle bushing</td>
<td>Coking and hardening fluids (mainly hydrocarbons)</td>
<td></td>
</tr>
</tbody>
</table>
SO seal general layout (rotary bellows version shown)

The seal is designed to every pump individually. Due to compactness of SO seals in radial direction they can be installed into sealing chamber of most pumps, mixers, reactors and other equipment, including imported one.

To receive an offer for SO mechanical seals for specific applications, it is advisable to fill in the seal selection form.

SO seals were successfully designed for the pumps of many famous manufacturers:
- Sulzer
- Flowserve
- Worthington
- KSB
- Byron Jackson
- RuhrPumpen
- EBARA
- Nigata
- Ingersoll Dresser Pumps

“TREM Engineering SO seals not requiring an additional heat exchanger proved to be reliable solution for hot pump with coke particles in fluid”

SIBUR
Mechanical seals for oil and gas refinery, petrochemical applications

APILITE RDT
TANDEM PUSHER SEAL (API 682, TYPE A)

Description
The APILITE (R) mechanical seal is a new addition to the RDT cartridge seal family. It is designed for sealing heavy and light hydrocarbons, including VOCs, and other hazardous fluids at oil refineries and petrochemical plants, gas plants, and chemical plants. APILITE RDT seal is an o-ring dual seal to be used with API Plan 52, 53, or 54.

Advantages
- Minimized bending of seal rings allows for stable operation under higher pressures and for longer MTBR (mean time between repair) because of less wear;
- Same seal can be used in tandem and double applications;
- Interchangeability of many parts and design solutions with the SD APITERM seal reduces inventory of spare parts, lets the seal survive under pump dry running, and decreases prices by encreasing parts production volume;
- Tolerates pump dry running even in tandem mode;
- Containment outboard seal version available for API 682 flush plans 71 and 72;
- Connections for API 682 flush plans 11/13, 21, 22, 31, 32, and 52/53/54 are provided as standard.

Technical data

<table>
<thead>
<tr>
<th>Parameter</th>
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<tbody>
<tr>
<td>Temperature</td>
<td>From 50 up to +260°C</td>
</tr>
<tr>
<td>Dynamic Pressure</td>
<td>Up to 50 bar</td>
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<tr>
<td>Static pressure</td>
<td>Up to 90 bar</td>
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<tr>
<td>Linear speed</td>
<td>Up to 50 m/sec</td>
</tr>
</tbody>
</table>

Recommended API plans for APILITE RDT seal

<table>
<thead>
<tr>
<th>API 682 Flush Plan</th>
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<th>Application guidelines</th>
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<td>52</td>
<td>Non pressurized external fluid reservoir with forced circulation</td>
<td>Most of combustible liquids, volatile flammable liquids (light and heavy hydrocarbons), alcohols, solvents, ethanolamine, etc</td>
<td>Barrier fluid tank with heat exchanger SO 1, SO 3, SO 12 or SO 20 with auxiliary valves</td>
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<td>53</td>
<td>Pressurized external fluid reservoir with forced circulation</td>
<td>Fluids with high content of mechanical impurities, hazardous fluids, crystallizing fluids</td>
<td>Barrier fluid tank with heat exchanger SO 1 (high temperature applications) or SO 3, SO 12, SO 20 with ball valves and instrumentation</td>
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<td>54</td>
<td>Circulation of clean fluid from external system</td>
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Materials

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<th>Materials</th>
<th>Specifications</th>
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</thead>
<tbody>
<tr>
<td>Seal faces</td>
<td>Tungsten carbide, Silicon carbide, Carbon, Trembide 85, Trembide 50</td>
</tr>
<tr>
<td>Secondary seals</td>
<td>Viton®, ethylene propylene, Kalrez®, etc.</td>
</tr>
<tr>
<td>Metal parts</td>
<td>SS304, SS316, SS321H, Special alloys</td>
</tr>
<tr>
<td>Springs</td>
<td>Hastelloy® C</td>
</tr>
</tbody>
</table>

All of the above systems can be supplied with:
- level sensors/indicators
- pressure switch
- temperature sensor
- safety valve
- ball valves
- and other C&I devices and valves

Level sensors/indicators
Pressure switch
Temperature sensor
Safety valve
Ball valves

TREM Engineering, 105077, Russia, Moscow 77, P.O. Box 151, tel.: +7 (495) 780 7676, fax: +7 (495) 780 4151, e-mail: order@trem.ru, www.tremseals.com
**RO**

**SINGLE SEAL FOR OIL & GAS APPLICATIONS**

**Description**
RO family seals are mainly designed for sealing crude oil, water and petroleum products in the oil & gas industry. There are several specially engineered seals to cover the needs of the industry:

- **Seal for water injection pumps.** This seal has special design to protect the dynamic o ring from hang up and to allow for shaft axial movement of 10 mm to compensate for thrust bearing wear. This new seal has had huge success and is widely used now at TNK BP’s biggest oil producing division in Russia.
- **Special seal for pumps pumping crude oil to main crude oil transportation pumps.** This seal also features 10 mm axial movement capability.
- **Seal for main crude oil transportation pumps.**
- **New: 50 – series high pressure mechanical seal.** The new seal operates with less friction, less wear and 10 times less leakage compared to older generation seals. Although new, this seal has already proved its high pressure capability at crude oil pumps and boiler feed water pumps.

**Technical data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>From 70 to +260 °C</td>
</tr>
<tr>
<td>Static Pressure</td>
<td>Up to 100 bar (200 bar with special design)</td>
</tr>
<tr>
<td>Dynamic Pressure</td>
<td>Up to 100 bar (50 series seal)</td>
</tr>
<tr>
<td>Linear speed</td>
<td>Up to 50 m/sec</td>
</tr>
</tbody>
</table>

**Advantages (depending on seal model)**
- Ability to compensate for huge shaft travel
- No O ring hang up
- High pressure capability

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**Oil exploration**
**Water injection multistage pumps**

**Pipeline high pressure applications.**
**Refinery high pressure applications.**
**SGDU GAS SEAL FAMILY**

**Description**

Use of dry gas seals in centrifugal compressors has increased dramatically during the last 20 years because these seals provide many benefits for the end user. In gas seals lubricating oil is not used, thus it can no longer contaminate the process.

All manufactured gas seals are run on test rigs at working parameters as well as beyond them (speed). Customers are welcome to visit our facility for a witnessed test. The procedure is as per API 617 Standard.

For compressors at GAZPROM’s natural gas pipeline transportation and distribution network, TREM Engineering has designed two series of dry gas seals:

1. SGDU 210 Gas Seal – for compressors NC 16 series (16 MW) – a compact gas seal with traditional carbon vs tungsten carbide faces.
2. SGDU 220 Gas Seal – for compressors PCL 804 series – a gas seal with diamond coated silicon carbide faces with varying depth of grooves.

For compressors at oil refineries and petrochemical plants, SGDU 210 Gas Seal is recommended.

TREM Engineering offers to its customers not only new gas seals and control systems. A complete package to upgrade a compressor from oil seals to dry gas seals is available. In this very popular package, besides seals, engineering, control panels and necessary new parts are included.

The following compressor sealing products are manufactured:

- Tandem seal, with additional labyrinth seal or without it
- Double seal, with additional labyrinth seal or without it
- Triple seal for extra clean processes (combination of tandem and double seals so that nitrogen does not get into the process, but the process gas does not get into the bearing / shop atmosphere as well)
- Single seal
- Rigid radial and thrust bearings (useful when upgrading from oil mechanical seals)
- Control panels, Emerson (Fisher/Rosemount) based (useful when upgrading from oil mechanical seals or for supply to OEM).

In addition, nitrogen generation, air supply systems and temperature & vibration monitoring systems can be offered.

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**Technical data**

<table>
<thead>
<tr>
<th>Shaft size, mm</th>
<th>50 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed, RPM</td>
<td>100 14000</td>
</tr>
<tr>
<td>Temperature, °C</td>
<td>50-200</td>
</tr>
<tr>
<td>Pressure, bar (dynamic)</td>
<td>100</td>
</tr>
<tr>
<td>Pressure, bar (static)</td>
<td>150</td>
</tr>
</tbody>
</table>

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The following jobs have been successfully done by 2010:

- New complete compressor sealing systems at
  - Syzran Oil Refinery, Russia
  - Omsk Oil Refinery, Russia
  - Mozyr Oil Refinery, Byelorussia.

New dry gas seals to replace original seals at

- Omsk Oil Refinery, Russia
- Nizhnekamsk Oil Refinery, Russia
- Gazprom’s Zavolzhskaya natural gas transfer station.

A number of other manufacturer’s dry gas seals have been repaired (the list available upon request).
Mechanical seals for oil and gas refinery, petrochemical applications

Photos of dry gas seals in the field
Major compressor upgrade job replacing wet seals with dry gas seals. Project: Oil refinery at Angarsk Petrochemicals (Rosneft), Angarsk, Russia, 2009. The transferred gas is petroleum gas with high content of solids and heavier fractions condensate!

This is the old wet seal. The compressor is horizontally split. The wet seal was part of the lubricating system so with the wet seal removed the lubrication system had to be modified.

New dry gas seal on compressor rotor, ready for installation.

Compressor being closed.

Job almost done. The complete job included wet seal removal, modification of the lubricating system, dry gas seal installation, rotor balancing, installation of the control panel, nitrogen supply connection, cables connection.
Mechanical seals for oil and gas refinery, petrochemical applications

50-series TANDEM SEAL FOR HIGH PRESSURES AND SPEEDS (API 682, TYPE A)

Description
The new generation high pressure 50 series mechanical seal is designed for high pressure applications, such as crude oil, hot water, light hydrocarbons, including VOCs, at oil producing, oil transportation, oil refineries and petrochemical plants, power plants. Depending on the application, it is made single, tandem or double.

Typical applications include
- Main crude oil transportation pumps single and tandem
- Boiler feed water pumps single
- Multi phase pumps double
- Flashing hydrocarbons under high pressure tandem or double.

Materials

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Material Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seal faces</td>
<td>Tungsten carbide, Silicon carbide, Carbon, Special materials, Trembide 85, Trembide 50</td>
</tr>
<tr>
<td>Secondary seals</td>
<td>Viton®, ethylene propylene, Kalrez®, etc</td>
</tr>
<tr>
<td>Metal parts</td>
<td>SS304, SS316, SS321H, Special alloys</td>
</tr>
<tr>
<td>Springs</td>
<td>Hastelloy® C</td>
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</tbody>
</table>

Technical data

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>From 50 up to +260°C</td>
</tr>
<tr>
<td>Dynamic Pressure</td>
<td>Up to 100 bar</td>
</tr>
<tr>
<td>Static pressure</td>
<td>Up to 100 bar (200 bar with special design)</td>
</tr>
<tr>
<td>Linear speed</td>
<td>Up to 50 m/sec</td>
</tr>
</tbody>
</table>

Reccomended API plans for 50 series seal

<table>
<thead>
<tr>
<th>Plan</th>
<th>Description</th>
<th>Application guidelines</th>
<th>Seal systems</th>
</tr>
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<tbody>
<tr>
<td>52</td>
<td>Non pressurized external fluid reservoir with forced circulation</td>
<td>Most of combustible liquids, volatile flammable liquids (light and heavy hydrocarbons), alcohols, solvents, ethanolamine, etc</td>
<td>Barrier fluid tank with heat exchanger SO 1, SO 3, SO 12 or SO 20 with auxiliary valves</td>
</tr>
<tr>
<td>11, 13</td>
<td>Recirculation via throttling orifice to/out of chamber before the seal</td>
<td>VOCs, crystallizing fluids, fluids with solids</td>
<td></td>
</tr>
</tbody>
</table>

Seal advantages
- Excellent for high pressure applications
- Stationary springs allow for high speed
- Special wear resistant, non-sticking materials are available for seal faces (see below).

Special hard faces available
- Further resist deformation
- Anti stick, low wear properties
- Can operate in non lubricating fluids such as hot boiler feed water.
SO-12/20 BARRIER FLUID RESERVOIRS FOR DUAL MECHANICAL SEALS

Description

SO 3 reservoir (see below) is available in API 682 3rd edition 12 and 20 liter versions. The reservoirs can be used with flush plans API 52 or 53A as per API682. To operate under the API 53A Plan, the barrier fluid tank may be equipped with a manual fluid make up pump. A 12 or 20 liter reservoir is chosen depending on pump shaft diameter as required by the API 682 standard.

The reservoirs are fitted with:
- socket welded ANSI B16.11 #800 block valves;
- ASME B16.5 flanges for barrier fluid IN/OUT lines, drain, fluid make up and vent connections. Connections may be threaded if specified.

The reservoirs can be fitted with instrumentation and control for automatic checking of mechanical seal performance and pump shut down in case of mechanical seal failure. The instrumentation and control may include a level sensor, a pressure switch, and a temperature sensor. Sensors and switches are either intrinsically safe or explosion proof depending on customer's order.

Example of use: SO 20 Liter Reservoir in API 682 Plan 53A

<table>
<thead>
<tr>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
<tr>
<td>C</td>
</tr>
<tr>
<td>D</td>
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<td>E</td>
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<tr>
<td>F</td>
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<tr>
<td>G</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Brief Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat exchanger type</td>
</tr>
<tr>
<td>Design Pressure</td>
</tr>
<tr>
<td>Design Temperature</td>
</tr>
</tbody>
</table>
SO-1 BARRIER FLUID TANK FOR DUAL MECHANICAL SEALS

The SO 1 barrier fluid tank (reservoir) is designed to contain barrier fluid for a tandem or double mechanical seal, to provide its cooling and to control mechanical seal performance. The SO 1 barrier fluid tank can be used with API Plans 52 or 53 as per API682.

**TECHNICAL DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat exchanger type</td>
<td>Shell and tube, floating head, four way, vertical</td>
</tr>
<tr>
<td>Cooling power</td>
<td>Up to 3.8 kW</td>
</tr>
<tr>
<td>Barrier fluid volume</td>
<td>7.8 liters</td>
</tr>
<tr>
<td>Maximum barrier fluid pressure in reservoir</td>
<td>35 bar</td>
</tr>
<tr>
<td>Maximum barrier fluid temperature after mechanical seal entering reservoir</td>
<td>150°C</td>
</tr>
<tr>
<td>Triggering pressure of the installed safety valve</td>
<td>6 8 bar</td>
</tr>
<tr>
<td>Heat exchanger cooling area</td>
<td>0.55 m²</td>
</tr>
<tr>
<td>Heat exchanger effective volume</td>
<td>1.2 liters</td>
</tr>
<tr>
<td>Heat exchanger tube pack length</td>
<td>0.58 m</td>
</tr>
<tr>
<td>Heat exchanger tube cross section</td>
<td>16x2 mm</td>
</tr>
<tr>
<td>Heat exchanger tubes quantity</td>
<td>5x4=20 pcs</td>
</tr>
<tr>
<td>Heat exchanger cooling fluid</td>
<td>Water 15 30°C</td>
</tr>
<tr>
<td>Cooling water flow rate</td>
<td>0.6 1.2 m³/hour</td>
</tr>
<tr>
<td>Minimum service life</td>
<td>10 years</td>
</tr>
<tr>
<td>Weight</td>
<td>54 kg</td>
</tr>
</tbody>
</table>

**Design Features**
The SO 1 barrier fluid tank can be easily disassembled, so the heat exchanger can be mechanically cleaned.

Materials of parts:
- metal parts SS321H
- gaskets reinforced flexible graphite MG140 1 or PTFE

Barrier fluid tank is supplied with ball valves with fittings for welded connections to fit barrier fluid tubes.

The basic version of the SO 1 heat exchanger includes a 1/2" safety valve, a pressure indicator, and a level gauge.

The system can be fitted with instrumentation and control for automatic checking of mechanical seal performance and pump shut down in case of mechanical seal failure. The instrumentation and control version of SO 1 can additionally include a level sensor, a pressure switch, and a temperature sensor. Sensors and switches are either intrinsically safe or explosion proof depending on customer’s order.

1 Reservoir
2 Level indicator
3 Safety valve
4 Pressure indicator
5 Ball valve
6 Ball valve
7 Low level switch connection
8 Pressure switch connection
9 High level switch connection
10 Temperature indicator connection
11 Temperature sensor connection
The SO-3 barrier fluid tank (reservoir) is designed to contain barrier fluid for a tandem or double mechanical seal, to provide its cooling and to control mechanical seal performance. The SO-3 barrier fluid tank can be used with API Plans 52 or 53 as per API682.

**TECHNICAL DATA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat exchanger type</td>
<td>Water 15–30°C</td>
</tr>
<tr>
<td>Cooling power</td>
<td>Up to 2.0 kW</td>
</tr>
<tr>
<td>Metal parts material</td>
<td>ss304 or ss321H</td>
</tr>
<tr>
<td>Gaskets</td>
<td>Flexible graphite</td>
</tr>
<tr>
<td>Barrier fluid volume</td>
<td>6.5 liters</td>
</tr>
<tr>
<td>Maximum barrier fluid pressure in reservoir</td>
<td>35 bar</td>
</tr>
<tr>
<td>Maximum barrier fluid temperature after mechani-cal seal entering reservoir</td>
<td>150°C</td>
</tr>
<tr>
<td>Heat exchanger cooling fluid</td>
<td>Water, diesel, glycol 5–30°C</td>
</tr>
<tr>
<td>Cooling water flow rate</td>
<td>0.6–1.2 m³/hour</td>
</tr>
<tr>
<td>Weight</td>
<td>32 kg</td>
</tr>
</tbody>
</table>

**Design features**

The system can be fitted with instrumentation and control for automatic checking of mechanical seal performance and pump shut down in case of mechanical seal failure. The instrumentation and control version of SO-3 can additionally include a level sensor, a pressure switch, and a temperature sensor. Sensors and switches are either intrinsically safe or explosion proof depending on customer’s order.

1. Reservoir
2. Level indicator
3. Safety valve
4. Pressure indicator
5. Ball valve
6. Ball valve
7. Low level switch connection
8. Pressure switch connection
9. High level switch connection
10. Temperature indicator connection
11. Temperature sensor connection
General double seal piping system

Plan 53 (API 682)

Plan 52 (API 682)

Designations:
- MS  mechanical seal
- IN  barrier fluid IN
- OUT  barrier fluid OUT
- LS  level switch
- PS  pressure switch
- PI  filling vessel
- V  thermo siphon vessel

Also readily available: 53B, 23, 65 and 75 seal systems.
Description

In flush Plan 53B barrier fluid circulates to and from a double mechanical seal (Arrangement 3 seal). Prepressurized bladder accumulator provides pressure to the circulation system. Flow is maintained by the seal impeller. Heat is removed by the heat exchanger. A centralized or local auto top up unit is recommended for higher pressures.

Plan 53B advantages:

Plan 53B is recommended when barrier fluid pressure is above 10 bar to avoid the problem of nitrogen dissolving into the barrier fluid. In Plan 53B barrier fluid and nitrogen are physically separated by the elastomer bladder.
A Plan 53B system does not require a nitrogen line near the installed pump unit. Nitrogen is injected into the system only once with the required pressure. Only fluid make up is required during operation (automated top up is recommended for higher pressures).

Description

Flush Plan 65 is used to detect excess leakage from a single mechanical seal. Since mechanical seals at high pressure applications will leak, it is important to differentiate between normal leakage from a healthy seal and high leakage from a failed seal. This system does it and sends an alarm when the seal fails.
Mixer solutions

Description
Implementing standard technology of SD/RDT/SGDU seals for mixers enables TREM to design mixer seals with features:
- Bellows mixer seals for applications where elastomers can not be used
- High pressure mixer seals for pressures up to 200 bar
- Seals for sticky, abrasive, polymerizing fluids
- Seals for top, side, bottom vessel entry

Advantages
- Various designs to meet most demanding applications.
- Finite element analysis optimized seal rings to minimize deformation and emissions longer seal life.

Materials
| Seal faces | Silicon carbide, carbon, tungsten carbide, Trembide 85 |
| Secondary seals | EPDM, fluororubber, perfluoroelastomer, fluorosilicone, and others |
| Springs | Hastelloy®C |
| Metal parts | SS316, SS304, SS321H, Titan, and others |

Technical data
| Temperature | From 196 up to +425 °C |
| Dynamic Pressure | Up to 200 bar |
| Static pressure | up to 200 bar |
| Speed | Up to 10 m/sec |
Diamond-Like Carbon (DLC) coatings - Longer, Farther, Faster!
Coating technology developed in Russia.

Due to our innovative equipment of applying DLC-coatings, seals show high terms of reserve maintenance periods, resistance to work in extreme conditions withstand extremely adverse and over difficult operating conditions.

**Properties of offered DLC-coatings:**

- Hardness - 1200-4500HV depending on type of coating:
- Dry friction against steel – 0.05-0.12
- Coating thickness – 5-40 μm. As coating is the final process no machining is made after the coating.
- Wear resistance is 13-20 higher than of steel and 3-5 higher than of tungsten carbide.
- Porosity – less than 0.5%, so it’s good for corrosion protection.
- High chemical resistance to most acids and alkalis.
- One grade of coatings can be used to coat deep and blind holes.

Currently size of parts accepted for coating is limited to 390 mm (15‘’) in diameter and 900 mm (35‘’) in length.
Our customers comment on our products and services
(more then 60 feedbacks from our customers in total)

“… In 2003 the SD TREM Engineering "o ring free" seals were installed (API plan 52) at hot heavy hydrocarbon and residue pumps of tar cracking unit. The seals were installed without any additional heat exchangers or injection of cooled fluids into stuffing box. After 20 months of operation all seals are still running well without any problems.”

Sibneft Omsk refinery

“…Tandem SD seals work well (API plan 62) at hot residue pumps without barrier fluid and additional cooling and show the same durability as previously installed seals by Sealol(UK)”

LUKOIL Volgograd refinery

“Tandem SD seals have been operating since 2000 at the following applications without problems:
1. Vacuum distillation and visbreaking Russian VNM pumps (hot hydrocarbons, t up to 380 С)
2. Vacuum distillation and visbreaking USA Flowserve pumps (hot hydrocarbons, t up to 380 С)”

Nizhnekamsk refinery

“…SD seal high quality and good reliability make it first choice for hot pumps service…”

GAZPROM, Sosnogorsk gas plant
Our customers comment on our products and services
(more than 60 feedbacks from our customers in total)

“...High quality TREM mechanical seals and sealing materials are up to the most demanding standards and application conditions…”

YUKOS, Syzran refinery

“...TREM SD tandem seals were installed at new Flowserve hot oil pumps at visbreaking and FCC units. TREM seals durability is at least as long as original Flowserve seals or even better”

Slavneft Mozyr refinery

“TREM seals successfully used at MPC286 76 (Borneman)pumps for multiphase fluid gas pumping at oil fields”

Rosneft

“TREM Engineering SO seals not requiring an additional heat exchanger proved to be reliable solution for hot pump with coke particles in fluid”

SIBUR
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