

INSTALLATION, OPERATION,
AND MAINTENANCE MANUAL

TVSP

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1. GENERAL

1.1 Introduction

Before installation and operation of the pump set, the following instructions should be carefully studied. Particular attention should be paid to the sections dealing with installation and operation if damage, early failure or injury to site personnel is to be avoided. The pump type and serial number will be found on the data plate attached to the pump. When ordering spares, please quote the pump type and serial number.

1.2 Guarantee

Guarantee is valid according to the contractual agreements.

General remarks about safety

The pump's operating safety is only ensured in the case of use as specified.

See data sheet.

Hot or undercooled pump parts can lead to dangers; they have to be protected from contact.

If dangerous refluxes are possible after shut-down of the pump a reflux prevention device has to be installed.

Protective contact devices (coupling guard) have to be installed before start-up of the pump.

The removal of leakage of liquids endangering environment has to come up to the lawful regulations.

The wear at casing, wear ring and impeller has to be controlled and opportune replacement of worn parts has to be ensured.

Observe accident dangers at assembly and dismantling. Guarantee steadiness of the pump in case of assembly.

Protect assembly parts against fall. Support loose parts.

Connection flanges, thread bores and other openings have to remain closed during transport and storage.

2. SAFETY

These operating instructions contain basic instructions to be observed during installation, operation and maintenance. Therefore, these operating instructions must be read by the mechanical engineer and the personnel/operator prior to installation and commissioning. It should be continuously available at the machine/installation. Not just the general safety instructions stated under the heading "Safety" are to be observed, but also the more specific safety instructions (e.g. safety instructions for products meant for private use) included in these operating instructions.

2.1 Symbols for the safety instructions in the operating instructions

Safety instructions in this manual whose non-observance may lead to physical injury are identified by the general danger sign and are more explicitly identified by when warning for electric voltage



Safety instructions whose non-observance may endanger the machine and its functioning, are identified by the word:

ATTENTION



- Instructions that are placed directly on the machine, e.g.
- arrow indicating the direction of rotation
- symbols for liquid connections, etc.

have to be observed and must be legible at all times.

2.2 Qualification and training of personnel

The personnel responsible for operation, maintenance, inspection and assembly must be qualified for this work
The owner must have made precise arrangements with regard to responsibilities and supervision of his personnel
If the personnel does not have the required knowledge, he/she will have to be trained and instructed. If necessary and requested by the owner, this can be done by the machine manufacturer for an additional fee. Furthermore, the owner will have to make sure that personnel fully understands these operating instructions.

2.3 Dangers in case of non-observance of the safety instructions

Non-observance of the safety instructions may not just endanger persons but also the environment and the machine and may result in loss of any and all claims for damages

Non-observance may, for instance, lead to the following dangers:

- Failure of important functions of the machine/installation
- Failure of prescribed maintenance and repair methods

- Danger to persons by electrical, mechanical and chemical influences

- Danger to the environment by leakage of hazardous substances.

2.4 Working safely

The safety instructions in this operating manual, the existing national regulations for prevention of accidents and any working, operating and safety instructions applicable at the owner's company are to be observed.

2.5 Safety instructions for the owner/operator

- If hot or cold machine parts cause danger, they must be protected against contact on the installation site.
- Protection against accidental contact with moving parts (e.g. coupling) must not be removed when the machine is in operation.
- Leaking (e.g. at the shaft seal) of dangerous substances to be handled (e.g. explosive, toxic, hot substances) must be discharged without endangering either persons or the environment. Statutory regulations are to be observed.
- Dangers caused by electric shocks must be excluded (for more details, please refer to the regulations and the local electricity board).

The specific safety instructions in the following sections of this operating manual have to be observed.

2.6 Safety instructions for maintenance, inspection and assembly

- The owner has to make sure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel, who have thoroughly studied this operating manual.
- In essence, work on the machine must only be carried out when the machine is out of operation. The procedure described in the operating manual for putting the machine out of operation is to be followed at all times. The machine is to be protected against inadvertent start-up.
- Pumps or pump units handling health-damaging media must be decontaminated.
- Immediately after completion of the work all safety and protective devices must be refitted and/or be reactivated.
- When the machine is put into operation again the points described in the section on initial start-up are to be observed.

2.7 Prohibition to make unauthorized conversions or modifications

- Modifications or conversions of the machine are only permitted in consultation with the manufacturer. Original spare parts and accessories approved by the manufacturer help ensure safety. Liability for any consequences may be disclaimed when other parts are used.

2.8 Unacceptable operating methods

- Operating reliability of the machine supplied is only guaranteed if it is used for the intended purpose and in accordance with the data in point 1.3 of this operating manual.
- The limiting values specified on the data sheet must never be exceeded

3. TRANSPORT AND STORAGE

3.1 Transport and lifting

3.1.1 General

For all transport jobs the generally accepted technical regulations and instructions for prevention of accidents are strictly to be observed. The regulations in force are to be observed. An expert instructor is to be appointed who has to check that the lifting and transport work is carried out correctly.

3.1.2 Transport



Transport devices (including power-driven vehicles) are to be checked for their maximum permissible carrying capacity. See the shipping document for the total weight of the delivered goods. The load must be secured against displacement and damaging during transport.

3.1.3 Lifting

Inspection of the load pick-up device/ropes



Make sure that the ropes and lifting devices used are safe and undamaged. The lifting device and the ropes must have sufficient carrying capacity to lift the goods. The weight data of the supplied pump unit are indicated on the arrangement drawing or on the shipping documents.

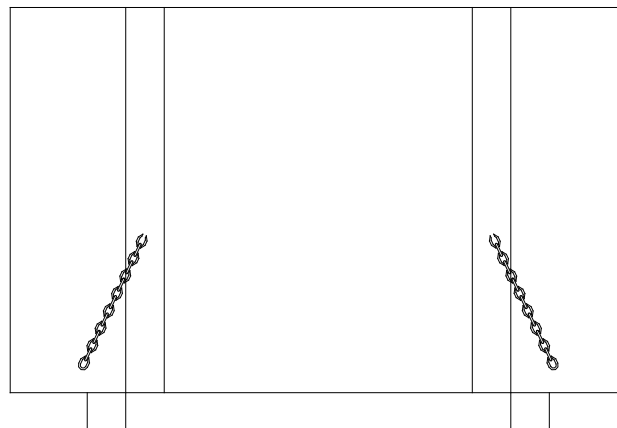
Never stand within the range of lifted loads

Sling points for crates

The sling points on closed crates have been marked. As the centre of gravity of a closed crate cannot be determined, the ropes must always be slung at the marked positions.

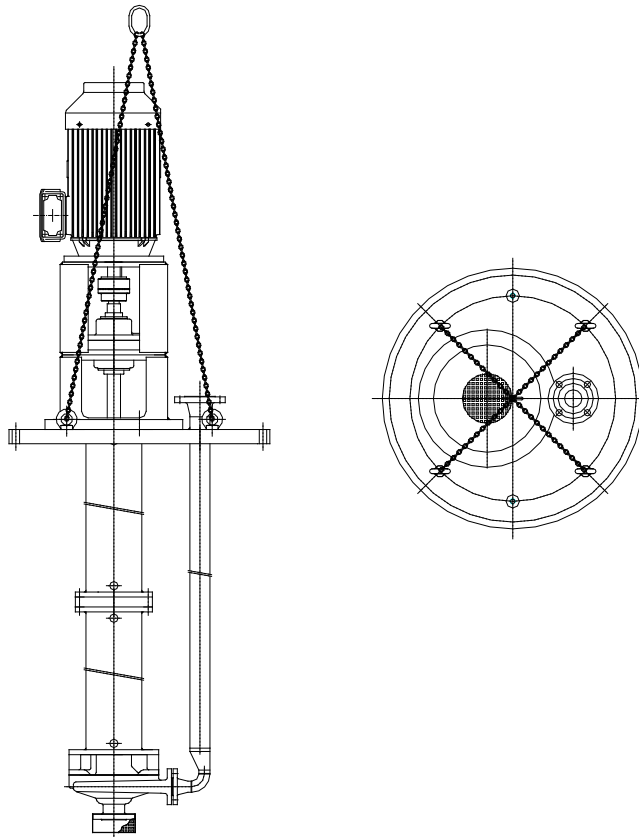
Shipping crate

Sling point as marked on crate



Sling points for pump units

If the base plate has lifting lugs or brackets, the unpacked unit is to be lifted by means of shackles at these places. Units up to a given weight can also be lifted with ropes that are placed around housing sections, for instance pump nozzles, bearing housings, motor housings etc.



Do not use eye bolts on pump parts and other parts of the pump unit to lift the completely assembled pump or even the complete pump unit. These bolts are only to be used to lift the individual parts during assembly and disassembly.

3.2 Preservation and storage

3.2.1 Preservation for shipment

Standard

Upon shipment of the pumps, non coated surfaces will have a light machine oil applied for protection.

ATTENTION: This protection is not meant for long-term preservation; maximum storage is six months.

3.2.2 Intermediate storage

Centrifugal pumps that are not immediately installed and commissioned after delivery may be stored for the period allowed by the preservation for shipping.

ATTENTION: To prevent condensation and thus corrosion (especially in gaps), and also storage damage and soiling, the storage space must be a dry room with a temperature as constant as possible. The selected position in the storage room should be clean and free from vibrations.

ATTENTION: Unfavorable ambient conditions will always affect the effective life of the preservation.

When the units are not or no longer in a special packing, the following rules are to be observed:

ATTENTION: In case of unfavorable ambient conditions, e.g. humid atmosphere, sharp temperature variations (day/night), acid or alkaline environments, risk of soiling, e.g. by sand, the connecting flanges of the pumps are to be closed air-tight with covers.

3.2.3 Prolonged storage – preservation

The following instructions are to be observed when the pump is to be preserved for a long period in the buyer's storage room on the site, when pumps are not used for a long period and for storage of spare pumps:

ATTENTION: When the pumps have already been used, the parts that have been in contact with the medium to be handled must be cleaned and, after having been dried, be wetted with preservative. This will usually require disassembly of the hydraulic pump parts.

I-Protection of bare, bright pump parts e.g.

- pump shaft
- the flange faces -coupling
- connections for auxiliary piping etc.

The use of normal lubricating oil as a rust inhibitor is strongly advised against. The mineral oil industry has developed special inhibitors for the preservation of bright pump parts; these agents are fluid in their original condition and can be applied by hand, with a brush, spray can or spray gun.

A wax-like film will remain after the solvent has evaporated.

The protective film can be removed with solvents or alkaline cleaning agents.

We recommend the rust inhibitors:

- Tectyl 506 from VALVOLINE
- Rust Ban 397 from ESSO

Other rust inhibitors of the same quality may also be used. Duration of protection 1-3 years, depending on the ambient conditions. Rust inhibitors will prevent rust, but will not remove it. The parts to be protected must therefore be clean and rust-free before the rust inhibitor is applied.

The parts must only be treated with the appropriate rust inhibitor after their surfaces have been thoroughly cleaned.

II -Protection of the interior pump spaces e.g.

- pump housing
- stuffing box spaces
- bearing housings, etc.

This is done with a liquid rust inhibitor on the basis of mineral oil with a viscosity of approx. 60-70 mm²/s

For a rust inhibitor we recommend:

for Perbunan (NBR), Viton (FPM) or Teflon (PTFE) seals:

- Mobilarma 524 from MOBIL
- MZ 110 from ESSO
- Ensis 30 motor oil from SHELL

for seals made of ethylene propylene (EPDM):

- Klüber Syntheso D220

III -Procedure for prolonged preservation

1. Stuffing box spaces

1.a Centrifugal pumps with mechanical seal

See seal manufacturers manual for instructions.

2. Pump-casing

First clean the pump flange faces thoroughly and preserve them with one of the rust inhibitors mentioned under I. In case of smooth flanges and flanges with ring grooves, fit gaskets; in case of grooved flanges, insert two seals in the groove and firmly blank off all nozzles with metal plates. Also blank off the connections for cooling water and circulation piping etc. with standard metal plugs using Molykote. Then fill the pump casing with rust inhibitor (see II).

Turn the pump shaft several times by hand during filling. Use the proper direction of rotation. Practice shows that with larger pumps the interior of the casing is only sprayed; if this is the case the preservation must be renewed at least every six months.

IV -Maintenance of centrifugal pumps put out of operation

If parts are filled with rust inhibitor (pump housing/stuffing box spaces/bearing housings), the condensation water is to be drained every six months and, if necessary, extra rust inhibitor must be added*. In order to avoid damage to the bearings due to corrosion, the pump rotor should be turned by hand simultaneously, so that the preservative oil is distributed over the running faces of the bearings.

ATTENTION: According to the information of the preservative manufacturers

the period of protection is 12 months, i.e. the rust inhibitors must be drained after 12 months and the spaces must be filled with new rust inhibitor*. If the rust inhibitor is used longer, this is entirely at the risk of the person responsible for storage of the machine. We recommend the use of maintenance sheets to ensure compliance with the maintenance instructions.

* If the interior was just sprayed, the complete preservation must be repeated every six months.

4. DESCRIPTION TVSP

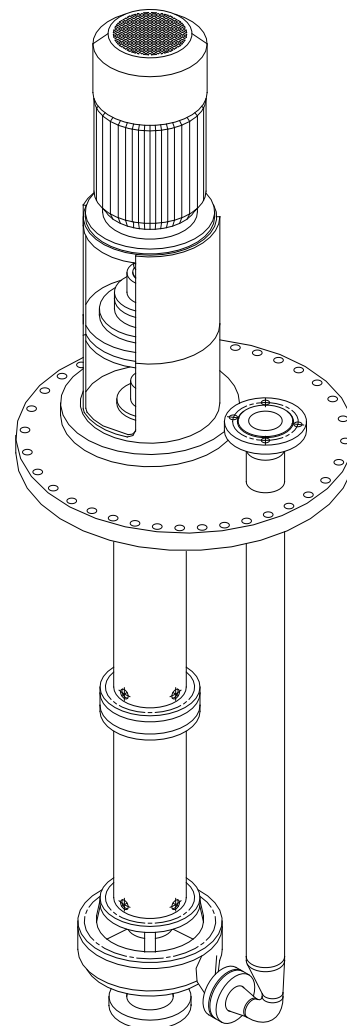
The submersible process pumps of the **TVSP** series are single-stage vertical, axial split, volute casing pumps, with a single-entry radial impeller. The suction branch is axial and the discharge branch is radial upwards. Depending on operating conditions, the pumps are hydraulically balanced by balance holes in the impeller. The pumps can be equipped with mechanical seals of most of any design. The seal-chamber dimensions are in accordance with API 682 table 2.3. Connections for sealing, flushing and cooling liquids are available in line with most of all API 610 plans. Fully machined discharge flanges to ANSI or DIN (ISO) are available. The one-piece heavy-duty all steel bearing bracket has grease lubricated antifriction bearings with labyrinth sealing. On request Oil Lubrication by means of a TRICO constant level-oiler, is available. The intermediate and pump bearings are normally lubricated by the pumped fluid. The bearing-housing and the shaft seal can be removed without dismantling the volute casing and discharge flange from the main pipework. When only a spacer coupling is used, the motor need not be removed. The direction of rotation is clockwise seen from the driven end. The TVSP pump design meets the requirements of API 610-10th edition and API 682, such as one piece pump shaft (depending on pump length), bearing span and bearing bracket design.

4.1 Applications

Applications

The TVSP pumps are mainly used for pumping clean or polluted, cold or hot, chemically neutral or aggressive liquids.

- In refineries
- In petrochemical plants
- On pressurized vessels, knock-out drums, slops tanks and similar applications.
- Where leakages are not allowed for environmental protection reasons



5. INSTALLATION OF THE PUMP.

5.1. Mounting of the pump.

The principal dimensions, position of foundation bolts, connections dimensions etc. are shown on the corresponding dimensional drawing.

Suitable lifting devices must be available for installation and repair work. Good lighting is important and sockets for portable lights should be available. The pump should be readily accessible from all sides.

The pump foundations and type of installation should be designed so that vibration is kept to a minimum both during operating and when the pump is at rest, otherwise the pump life will be reduced.

The protective plastic plug covering the flanges and any threaded connections should be left in place until the pump is ready for installation. Serious damage may result if dirt or foreign objects are allowed to enter the pump. The foundation or any other necessary building work must be finished, set and dried. Roughen and clean the foundation.

All preliminary work for erection must be completed with large units, suitable door and wall openings are to be provided for transport to the installation site.

If a drain is mounted :

A drain must be provided so that gland leakage cooling water (open system) and liquid drained from the pump during overhaul can be led away.

The draining of the pump respectively the disposal of the leakage for pumps delivering toxic, explosive hot or in any other ways dangerous fluids must not lead to any endangering of operator(s) and environment.

Installation of pump and driver :

Insert foundation bolts into the holes in the base plate and tighten the nuts a few turns.

Place base plate with pump and driver on the foundation.

Align the pump with jackscrews or with the aid of steel shims of varying thickness. The pump-unit should be installed in such a way, that the shaft is running in a vertical position. A maximum of 0.5mm/meter would be acceptable.

Tighten the foundation bolts when the concrete has set. Check vertical alignment again, if the position of the pump has changed, correct the alignment.

5.2. Discharge pipework

General.

Pipe diameters will have already been determined at the planning stage and many factors unknown to the pump manufacturer will have been taken into account. As a general rule the liquid velocity should not exceed 3 m/sec. in the discharge pipework. A few useful hints are given below which should be observed when the pipework is installed.

ATTENTION: In case the possibility of dangerous recirculation may occur after shut-down of the pump, especially with "emergency trip out"; back-flow preventors have to be built in.

Assembly.

ATTENTION: The pipework must be supported in an adequate manner to ensure that no bending moments or stresses caused by the weight of the pipework or thermal expansion are transmitted to the pump flanges (install an expansion piece). The pipework flanges must be parallel to the pump flanges.

The pieces should be designed and constructed so as not to obstruct the free flow of the liquid. The transition

from small to large pipe diameters must be gradual. As a general guide the length of a concentric taper piece must be 5- 7 times the difference in pipe diameters.

Where flanged joints are used ensure that the gasket is correctly centred so that the bore of the pipe is not restricted.

Sudden reductions in pipe cross sectional area and sharp bends should be avoided, as these greatly increase the frictional resistance within the pipework.

Cleaning the pipework.

ATTENTION: Before a pumpset is commissioned, all traces of foreign bodies and impurities must be carefully flushed out of the supply tank and pipework. Where pipework has been welded, all welding slag etc. must be removed.

Pressure test.

ATTENTION: The pipework should be pressure tested in accordance with statutory regulations .

Pipe fittings.

ATTENTION: Fittings having the same nominal bore of the pipework should be used. If the pump branches have a smaller nominal bore than the fittings suitable taper pieces should be used.

5.3 Auxiliary piping / Auxiliary devices.


General.

Auxiliary equipment is used to monitor the pump (measuring equipment for pressure, temperature etc.) and to maintain operation (cooling, flushing, sealing etc.). The extent depends on the application and installation requirements. For type, position and dimensions of the ancillary connections please see installation drawing.

In case the failure of any auxiliary devices (e.g. cooling, circulation) may lead to an inadmissible pressure build-up in the pump suitable safety devices have to be installed by user (e.g. alarm, emergency shut-down or similar).

ATTENTION: Do not mix up connections. After laying the pipes (and also after repairs) , check the pipe runs. The following instructions may be used as a guide in so far as they apply to the pump as delivered .


Auxiliary piping


 Drainage of the pump casing can be effected by leading a pipe into the drip tray of the bed plate or into a collection pipe. Isolating valves must be installed in the pipe and must have a pressure rating at least equal to the rating of the casing.

The draining of the pump from toxic, explosive, hot or otherwise dangerous ~ fluids must not lead to any endangering of operator(s) and environment.

- Gland Leakage from the shaft seal can also be led into the drip tray or collection pipe.

The leakage of dangerous fluids has to be drained or quenched in such away as to prevent any dangers to persons and environment.

-  Cooling may be required and will be indicated on the arrangement drawing or separate cooling water diagram. (Cooling water pipes should be arranged for entry into the cooling chamber at the lowest point and exit at the highest point). Do not confuse inlet and outlet connections. Regulating valves are installed in the inlet pipes to regulate the cooling water quantity. In open systems the outlet drainage is to be led via a drainage-collecting funnel.

-  Flushing and / or sealing may be required and will be indicated on the arrangement drawing or separate diagram. Should connections be necessary to a heat exchanger, pressure transmitter or sealant tank then a vent must be fitted at the highest point. If thermosyphonic action is used the pipes must be as large as

possible. The pipework must rise continuously and not have any sharp bends.

- Quench: In case the necessity arises to quench any leakage from the mechanical seal see 1.3.8. for information on quench media and quantity.



Pressure measuring equipment.

The start-up and monitoring of the operating point of the pump is made easier with pressure gauges. See 6.1. and 6.3. Pressure gauges should be mounted on a common gauge panel and connected to the tapped connections in the pump branches or adjacent pipework using a hydraulic tube with an expansion loop. Isolating and vent valves should be installed in the pipework for ease of maintenance.

Electrical connections.

Electrical connections for motors and controlling devices may only be implemented by skilled personnel. The instructions of the electrical equipment manufacturers have to be observed as well as the valid national regulations on electrical installations and the legal regulations of the local power suppliers.

Note: In accordance with local-safety standards these instructions must form part of every operating manual. Safety instructions for pumps which operate in the partial load region. The following information may be disregarded, if the pump supplied never runs in the partial load region.

Minimum flow device.

General.

ATTENTION: In the partial load region (when operating the pump near zero flow) almost the total pump power is imparted to the flow as thermal energy. If this flow is less than a certain minimum (see 1.3.1.), heating will occur and continue until the liquid boils, causing severe damage to the impellers and casing wearings leading to eventual breakdown of the pump. In case of mechanical seals a destruction of the seal parts has to be expected in addition. To avoid this there must always be a certain flow of liquid through the pump. A device must be fitted in the discharge pipe immediately after the pump, which guarantees minimum flow even with closed discharge valve. The following devices have proved successful in use:

- a. Automatic leak-off-non-return valves operate such that as the flow decreases the minimum flow line automatically opens and an integral throttle element controls the minimum flow. The contrary happens on increasing the capacity. The minimum flow line is directly flanged to the automatic leak-off-non-return valve.
- b. Constant by-pass. A by-pass line is fitted between the pump and the discharge valve, which also leads back to the suction tank. A throttle is built into the pipe which determines the flow rate. With this type it should be remembered that the by-pass quantity also flows with the discharge valve open, which reduces the efficiency of the pump.

It must be considered carefully whether it is worth buying an automatic leak-off-non-return valve.

Minimum flow line or by-pass.

ATTENTION: The minimum flow line is not supplied by the pump manufacturer. It must be provided by the operator. The pipe must always lead from the pump to the suction tank. For shutdown and disconnection for maintenance, a shut-off valve must be fitted in the minimum flow line, but must be locked open before commissioning. If several pumps are installed to operate in parallel and the minimum flow pipework connects into a common header, it is necessary to install a non-return valve in each feed piping.

6. OPERATION.

6.1. Commissioning

ATTENTION: The items described individually have to be carried out, as far as applicable, step by step during commissioning.

With electric drive it has to be assured by qualified personnel that the necessary protection measures work. Earthing, reset, residual current failure operated device etc. have to be ready for service acc. to approval by skilled personnel.

Start -up and operation of the pump

- a. Put the auxiliary devices, if installed, into operation (e.g. sealing pressure), open the valves in the auxiliary piping (do not open the quench line until the pump is in operation), vent the pressure gauge.
- b. Start with an unpressurized system.
 - Close the shut-off valve in the delivery piping {minimum flow must be ensured}.
 - Start the drive machine.
 - Slowly open the shut-off valve in the delivery piping until the differential pressure has dropped to the value indicated on the data sheet.
- c. Start with the available system pressure {provided there is a non-return valve in the delivery piping}.
 - Start the drive machine with opened shut-off valve.

Warning: Also in case of installations with fluctuating system pressure, the differential pressure must not remain significantly below the design point. Attention: the delivery side of the pressure gauge indicates the differential pressure plus the inlet pressure.

- d. Pay attention to the amperage. The amperage indicated on the motor rating plate must not be exceeded.

Unacceptable modes of operation

Overloads must be avoided, because they may cause failure of a component due to excessive mechanical stress. Such overload situations arise when the pump is not used for the intended purpose or not in accordance with the specifications. This includes:

- exceeding the maximum permissible speed
- exceeding the maximum permissible inlet pressure
- exceeding the maximum permissible temperature
- exceeding or remaining under the operating range of the pump
- operating the pump when the pump interior is not sufficiently vented
- operating the pump without the required safety devices {safety valves, electric overload protection etc.}
- operating the pump with a closed or strongly throttled shut-off valve in the delivery piping without a minimum flow control having been installed (start-up excepted)
- operating the pump with a closed shut-off device in the inlet piping (running dry)
- operating the pump to handle media for which the pump materials are not suited
- operating the pump in the wrong direction of rotation
- operating the pump when the bearings are insufficiently lubricated or with the wrong lubricant.

These and other unacceptable modes of operation may cause severe damage to the pump and other parts of the installation. Pressurized parts could burst and persons within the danger zone could be hit by fragments or by the release of medium that may be hot, aggressive or toxic. This constitutes a lethal danger.

6.2 Stopping (stick to the sequence below)

- 1) If the delivery piping has a built-in non-return valve, the shut-off valve in the delivery piping can remain open when the pump is briefly stopped. If the pump is stopped for a prolonged period of time, and in case of repair work -if there is no built-in non-return valve -the shut-off valve in the delivery piping must always be closed.
 - 2) If installed: close the quench piping.
 - 3) Stop the drive machine, check that the rotor runs out smoothly.
 - 4) If installed: close the valves in the auxiliary piping, with the exception of the cooling water valve, which may only be closed after the pump has cooled down.
 - 5) In case of frost risk and prolonged standstill the pump housing and cooling spaces must be emptied and, if necessary, be preserved.
- Drainage of toxic, explosive, hot or otherwise hazardous media to be handled must not endanger the operators or the environment.

6.3 Monitoring

Checking the duty point (design point)

Check the following points, especially when commissioning the machine:

- determine the speed
- read the pressure gauge on delivery side; deduct the inlet pressure (pressure gauge on suction side)

After conversion, this value (differential pressure) has to correspond with the head stated on the pump rating plate at the corresponding speed.

Pump head (m) $\frac{\text{Differential pressure (bar)} \times 10\,200}{\text{Specific mass of medium to be handled (kg/m}^3\text{)}}$

Diff. press. (bar) $\frac{\text{Pump head (m)} \times \text{Spec mass of medium handled (kg/m}^3\text{)}}{10\,200}$

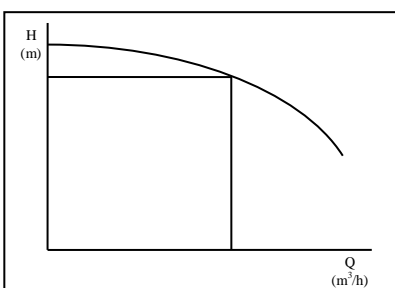
- Do not allow the differential pressure to drop below the indicated value, because otherwise the permissible max. capacity is exceeded and the flow rate may collapse.

Determining the flow rate

Pump characteristic

The pump characteristic sheet can be used to determine the flow rate; this is done on the basis of the delivery head (m), which can be calculated from the differential pressure.

Pump characteristic curve:



First, find the calculated value of the delivery head on the characteristic sheet. From that point, determine the intersection of the horizontal line and the curve. The corresponding flow rate can be read vertically below the point of intersection.

7. MAINTENANCE AND OVERHAUL.

7.1 Pump general.

ATTENTION: The pumpset should be checked for smooth, vibration-free running in service. Pay attention to abnormal running noises. If any vibrations, unusual noises or faults are observed stop the pumpset at once. Ascertain the cause and rectify (see 8.1./8.2.).

Monitor ancillary equipment during operation: (if fitted)

Gauges: pressure and temperature at regular intervals.

Cooling: flow and temperature.

Flushing/Sealing: pressure, temperature, (quantity).

Any deterioration in pump performance not caused by alteration or furring of the pipework is probably due to wear of the pump internals. The pump should be taken out of service and overhauled. See section 7.4. to 7.6. for details on overhauling the pump.

It is recommended to enter operating data and also data on lubrication, repairs etc. in an operating log.

Standby pumps should be started at regular intervals to ensure their readiness for immediate service. During a prolonged shut-down the pump (and cooling system if fitted) should be drained and protected.

7.2. Shaft seal.

Mechanical seal.

Mechanical seals do as a rule not require maintenance. See seal manufacturers manual. It is unnecessary to check a well functioning mechanical seal at regular intervals.

Checking is required only when the sealing shows strong leakage.

In order to prevent a long standstill in the operation in case of sealing defects a set of spare parts for the sealing should always be kept in stock.

Mechanical seals are to be handled always with extreme care; the slightest damage at the sealing surfaces of the sliding rings produces already a leaking seal. The mounting of the secondary sealing rings (o-ring or anything of the sort) should equally be performed carefully such as to avoid damage. As mounting help when pushing up the sealing rings no oil, grease or molycote paste should be used. It is advisable to use molycote powder or glycerol. Mechanical seals in which the rotating sealing part is carried by means of a coil spring are dependent upon the direction of rotation. At mounting it is therefore required to apply the right coil spring. When seen against the rotating sealing surface a rotating part running to the right requires a coil spring wound to the right and a rotating part running to the left a coil spring wound to the left.

7.3 Bearings

The bearings of the TVSP pump are executed with oil lubrication, controlled by a TRICO constant level oiler

Centrifugal pumps are often exposed to heavy stress caused by continuous operation and heavy forces (radial, axial). Therefore, a proper oil quality is a prerequisite for a long bearing life and trouble-free operation.

The oil must not contain any foreign substances, acids or resins.

Since, with antifriction bearings, the self-heating of the bearing due to fulling plays an important role, and since, on the other hand, an oil viscosity of at least 12 mm²/s at operating temperature of the bearing is required for a sufficient lubrication film, the oil viscosity shall be as follows:

Temperature °C		ISO Viscosity class	kin.visc.in mm ² /s 40°C	Ignit. point
Sump	Bear. frame			
>40 - 65	>60 - 85	VG 46	45	185 °C

ATTENTION When during operation under extreme conditions (high ambience temperature, high bearing load etc.) a higher temperature is found at a certain measuring point, oil of the viscosity class ISO VG 68 has to be used. In case of bigger deviations contact the service. Besides we recommend to carry out the lubrication renewals under extreme bearing temperatures as described below in change intervals of 4000hours.

Oil filling

In case of first commissioning or of an overhaul, drain and clean all the oil after 10-15 hours of operation. If further pollution by foreign substances and water is low, the oil should normally be changed every 8000 operating hours. The oil level is checked using a sight glass and a TRICO constant level oiler regulates the oil level.

Sleeve type bearings

Before assembling the bearings, lightly grease for the first start up.

Intermediate and or pump bearings are free of periodical maintenance. During the above mentioned inspection of the whole pump the bearings have to be disassembled and cleaned to check the clearances.

After assembling the pump the flushing/lubrication of the intermediate and or pump bearings has to be checked, for instance by disconnecting the piping near to the bearing for a short time.

If the bearings are grease lubricated by means of an automatic grease pump than the reservoir should be refilled when it is empty for % part. There has to be enough grease in the reservoir for proper functioning at all times. Per bearing approximately 1 kilogram grease will be used each 500 hours.

Lubricant capacities of external source for various lubrication systems per bearing		Bearing diameter		
		Ø45	Ø55	Ø65
Clean water flushing L/min. Carbon bearings	3000 rpm	10	10	10
	1500 rpm	5	5	5
Clean water flushing L/min. Rubber bearing	3000 rpm	15	20	25
	1500 rpm	15	20	25
Grease lubrication cm ³ /hour Bronze bearings	3000 rpm	4	5	6
	1500 rpm	2.1	2.8	3.5

7.4 Repairs

If the pump has to be repaired, it would be useful to buy the required spare parts (wear parts) in good time to avoid prolonged standstill. When ordering spare parts, describe the part in detail (article No., Pos. No. and description), state the pump type and the Truflo pump number.

See the pump's nameplate and/or the Bill of material and cross sectional drawing provided.

TVSP range pumps are manufactured with utmost care and should be dismantled and assembled by skilled technicians only.

Trained Service mechanics are available on request to carry out mounting and repair work.

Where repairs are carried out by the operator's own personnel or by specialist mechanics, it must be ensured that the pump is fully drained and cleaned.

This particularly applies to pumps which are sent for repair to our factory or one of our service workshops. We must refuse acceptance of repair work on pumps filled with fluid, for the protection of our staff and for environmental reasons. Otherwise we must invoice the customer/operator for the costs of environmentally compatible disposal.

Where repairs are to be carried out on pumps which have been operated with hazardous substances¹ and/or environmentally harmful media, the customer/operator must inform its own personnel on site, or our personnel where repairs are returned to our factory or a service workshop, without being specifically requested to do so.

In such cases a verification of delivery material, for example in the form of a DIN safety data sheet, must be submitted to us together with the request for a Service mechanic.



¹ Hazardous substances are:

- Toxic substances
- Health—endangering substances
- Corrosive substances
- Irritants
- Explosive substances
- Fire—inducing substances
- Highly flammable, easily flammable and normally flammable substances
- Carcinogenic substances
- Substances impairing fertility
- Genetically distorting substances
- Substances in other ways hazardous to humans

7.5 Disassembly

1) Motor

a) Remove couple bolts and the motor platform and place the motor on the floor so that its shaft does not contact the floor.

2) Pump

a) Drain the lubricant completely and disassemble all of the piping.

b) Remove the motor platform from the discharge casing.

c) Loosen the adjustment nut from the shaft and remove casing from the shaft.

d) Remove the cover of the bearing housing and then the bearing holder from the shaft. Take away the bearing from the holder.

- e) Remove the bearing housing from the discharge casing, and then disassemble bearing seats, bearing outer rim and oil – holding pipe from the housing.
- f) Loosen the gland and remove its packing from the packing case (in case of packing).
- g) Disassemble packing case, remove sump cover plate and lift away from the pump.
- h) Clamp the middle of the column pipe and the discharge casing from the pipe.
- i) Remove bearing retainer and shaft.
- j) Lift the column pipe again using hoist. Clamp the bottom pipe with clamp untied from the middle part and disassemble column pipe and its mid-shaft and shaft of column.
- k) Clamp the sump guide casing from which column pipe shall be removed with the mid-shaft removed from the pump shaft.
- l) Lift the pump shaft with a hoist and place it on a flat surface.
- m) Disassemble the strainer.
- n) Loosen the cap nuts and remove impeller from the shaft.
- o) Remove key, sleeve and coupling from each shaft.
- p) Remove bearing bush from casing and bearing retainer.

7.6 Inspection of the internals

Check all internals for wear, repair or replace them, if necessary.

Impeller, gap clearance

Check the impeller for damage by corrosion and erosion. Replace it, if necessary. Determine the gap clearances. If the permissible gap clearances are exceeded, replace the impeller and wear rings; if necessary, mount a new impeller.

The permissible clearance between the impeller wear ring and casing wear ring in relation to the diameter is shown in the table below.

Diameter at impeller sealing clearance (mm)	Up to 75	> 75 < 140	> 140 < 200	> 200 < 320	> 320 < 400	> 400 < 600	Index
Minimum clearance in mm* (with new parts)	0.3 0.5	0.4 0.6	0.5 0.7	0.6 0.8	0.7 0.9	0.8 1.0	1) 2)
Max. clearance in mm* (with worn parts)	0.9 1.5	1.2 1.8	1.5 2.0	1.8 2.5	2.0 2.8	2.5 3.0	1) 2)

* clearance in relation to diameter

1) gray cast iron or soft nitride steel

2) stainless steel

Shaft concentricity.

Lay the shaft on the bearings (use prisms or rolls) and check for radial run-out (max. permissible run-out 0.025 mm). Ask the manufacturer for instructions when the radial run-out exceeds the maximum tolerance.

Stuffing box packing

- Check the 0.5 shaft sleeve for scratches and rework, if necessary*, if the new diameter is not more than 1 mm below the nominal size (measure the nominal size at a place on the shaft sleeve undamaged by wear). Adapt the packing rings to the new sizes. In case of sealing at higher pressures (more than 10 bar), always replace scratched sleeves by new sleeves of the nominal size.
- Check the clearance between the gland and the shaft sleeve.

Lipseal

Check the shaft surface. The shaft has to be renewed or reconditioned when the roughness surpasses 5 micron. The tolerance of the diameter has to be in accordance with ISO tolerance class H 11 .The lip seals has to be renewed every 8000 hours or max. 2 years.

Antifriction bearing.

Clean bearing with e.g. petrol and check on damage, clearance etc.

Sleeve bearings.

Clean bearings and check clearance, damage etc.

The maximum clearance amounts to 0,24 mm. measured diametral.

The maximum clearance for rubber bearings amounts to 0,3 mm.

Other components.

Check wear, damage etc. and if necessary replace them by new ones.

Assembling

The assembling takes place in reverse order as the disassembling. When assembling the o-rings and packings should always be renewed.

In order to facilitate the assembling all contact surfaces should be thoroughly cleaned and greased lightly with molycote paste, with the exception of those on which o-rings are slid.

Sealing surfaces and running surfaces should be cleaned too before assembling.

O-rings may not get into contact with grease, oil or molycote paste. When mounting use glycerol or molycote powder.

During assembling the adjustment measures, which has been mentioned in the sectional and dimensional drawing, should be hold on exactly.

7.7 Assembling and disassembling.

7.7.1 Adjustment of impeller's axial position

For vertical pump adjustment of the impeller's axial position is a three-step procedure that requires manual rotating of the screw (Position 097.0) in two directions:

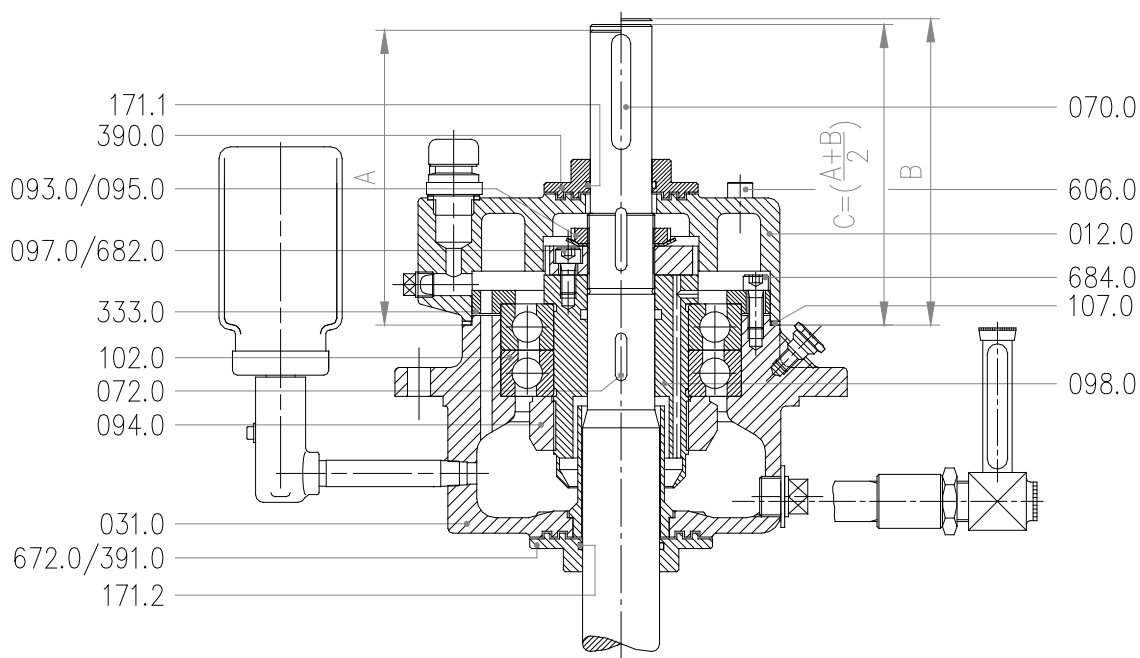
- First, clockwise
- Then, counter clockwise

In either case until the screw stops.

Before starting to adjust the impellers position the labyrinth-ring (position 390.0) and the bearing cover (position 012.0) have to be taken of. Also make sure that the labyrinth-ring (position 391.0) is lowered far enough not to be in the way when pulling up the shaft.

1. Rotate the adjusting nut (097.0) counter clockwise until the impeller's lowermost position is reached, i.e. until it touches the pump wall. When the nut is loose from the ball bearing sleeve (098.0) measure the distance (A) from shaft end to bearing housing with a depth-gauge.
2. Rotate the adjusting nut (097.0) with a hook spanner clockwise until the impeller's uppermost position is reached i.e. until the impeller touches the pump wall. When the nut fails to move any further measure the distance (B) from shaft end to bearing housing with a depth-gauge.
3. Calculate the distance (C) to position the impeller in the very middle of the casing by adding distance (A) and distance (B) and dividing by 2. Rotate the adjusting nut (097.0) counter clockwise till distance (C) is realised. Position the nut (097.0) so that the boltholes correspond with the thread holes in the ball bearing sleeve (098.0). Fix nut (097.0) to the ball bearing sleeve (098.0) with the socket head screws (682.0). Then put lock ring (095.0) on the shaft and screw nut (093.0) tight and lock with the lock ring.

After adjusting the impeller's axial position the bearing cover and gasket can be put back on as well as the labyrinth-rings. Adjust the labyrinth-rings so, that they have a clearance of approximately 1.0mm to the bearing housing / bearing cover



8. OPERATING FAULTS

Hydraulic or mechanical problems can seriously affect the operation of a centrifugal pump. In addition, there are other Operating faults that are caused by the installation itself.

The various types of operating faults are usually related to some extent. It is, therefore, expedient to list and compare the symptoms and the possible causes. Nearly always it will be possible to find an immediate solution to the individual operating faults.

8.1 Symptoms

Pump does not pump
Flow too small

Key no.

1-2-3-4-5-6-11-12-14-19-20-21

| 2-3-4-5-6- 7 -8-9-10-11-12-14-

15-17-18- 20-21-22-30-31

Pump develops too little pressure

5-12-14-1 5-18-20-21-22-29-30-31

Pump loses prime after start-up

2-3-5-6- 7-8-11-50*-51 *

Power requirement too high

13-14-15-16-17-.18-22-23-25-26-

27-28-29-30-53 *-54 *-55 *

Pump vibrates or causes too much noise

2-3-4-9-10-11-19-21-23-24-25-26-

27-28- 29-31-32-33-35-37 -38-39-
40

Bearing wear too quickly

23-25-26-27-28-29-32-33-35-37-

38-39- 40

Pump becomes hot and seizes

1-4-19-20-22-23-25-26-27-28-29-

32-33- 35-37-38-39-40

Strong leakage of mechanical seal

29-32-33-41-42-43-44-45-46-47

Cover of mechanical seal is too hot

41-42-43-49

Increase in sealant liquid.

47-48

Undesired icing of mechanical seal

46

Stuffing box drips too much

* 13-23-25-27-32-33-52-53-54-56-

57-58

* Only for pumps with stuffing box

8.2. Possible causes of faults.

1. Pump not vented
2. Pump or suction pipe not completely filled with liquid
3. Suction lift too large
4. Too little difference between suction and vapour pressure
5. Too much air or gas in the pumped liquid
6. Air pockets in the suction pipe
7. Air leaking into the suction pipe
8. Air leaking into the pump through the shaft seal

9. Foot valve too small
10. Foot valve partly blocked
11. Suction mouth is not submerged deeply enough into pumped liquid
12. Speed too low
13. Speed too high
14. Wrong direction of rotation
15. Total system head higher than the rated pump head
16. Total system head lower than the rated pump head
17. Density of the pumped liquid differs from the specified value
18. Viscosity of the pumped liquid differs from the specified value
19. Operation with very low flow
20. Parallel operation of pumps that are not suitable
21. Foreign bodies in impeller
22. Pump not running at operating point
23. Alignment faults
24. Foundation too weak
25. Shaft bent
26. Rotating and stationary parts are rubbing
27. Rotor position incorrect
28. Bearings loaded during assembly
29. Bearings damaged

30. Wearings Worn
31. Impeller damaged
32. Shaft not running centrally as a result of worn bearings or incorrect alignment
33. Imbalance of rotor, which causes vibrations
34. No liquid available to cool the water-cooled shaft seal or stuffing box
35. Excessive axial thrust
36. Too much grease or oil in the bearing bracket, resulting in a very high bearing temperature
37. Inadequate lubrication
38. Incorrect fitting of bearings or damage during fitting
39. Dirt getting into bearings
40. Bearings rust through penetration of water into the bearing bracket
41. Evaporation in the area of the seal rings; cooling insufficient or failed
42. Double-acting mechanical seal running dry on atmospheric side, sealing liquid or sealant tank liquid is missing

43. Mechanical seal not vented
44. Formation of crystals; flushing insufficient or missing
45. Solids are deposited, glue up sealing rings or springs; flushing insufficient; cyclone separator does not work
46. Heating of shaft seal housing or mechanical seal cover caused by insufficient cooling or lubrication



47. Failure of mechanical seal by spring being broken; seal rings damaged; auxiliary gaskets (o-rings, etc.) defective
48. Double-acting mechanical seal leaking on product side; sealant or sealing pressure too low
49. Sealing liquid or sealant tank liquid unsuitable
50. Gland sealing water pipe blocked.

51. Incorrect positioning of lantern ring in the stuffing box So that the water cannot flow and no seal is achieved
52. Shaft protection sleeve worn or grooved

53. Packing incorrectly fitted
54. Use of unsuitable packing for operation conditions
55. Stuffing box gland too tight, therefore no flow of pumped liquid to lubricate the packing
56. No liquid available to cool the water-cooled stuffing box
57. Gab between shaft and housing too large at base of stuffing box, where by the packing is pressed into the pump pressure
58. Dirt or sand in the sealing liquid resulting in scoring of shaft protection sleeve